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Day 1, WEDNESDAY JULY 6

P1-A-1 Bilateral and unilateral training does not affect classification accuracy for prosthesis control

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BACKGROUND AND AIM: Most powered transradial prostheses use the amplitudes of surface electromyography (EMG) signals from the forearm flexors and extensors to control the opening and closing of the hand. Users must co-contract their forearm muscles as a switch to rotate the wrist. This operation can be slow and is not intuitive, as the user is required to use the same muscle contractions to control different functions. Pattern recognition based controllers perform movements based on EMG patterns, rather than using individual EMG from the residual muscle. Therapists use a series of movements to train prosthesis users to successfully operate their devices with the assumption that the intact limb is considered the dominant side while the affected limb (whether by congenital or traumatic occurrence) becomes the nondominant side. The purpose of this work was to examine upper limb movements to determine 1) if there is any decrement to pattern classification accuracy due to the type of movement (bilateral versus unilateral) and 2) if limb dominance affects pattern classification accuracy. Understanding the impact of these movements may help to improve training protocols for upper limb prosthesis users. METHODS: Ten able-bodied males (mean age = 31.6 ± 12.0 years) participated in this study. A high-density (HD) EMG system (REFA, TMS International) was used to evaluate four different hand movements (?hand open,? ?hand closed,? ?pronation,? and ?supination?) at a self-selected medium contraction level. Participants were asked to complete the movements in two conditions, bilateral (both hands together) and unilateral (one hand at a time). Participants were asked to indicate their dominant limb. Surface electrodes (n=32) were placed over the forearm to collect HDEMG data. Pattern classification accuracies were computed for all movements using an LDA pattern classifier. RESULTS: The mean classification accuracies for each movement and condition are shown in Table 1. Analysis of Variance indicated that there was no statistically significant difference in classification accuracy due to condition (bilateral vs. unilateral) or limb dominance. CONCLUSION: The results suggest that high pattern classification accuracy can be achieved and that there is little to no impact due to the type of movement completed, whether it is with one hand or two. In addition, limb dominance did not affect classification accuracy. This suggests that therapists may not be limited to specific actions for user training.

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P1-A-2 Assessment of muscular fatigue and force by double normalized surface electromyography spectrum - proof of concept

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A new model was developed to assess muscular force and fatigue by surface electromyography measurements. This model includes a double normalization of the frequency-amplitude-spectrum (FAS) from the SEMG. It allows discriminating between simultaneously changing force and fatigue levels and is based on the fact that force and fatigue induce different but predictable pattern in the changing FAS. An individual baseline FAS and several normalization measurements allow to estimate transform functions for fatigue and force in relation to the mentioned baseline FAS. These "normalizing" or "convolution" functions enable estimating the magnitude of applied muscular force and the level of fatigue by the FAS of an occupational task. Simplifying these functions to normalized amplitude relations in selected frequency bands is also possible if larger errors are acceptable. Here, a proof of concept of this model will be provided for isometric muscle contraction of two muscles of the shoulder-arm region. Method: In one experiment (exp A) 15 subjects performed isometric muscle contractions at the lower arm and in another experiment (exp B) 10 subjects performed isometric muscle contractions at the shoulder. These contractions included different force levels related to the force measured under maximal voluntary contraction (MVC) and were different in duration in order to induce defined force and fatigue levels which were controlled by a force sensor. Bipolar SEMG was recorded continuously and transformed to the time domain using Fourier Transformation. In exp A the SEMG of extensor digitorum muscle was recorded. Subjects performed a MVC, short contractions at 20% and 40% MVC as well as a fatiguing contraction until task failure (30% MVC). In exp B SEMG of the trapezius muscle was applied. The subjects performed a MVC, short contractions at 20% and 50% MVC as well as fatiguing contractions until task failure (20% and 40% MVC). In both experiments the FASs of time intervals from the SEMG curves were determined. These time intervals included SEMG curves from the unfatigued muscle at different force levels as well as SEMG curves from the exhausted muscle with a substantial amount of muscle fatigue. To proof the concept the values of the known muscular forces and fatiguing levels were compared to the values estimated by SEMG analysis. Results: So far, about 40% of the data were analyzed. The preliminary results show a very good accordance between applied force and muscular force assessed with the new method (double spectrum normalization) particularly at low and mid fatigue levels. Muscular fatigue could be estimated semi-quantitative e.g. described by "non-low-medium-high fatigue". Our results further indicate that this applies to different force levels. Further investigations will be done in order to proof the model.

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P1-A-3 Concentric and eccentric muscle activation of patients with knee osteoarthritis during dynamic contractions - A categorized and probabilistic analysis.

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BACKGROUND: In patients with osteoarthritis (OA) deficits on muscle activation are attributed to the weakness and imbalance of the muscles around the knee. From healthy subjects it is known that during dynamic contraction joint position, movement velocity and contraction type affect significantly the activation of different muscles by the central nervous system. However, its impact during dynamic activation is still doubtful in patients with knee OA and becomes a challenge due to their complex and uncertain characteristics. AIM: The aim of the study was to determine the effect of joint angle position and movement velocity on concentric and eccentric activity of knee muscles of patients with OA and to compare the results with the muscle activation of age matched healthy subjects. METHODS: In twenty-seven women, sixteen with knee OA (age 64 years (SD=5.7); weight 69.6 kg (10.3); height 1.63 m (0.08 m)) and eleven controls (age 65 years (4.4); weight kg 61.1 kg (8.0); height 1.54 m (0.08 m)) volunteered to participate in this study. Surface electromyography (sEMG) of knee extensor and flexor muscles were recorded during twenty-five extension and flexion movements performed on an isokinetic dynamometer in three different velocities (90, 120 and 240 °/s). Three joint angle intervals of approximately 15° steps were determined between 30º to 70º. Initially, for patients and healthy subjects the data were categorized into groups of constant velocity, activation type (eccentric or concentric) and joint angle interval. For each categorized group the cumulative frequency distributions of the normalized sEMG envelopes were computed for each muscle separately. From the frequency distributions, the probability has been calculated that in OA patients normalized sEMG envelope values could be higher or lower than in controls. RESULTS: During extension movements, patients with OA are more likely to show higher EMG activity of the eccentric working of BF and ST muscles regardless of the joint position and velocity. Concentric working muscles VM, VL and RF are more likely to show lower activation than controls, especially in the more extended positions of the knee. During flexion movements, patients with knee OA are more likely to show higher activity of the eccentric working of the VL muscle without taking into account the joint position and the movement velocity. CONCLUSION: The difference in muscular activation strategy of OA patients compared to controls depends on the contraction type (eccentric or concentric), regardless the joint position and the movement velocity. Based on this knowledge improved new strength and balance exercises may be designed and the potential for intervention and prevention might be improved

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P1-A-4 EMG-force relationship of the lower posterior neck during isometric contractions

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BACKGROUND AND AIM: In order to provide basis for improved accuracy of current biomechanical neck models, this study examined the relationship between surface electromyographic (EMG) activity and isometric force of the posterior neck. METHODS: Nine males and nine females in the age of 20 to 48 years conducted isometric neck extensions in a neutral spine posture against a fixed force transducer. Seven muscle contractions were reiterated in a random order at 5-90% of maximal voluntary force. EMG activity was registered bilaterally from the cervical erector spine at C7 level, and processed with a zero phase band-pass filter at 20-400 Hz; and both EMG and force data was smoothed with a one second moving average. An automated script was utilized to identify the most stable second within 5% of target force together with the coinciding EMG activity. The neck torque was calculated and adjusted for gravitational acceleration, and EMG and force data were normalized as the percentage of maximal reference activity. To improve data stability, normalized EMG data was averaged between neck sides. Linear mixed-effects models regression was used to predict EMG from force and the most parsimonious model was selected as the final model. To assess absolute model fit, the coefficient of determination (R2) and the root mean square error (RMSE) were used. RESULTS: Figure 1 shows lowess curves for the observed data (black) and for the fitted model (red). A positively oriented quadratic curve had the best fit. Marginal and conditional R2 values were 0.93 and 0.98, respectively, and RMSE was less than 4%; both indices supporting a good model fit. CONCLUSIONS: These results suggest that the lower posterior neck's EMG-force relationship over nearly the full range of voluntary maximal activity is curvilinear, and that the slope is steeper for higher intensities.

P1-A-5 A method for evaluation of dependency between diseased side and opposite side of hemiplegia patient during FES-Cycling by using transfer entropy

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[1]The Univercity of Electro-Commnications

BACKGROAUND AND AIMS: Functional electrical stimulation (FES) is an effective method of rehabilitation for patients have paralyzed limbs caused by brain disease. FES can promote functional recovery because the stimulation produces contraction in paralyzed muscle and

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joint movement. In particular, for patients with hemiplegia, cycling with FES by using an ergometer is widely executed. Although the performance of cycling is usually evaluated using the crank angular velocity, pedaling force, and so on, it is difficult to evaluate the recovery level for hemiplegia by these indexes. Because the diseased side is assisted by healthy side, the performance of during cycling is averaged. It can be evaluated whether the diseased side contributes to cycling motion by using the electromyogram (EMG). However EMG cannot be measured under FES. It is necessary to evaluate muscle activities under FES without electrical methods. Therefore, objective of this paper is to find indexes that can evaluate the difference of performance between the diseased side and the healthy side during FES-Cycling. METHODS: We adopted the Ultrasonography for measuring muscle activities. For verification, we measured EMGs simultaneously. Moreover, EMG, the crank angular, and the pedaling force also measured. We measured the healthy subject, and applied a load to his one leg to imitate the hemiplegia. Muscle activities achieved by ultrasonography are quantified by using image processing., and compared with EMG. Moreover, we verified whether it is possible to evaluate the difference of performance between hemiplegia legs by using transfer entropy. Transfer entropy is a quantity that can evaluate the dependency between two measured data of differ phenomena each other. RESULT: From the transitions of EMG and muscle activities, it is found that the interval which demonstrated muscle force of the loaded leg is delayed. Because the loaded side is assisted by opposite side, the velocity of muscle contraction according to applied load is varied. These facts should be confirmed by not only performance measuring. The transfer entropy between EMG of each quadriceps is varied depend on the condition whether one leg is loaded or not. Moreover, there is a correlation between the transitions of EMG and muscle activities. CONCLUSION: In this paper, we constructed the system that evaluates the performance and muscle activity during FES-Cycling. For the result, we found the following three points; (1) the difference of performance between hemiplegia legs is revealed by observing the transition of EMG and muscle activities, (2) the transfer entropy between each quadriceps is varied depend on the condition whether one leg is loaded or not, and (3) the feature quantity related to the condition of load on one leg is obtained by using ultrasonography. From the above, in case that EMG cannot be measured, for example during FES, ultrasonography substitute for EMG to evaluate muscle performance.

P1-A-7 Decomposition of Clinically-Detected EMG Signals Using Dynamic Time Warping and Spectral Clustering

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AIM: A system capable of decomposing clinically-detected electromyographic (EMG) signals is described. The system is specifically tailored to extract information for the characterization of neuromuscular disorders. The design philosophy behind the proposed system is conservative but reasonably effective. It is conservative in that it does not try to assign every segmented motor unit potential (MUP), nor identify every component MUP train (MUPT). Instead, the focus is to identify a subset of MUPTs that can be used to investigate disease induced changes in MUP shape and the stability of MUP shape across a train. The proposed methods are specifically tailored to accommodate issues that are particularly relevant to the analysis of clinically-detected EMG signals in the context of characterizing neuromuscular disorders. These issues include: (1) random within-train MUP shape variability due to neuromuscular transmission variability and (2) trending within-train MUP shape changes mainly caused by slow and slight electrode movement. METHODS: Segmenting MUPs from a composite filtered EMG signal starts by estimating the characteristics of the baseline activity. This is followed by finding peaks and evaluating the shape of isolated MUPs. Each of the potentially isolated segmented MUPs is set to be a node in a similarity graph. The edges of the graph are added based on morphological similarity as evaluated using dynamic time warping (DTW). A spectral analysis of the similarity graph is then utilized to perform clustering. RESULTS: The methods were validated and evaluated using simulated signals obtained from an electro-physiologically sound model. The results confirm the representativeness of the identified MUPTs. Those MUPTs, who's MUPs have an amplitude-to-noise ratio that is five or above, mostly contain MUPs comprised mainly of contributions from the same motor unit (99% ± 5.8%). The average processing time for ten seconds of EMG signal is 4.7 ± 0.38 seconds. CONCLUSION: The main advantage of using spectral clustering for MUPT identification is that it is a graph based clustering approach that finds clusters optimizing the connectivity among MUP shapes rather than their compactness. This is important to track MUPTs with slowly varying characteristics due to slow electrode movement. The main reason for using DTW alignment is to calculate a distance that is least affected by within-train MUP shape variability resulting from neuromuscular transmission variability.

P1-A-8 Different responses of fingertip forces and muscle activity of the enslaved finger during dynamic tasks

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BACKGROUND AND AIM: Fingers of the human hand cannot move or exert force independently, a phenomenon that is called enslaving. Anatomical research has indicated many cross-connections between muscle bellies of the long finger flexors (Frohse & Frankel,

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1908), of which the mechanical effect is as yet uncertain. Enslaving might have a mechanical course, but alternatively involuntary co-activation of multiple muscle heads may be responsible. Investigating finger interaction during dynamic tasks can provide more insight into the relative contribution of neuromuscular control and mechanics. The aim of the current study was to investigate finger force enslaving during index finger flexion and to assess the relationship with activity patters of several extrinsic muscle regions. METHODS: Eleven right-handed subjects (22-30 years) were asked to flex the index finger from 0 deg. to approximately 45 deg. in 1.35 seconds while overcoming a 6N constant resistance force orthogonal to the finger tip. This force was produced by a robotic arm following the index finger while the other fingers (middle, ring and little) were resting against a board. Forces exerted by the restricted fingers were measured using unidirectional force sensors. Forces exerted by the index finger were measured by the robotic arm. Activity of muscles was measured using surface electromyography electrodes (sEMG). 24 electrodes were placed on flexor digitorum superficial (FDS) and extensor digitorum (ED) muscle regions. Each subject performed the task 4 times. RESULTS: Flexion force applied by the non-instructed middle finger increased substantially (by 1.91 N ± 0.79) during flexion of the index finger. Force exertion on the middle finger started to increase (defined by a threshold of 5%) with a delay of 108 ± 94. In contrast to the finger forces, the activity of the middle finger FDS region (FDS III) changed only minimally (by 4.8 % of EMGmax) upon flexion of the index finger. Therefore, any delay could not be accurately detected. The change in EMG activity of FDS III was not significantly correlated to the change in middle finger force (R= 0.26 p=0.15). Change in the activity of the middle finger ED region (ED III) was 1.8 % of EMGmax; Also for ED III no accurate delay could be computed. CONCLUSIONS:Our results indicate that the response to index finger flexion of fingertip forces in the non-instructed middle finger was different to that of FDS III and ED III activity. This mismatch between forces and EMG suggests that mechanical connections between muscle-tendon structures were likely to be responsible for the observed finger enslaving. The delay in the development of middle finger force may be explained by intertendinous connections initially being slack and pulled tout by index finger flexion. In addition, force transmission between muscle bellies corresponding to index and middle fingers may play a role.

P1-A-9 Effect of yoga on balance, lumbopelvic stability and back muscles power in women

Areerat Suputtitada[1], Sompol Saguanrungsirikul[1], Kittikorn Singhabut [1]
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Effect of yoga on balance, lumbopelvic stability and back muscles power in women Professor Areerat Suputtitada ,M.D. 1,2,3 , Associate Professor Sompol Saguanrungsirikul,M.D.,2,3,4,

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Kittikorn Singhabut ,PT, MsC 2,3 1 Department of Rehabilitation Medicine, Faculty of Medicine, Chulalongkorn Universitry, Bangkok, Thailand 2 Excellent Center for gait and Motion, King Chulalongkorn Memorial Hospital, Bangkok, Thailand 3 Sport Medicine, Faculty of Medicine, Chulalongkorn University,Bangkok, Thailand 4Department of Physiology, Faculty of Medicine , Chulalongkorn Universitry, Bangkok, Thailand Abstract Background: Yoga is considered to be popular exercise especially for women. There are few studies of effect of yoga on motor performance. The aim of this study was to reveal the motor performance of yoga exercise. Methods: Randomized, single blinded controlled study was done. The effect of 6-week yoga exercise, 30 minutes per day for twice a week, was studied in healthy middle aged women. Thirty-nine women, aged between 30-45 years old, were randomized into yoga and control group. Before and after 6 weeks, participants were measured postural sway by using force plate during double and single leg stance while eyes opened and closed, lumbopelvic stability by angular displacement and angular velocity during single-leg landing, Gluteus medius and back muscles activities by surface EMG and muscle power by using isokinetic dynamometer. Results: We found that balance in single-leg stand in yoga group were significantly greater than control group ($p<0.05$). There was no significant difference between groups for angular displacement and angular excursion. The angular velocity showed significant difference between groups for mean velocity of lateral bend ($p<0.05$). EMG activities of gluteus medius muscles and back muscles power in yoga group revealed decrement than control, but no statistically significant difference. Conclusion: Therefore 6-week yoga exercise , 30 minutes per day for twice a week, totally 12 days, can improve balance, back muscles power and lumbopelvic stability. These might decrease risk for low back pain and fall risk in women. Keywords: Yoga, Balance, Lumbopelvic stability, Back muscle power

P1-A-10 Dynamic Curve Analysis of Surface EMG Patterns of Abdominal Muscle as a Function of Exercise and Load

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BACKGROUND AND AIM: Human movement variability has been conceptualized as a complex adaptive system that can be evaluated across multiple levels. The time-dependent structure of human movement and physiological signals provides insight into the state of the neuromuscular system with a wide range of analytical approaches used to characterize the complexity of signals. However, limited study of electromyography (EMG) complexity has occurred in healthy individuals which is needed to determine effective rehabilitation approaches. METHODS: The present study examined surface EMG (sEMG) activity from the rectus abdominus muscles during two exercises (traditional sit-up and reverse crunch). There

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exercise were performed in bodyweight (BW) and loaded (4.54 kg) conditions and with a fixed pacing (60 bpm). Dynamic curves of sEMG were computed over five consecutive movements for root mean square (RMS) and approximate entropy (ApEn). Comparisons of the dependent variables were made for mean values during concentric and eccentric phases. Additionally, the collective dynamic curves for RMS and ApEn were inspected to characterize dynamic changes during the concentric and eccentric phases as a function of exercise and load. RESULTS: Mean RMS showed non-significant differences during both concentric and eccentric phases for the main effects of exercise and load. The mean ApEn value of the sit-up was significantly higher than the reverse crunch for the concentric phase ($p<0.01$) but similar during the eccentric phase ($p=0.15$). No effect of load was observed for ApEn in either phase. The RMS curves reveal the envelope of sEMG with distinct transitions between concentric and eccentric phases. Characteristic drops in ApEn preceded the initiation of sEMG activity but primarily occurred during the concentric, but not eccentric, phase. CONCLUSION: In clinical and rehabilitation settings EMG has been widely used to evaluate and assess various neurological conditions but little is know about the time-dependent properties of muscular activity. The reported findings contribute to our understanding of the nonlinear dynamic properties of sEMG and highlight the need to examine the complexity of sEMG to aid in the ability to distinguish between healthy individuals and neurological disorders.

P1-A-11 Use of high density EMG grid recordings to characterize the level of injury in individuals sustaining cervical spinal cord injury

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BACKGROUND AND AIM: Ability to control limbs and muscles after spinal cord injury (SCI) depends on the severity and level of injury. Currently, the SCI level assessment is based on a combination of clinical tests (manual muscle testing: MMT) and medical imaging (MRI). There is an imperfect correlation between them. As a first step in establishing the functional level of motor injury, we here report the feasibility of using high-density surface EMG grid (HDsEMG) to characterize muscle regions innervated by damaged ventral roots. METHODS: In an ongoing study, we recorded a surface EMG 16x8 grid; IED=8.5mm (2KHz; monopolar; isometric non-fatiguing contractions) from Biceps Brachii (BB) in chronic SCI individuals (n=2; C5-C6 with ASIA C and C5-C7 with ASIA D). Subjects were examined in a sitting position, 120° elbow flexion, 30° shoulder flexion and 35° abduction with 45° pronated wrist. EMG data and elbow flexion force were recorded at rest, during maximum voluntary contraction (MVC) and at sublevels (20%, 40%, 60%MVC). The recorded EMGs were preprocessed by a low pass filter (10-500Hz; Zero lag; 4th order Butterworth) and powerline interference was removed using the spectral interpolation. We localized the innervation zones (IZ) along

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columns of the EMG grid by visual inspection of single differential EMG signals on both arms. In addition, the EMG signals were segmented in time using 125ms epochs and root mean squared (RMS) maps were calculated in all epochs. The active regions in the resulting RMS maps were extracted using the watershed segmentation, and frequency of each channel appearing in the active region was counted. RESULTS: Both participants were injured at cervical levels from C5 to C7 where musculocutaneous nerve originates and innervate both the BB and Brachialis. Injuries at these levels affect elbow flexion and extension. The left and right arm's IZ maps were different in terms of number and distribution of IZs. We observed multiple IZs distributed up to 25mm apart along the BB's fascicles on the less functional arm, which provides evidence of successive de/re-innervations. The recorded difference between left and right BBs highlights the sensitivity of the proposed technique in estimating the SCI extent. We did not see any spasms during recordings, but active motor units (MU) were observed through analyzing EMG signals at rest. Using the HDsEMG and watershed segmentation we quantified the active EMG channels and localized the active MUs in the resting state. The analysis of RMS maps at sub-levels of the MVC revealed the location of newly recruited MUs in response to the descending commands in response to the required forces. CONCLUSIONS: Our preliminary data is promising and established the feasibility of HDsEMG technique in characterizing, quantifying and tracking the extent and level of SCI. The proposed technique potentially complements the clinical examinations such as MRI and MMT and provides a functional map of injury.

P1-A-12 Reliability of muscle fiber conduction velocity and fractal dimension of surface EMG during isometric contractions

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BACKGROUND AND AIM: During isometric constant-force contractions, muscle fiber conduction velocity (CV) decreases, whereas the level of motor unit synchronization, by the central nervous system increases. Therefore, the evaluation of peripheral aspects of fatigue might be obtained by estimating CV rate of change during an isometric task. As regards central components of muscle fatigue, fractal dimension (FD) is considered a promising sEMG with a high sensitivity to motor unit synchronization. The aim of this study was to determine the test-retest reliability of CV and FD rates of change obtained from multichannel surface electromyographic (sEMG) recordings. METHODS: 40 healthy subjects (20 men and 20 women) performed two elbow flexions, on two sessions with a 1-week interval. The first was a 20% maximal voluntary contraction (MVC) of 120 s, and the second at 60% MVC held until exhaustion. sEMG signals were detected from the biceps brachii using a bidimensional

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array of 64 electrodes. CV and FD were estimated on single differential signals, using non-overlapping signal epochs of 1s. Rates of change of CV and FD were used for the reliability analysis. RESULTS: The intraclass correlation coefficient (ICC) values for the isometric contraction at 20% MVC were 0.67 (95% CI: 0.49 - 0.79) and -0.09 (95% CI: -0.72 - -0.31) for FD and CV respectively. The ICC values for the isometric contraction at 60% MVC were 0.82 (95% CI: 0.73 - 0.89) and 0.78 (95% CI: 0.65-0.86) for FD and CV respectively. The Bland Altman plots for the two isometric contractions showed a mean difference close to zero: at 20% MVC 0.00153 for FD and -0.0277 for CV, and at 60% MVC 0.00666 for FD and 0.00907 for CV. CONCLUSIONS: The results suggest that during an isometric fatiguing contraction, CV and FD rates of change, are reliable variables, with potential application to evaluate peripheral and central contributions to muscle fatigue.

P1-B-13 A comparison of knee joint kinematics and kinetics during landings in three one-leg hop tests (hop for distance, vertical hop and side hop) performed by female elite floorball athletes.

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[1]Umeå University

BACKGROUND AND AIM: Anterior cruciate ligament (ACL) injury is very common in sports, with an increased risk for females [1]. They mainly occur in non-contact situations with multi-plane knee loadings, often involving an eccentric movement. Common one-leg tests conducted before returning to sports include the hop for distance (OLH), the vertical hop (VH), and the side hop (SH). More knowledge is needed regarding the demands these tests put on the knee joint for improved evaluation and rehabilitation of knee function before returning to full sports participation. The aim was to study differences in knee joint landing kinematics and kinetics during these three hops for healthy elite female floorball players. METHODS: Ten female elite floorball players (Age: 21.4 ± 2.6 yrs., BMI: 22.2 ± 2.5 kg/m2) with no known injuries participated. Knee joint angles and moments in sagittal, frontal, and transverse planes were recorded using an eight-camera motion capture system (Oqus, Qualisys AB, 240 Hz) and one force plate (Kistler, 240 Hz) during landings from three one-leg hop tasks: OLH, VH, and SH. The SH was standardized to a lateral hop distance of 25÷body height with a rebound hop back to the start position. The landing phase was defined from ground reaction force >10 N to the first local minimum point on the ground reaction force curve. Knee moments were normalized to height and body mass. Repeated-measures ANOVAs followed by Bonferroni post-hoc tests were performed. RESULTS: Knee joint angles and moment magnitudes were generally greatest for the OLH test. Subjects had greater maximal knee flexion angle ($p<0.001$), adduction angle ($p=0.001$), flexion moment ($p=0.001$), and external rotation moment ($p<0.001$) during OLH than both VH and SH. Subjects had

however greater abduction angle (p=0.004), internal rotation moment (p=0.012) and abduction moment (p=0.005), but lower adduction moment (p=0.001), in SH compared to OLH. During SH compared to VH, subjects had greater abduction moment (p=0.024) and internal rotation moment (p=0.017), although lower adduction moment (p<0.001) for the SH. CONCLUSIONS: Elite female floorball players showed significantly different movement patterns in landing between the three different hop tests. The OLH had greater demands on flexion, adduction, and external rotation, while the SH had greater demands on internal rotation and abduction. This indicates that each of these tests provide valuable information of knee function demands but in different movement directions, something that is important to consider in the rehabilitation after a knee injury. KEYWORDS: Movement patterns, biomechanics, kinesiology, knee function, anterior cruciate ligament [1] Myklebust et al., A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball. Scand J Med Sci Sports, 1998. 8(3): p. 149-153.

P1-B-14 The Kinematic Chain Ratio of Pronation-to-Supination of the Calcaneus and Internal-to-External Rotation of the Shank Affects Calcaneus Motion during Gait

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BACKGROUND AND AIM: The kinematic chain of pronation-to-supination of the calcaneus and internal-to-external rotation of the shank in the standing position provides smooth movement, such as gait, because the kinematic chain has a conversion function between movements of the foot and shank on the plane of motion. Therefore, it appears that the effects of individual differences in the ratio of the movement of both segments have a significant influence on lower limb movements during gait that cannot be ignored because there is a large individual variation in the ratio. This study clarified the relationship between the kinematic chain of the calcaneus and shank and lower limb movement during gait. METHODS: Forty limbs of 20 healthy adults (13 males and 7 females; age, 26.3±3.9 years) without a history of orthopedic disease in the lower extremities were studied. Using a 3D motion analysis system (VICON-NEXUS; Vicon Motion Systems, Ltd., Oxford, UK) and force plates (AMTI, MA, USA), the kinematic chain movement, such as pronation/supination movement of the calcaneus and rotational movement of the shank in the standing position, and lower limb movement during gait were measured. We defined the linear regression coefficient between the calcaneus and shank angles during standing as the kinematic chain ratio (KCR, shank angle-to-calcaneus angle) in the kinematic chain movement. The relationship between the KCR and angles of the calcaneus and shank during standing was analyzed using Pearson's correlation coefficient (significance at p<0.05). RESULTS: The mean

of the KCR was 1.0±0.2. The mean of the range of movement of pronation/supination of the calcaneus was 10.4±2.3 degrees, and the internal/external rotation of the shank was 18.7±4.4 degrees during gait. The correlation coefficients between the KCR and the range of calcaneus and shank movement were r=-0.69 ($p<0.001$) and r=-0.38, respectively. CONCLUSIONS: We previously described large shank rotation, namely a large KCR in the high arch alignment of the foot (The 50th Congress of the JPTA). Furthermore, a high arch foot has a small movement of the calcaneus during running because the foot has high rigidity (Nawoczenski, 1998). We suggest that such a relationship is the basis for a relatively strong negative correlation between the KCR and the range of calcaneus movement during gait. Although the KCR and the calcaneus movement are factors to increase the shank rotation, the correlation coeffecitnt between the KCR and the shank rotation was not significant. This phenomina was caused by various KCR among subjects to keep the shank rotation in medium range. From the above, if the deviant state from the results of this study, namely if the KCR and the calcaneus movement are large, there will be a possibility that the shank rotation is occurring in excess. When analyzing lower limb motion during gait, it should be noted that there is a large individual variation in the KCR.

P1-B-15 Effects of Non-local Fatigue on EMG Amplitude During Dynamic Resistance Exercise

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BACKGROND AND AIM: The physiological mechanisms responsible for the manifestation of non-local fatigue during resistance exercise are not well established. Alternating upper- and lower-body exercises provides for time-efficient workouts, but can impair external work of the lower-body, when compared to lower-body only resistance exercise. The purpose of this study was to determine how added upper-body resistance exercise affects lower-body muscle activation. METHODS: Four resistance-trained males (20.8±2.9 yrs; 79.38±8.75 kg) completed two workouts on two separate days. One workout (lower body: LB) consisted of two warm-up hip sled sets followed by three hip sled sets to failure at 90% of one-repetition-maximum (1RM). Another workout (whole body: WB) consisted of two warm-up sets of hip sled and lat pull-down exercises followed by three sets of 90% 1RM hip sled sets to failure with 80% 1RM lat pull-down sets performed to failure between the three 90% hip sled sets. Subjects received instantaneous visual feedback to perform repetitions at a rate of 2 seconds for eccentric and concentric movements. Bipolar electrodes sampled surface electromyographic EMG signals at 1000 Hz from vastus lateralis, vastus medialis, and rectus femoris muscles. EMG amplitude was expressed as percent of average EMG root mean square (rms) during the first warm-up set. Custom LabVIEW software was used to process

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the data. Alpha was set at .05. RESULTS: A 2 (workout) by 3 (set) ANOVA found there to be no significant main effect of workout condition on number of completed repetitions (p=.367; η=.273); there was a significant main effect for set (p=.014; η=.862) reflecting fewer successful completed repetitions in later sets; there were no significant interactions. A 2 (workout) by 3 (set) by 3 (muscle) ANOVA indicated no significant main effect of workout condition on mean EMG rms (η=.516; 95% CI LB=203.01-246.41%; 95% CI WB=158.45-248.25%). However, there was a significant main effect for workout (p=.014; η=.898) where WB (4.83% increase per repetition) had a lower slope than LB (7.00% increase per repetition). There were no significant interaction effects for EMG rms. CONCLUSION: Performing upper-body resistance exercise between lower-body resistance exercise sets may result in lower intra-set increases in EMG amplitude. This may be explained by lower-body muscles maintaining higher metabolite concentrations during lower-body "rest" intervals due to increased circulating metabolite concentrations.

P1-B-16 Electromyographic analysis of the soleus and vastus lateralis muscles during squat exercise with and without isometric contraction in the end of eccentric phase

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BACKGROUND AND AIM The squat is a free weight exercise used to maximize the strength of the lower limbs, contributing to a better athletic performance. Surface electromyography (EMG) and creatine kinase (CK) are used as indicators of muscle fatigue enabling process understanding of neuromuscular behavior for training methods of athletes. The aim was identify the behavior of EMG and CK variables in two protocols that differ by the additional isometric contraction phase during the squat exercise. METHODS Five subjects (23,5 ± 2,79 y.o., 78,47 ± 9,12 kg, 174,4 ± 6,22 m) with 2,5 ± 3,2 years of experience give their written consent to participate the study. One-repetition maximum test (RM) was performed 72 hours before for each of the two protocol and it was observed a rest (without training) of 10 days between them. Protocol 1 (P1) without isometric contraction phase at 70% of RM and Protocol 2 (P2) with isometric contraction phase (2s) in the end of the eccentric contraction phase at 70% of RM. Both protocols were with 5 series and 12 repetitions. The EMG signals of soleus and vastus lateralis muscles were acquired during the P1 and P2. It was adopted the 1s window length for the 1st contraction (first), 8th contraction (middle) and 16th contraction (last) of each series (1º, 2º, 3º, 4º and 5º). The feature median frequency (MF) was used for statistical tests (Two-way ANOVA - p=.05). Creatine Kinase (CK - U/L) was collected at 72h before, 24h and 48h after protocols (statistical tests - Multivariate repeated measures

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analysis - p=.05). RESULTS Few differences in the EMG signal were observed in the protocols (P1 and P2) and in the series for both muscles (Fig. 1). It was not expect differences for the soleus muscle (postural) among contractions over the protocols, while the vastus lateralis muscle (with a predominance of fast fibers) had change in the frequency of the EMG signal due to the occurrence of muscle fatigue generated in the protocol. For the CK values it was observed that the CK after 24 hours for P1 (769.6 ± 681.45 U/L) showed a significant increase of 31%, approximately (p = 0.02) when compared to P2 (530, 8 ± 518.47 U/L), with the highest concentration to P1 (p = 0.01), indicating the occurrence of muscle damage. There were no significant differences between groups for the before 72 hours CK (P1 = 419.4 ± 270.4 and P2 = 345.6 ± 225.9 U/L) and in CK after 48 hours (P1 = 524.8 ± 441 and P2 = 318.14 ± 407 U/L). The MF feature is considered a frequency indicator of recruitment of motor units, however, it was not sensitive to the occurrence of muscle damage indicated by CK during dynamic and isometric contraction. CONCLUSIONS Considering the inclusion of isometric contraction (P2) was the only difference between protocols and that only the value of CK 24 hours after had statistical differences, the EMG MF feature was not sensitive to measure this type of squat exercise protocol.

P1-B-17 Muscle fatigue in vibration exercise at different frequencies

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BACKGROUND AND AIM: Because of enhanced neuromuscular demand, Vibration Exercise (VE) has been suggested to improve muscle strength and power performance. However, the use of optimal VE protocols in rehabilitation programs is still lacking due to poor understanding of the underlying physiological mechanisms. In this study, the fatiguing effect of vibration at different frequencies was investigated by employing a force-modulation VE system. This system, described in [1], applies to the muscle a baseline force (tension) that can be modulated at different frequencies. METHODS: 15 volunteers performed four 12-s isometric contractions of the biceps brachii. The load consisted of a baseline force of 80% of the maximum voluntary contraction (MVC) with 60% sinusoidal force modulation at 0 (control condition, no vibration), 20, 30, and 40 Hz, in randomized order. The EMG was measured by a 64-channel high-density grid with a Refa8 multichannel amplifier (TMSi, Netherlands). Mechanical fatigue was estimated by assessment of the MVC decay. The MVC was measured before and after each task with a load cell embedded in the system. Myoelectric fatigue was estimated by analysis of the EMG signals recorded during VE. The time-evolution slope of the EMG conduction velocity, mean-frequency, power (RMS), and fractal dimension were considered as indicators of myoelectric fatigue [2-3]. The latter was considered as a possible indicator of central fatigue [3]. All the myoelectric indicators were

estimated with and without Vibration-Frequency Removal (VFR) from the EMG, as these frequency components can derive from either motion artifacts or muscle activity [4]. RESULTS: All the results are shown in Fig. 1. Normalization to the maximum value was performed for each subject. These results suggest VE, especially at 30 Hz, to produce a larger degree of fatigue as compared to control condition. DISCUSSION AND CONCLUSIONS: Statistical significance was achieved for all fatigue indicators with exception for the fractal dimension, suggesting VE to enhance peripheral fatigue as compared to central fatigue. Further analysis of VE central fatigue is required by dedicated measurements. In general, these results motivate towards the introduction of VE in rehabilitation with improved training programs. REFERENCES: [1] L. Xu et al, 'Novel vibration-exercise instrument with dedicated adaptive filtering for electromyographic investigation of neuromuscular activation,' IEEE T-NSRE, 21(2):275-282, 2013. [2] R. Merletti et al, 'Myoelectric manifestations of fatigue in voluntary and electrically elicited contractions,' J Appl Physiol, 69(5):1810-20, 1990. [3] L. Mesin et al, 'A bi-dimensional index for the selective assessment of myoelectric manifestations of peripheral and central muscle fatigue,' J Electromyogr Kinesiol, 19(5):851-863, 2009. [4] L. Xu et al, 'On the nature of the electromyographic signals recorded during vibration exercise,' Eur J Appl Physiol, 115:1095-1106, 2015.

P1-B-18 Effects of Neuromuscular Training for Runners with Flexible Flatfoot and Related Running Injuries

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Background and Aim: Biomechanical stresses in subjects with flexible flatfoot (FFF) during running and other loaded activities with high repetition easily cause significant injuries to the musculoskeletal system. Excessive rearfoot pronation would cause increased lower extremity internal rotation and pelvic anterior tilt, and could also lead to excessive knee valgus, hip adduction, and pelvic instability in dynamic movements. These abnormal skeletal malalignment causes poor force transfer between the foot and spine in functional movements and accumulated tissue stresses in the lower extremity and lumbar region over time, leading to the development of lower extremity injuries such as patellofemoral pain syndrome, shin splints, plantar fasciitis and low back pain. To offset the malalignment associated with FFF, it is important to re-establish the kinetic control and maintain joint stability from the foot to spine and integrate them into functional activities of daily living. However, no studies have investigated the effects of neuromuscular control exercise on lower extremity kinetic control and symptom improvements; especially in runners with FFF. The purpose of the study was to investigate whether neuromuscular training from the foot to spine is beneficial in runners with FFF and lower extremity pain. Methods: This study was a

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one-group pretest-posttest quasi-experimental design. We recruited 17 runners with FFF and running related lower extremity pain and provided them with neuromuscular training from the foot to spine. Outcome was evaluated by visual analog scale (VAS) for pain and lower extremity functional scale (LEFS), as well as lower extremity kinematic and electromyographic changes after 6 weeks of training. Results: There was no significant difference on the kinematics data, but muscle activation of tibialis anterior and biceps femoris was significantly higher during both functional tasks, and activation of peroneus longus was lower during level walking in symptomatic runners with FFF. After 6-week neuromuscular training, runners with FFF showed significantly smaller hip adduction and trend of decreased hip internal rotation during single leg squatting. In muscle activity, tibialis anterior were lower during level walking and higher during single leg squatting. These subjects also reported decreased pain and increased lower extremity function after 6-week training. Conclusion: Neuromuscular training was benefical to lower extremity motor control and improved pain and dysfunction in runners with FFF.

P1-B-19 Does longer application of kinisiotape delay the muscle fatigue of the knee joint during isotonic flexion/extension?

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INTRODUCTION: Kinesiology tapes (KT) claim to improve biomechanical performance of users through a delay of muscle fatigue. There is a controversy from previous studies that researched short-term performance of these claims in both healthy and injured subjects [1-4]. A number of studies demonstrated some improvement in active range of motion of the knee joint & reduction in pain in subjects with knee injuries [1,2], while other studies shown little to no improvements in strength in healthy subjects [3,4]. The aim of this pilot study is to investigate whether the longer term application of KT improves performance of the healthy knee joint and delays the muscle time to fatigue (TTF). METHODS: Four healthy male subjects (ages 20-25, height 72.2±2.0in, weight 168.7±22.5lbs) with no previous history of knee injuries volunteered to participate. A commercially available KT was applied to the dominant knee per manufacturer's guidelines. A 7-day isotonic fatigue protocol, with a resistance of 60lbs, was conducted in 24hr increments from prior to KT application (nKT) to 6-days of KT application (D1-D6) using a Biodex 4 Pro dynamometer. EMG's of the Vastus Lateralis (VL) and Medialis (VM) were collected unilaterally at 2kHz, and band pass filtered at 20-450Hz using DelSys Trignio surface EMG sensors. The RMS of muscle activity was calculated and normalized to a 3sec standing baseline of its corresponding day. The percent change across each day was calculated for RMS and MDF with KT and was compared to nKT. TTF was determined from the time the subject starts to when they can no longer perform knee

extension/flexion and rate was calculated as number of cycles per second. RESULTS: No change was seen at the time immediately after KT application in any of the parameters. An increase in RMS and a decrease in MDF from start to end of each trial, indicating fatigue, was seen in all subjects. Overall greater drops in MDF were seen at nKT with an average of 27.9% and 18.6% for the RVL and RVM respectively. Continuous delays in TTF were seen throughout all days of KT application. A maximum delay of 85% in TTF was reached at D4 and then it gradually started to decline. Slight increases (up to 13%) in average rate of knee extension and flexion were seen across all subjects. Therefore, the delays in TTF cannot be due to slow down in rate, and may indicate a potential advantage of KT. SUMMARY: It was found that the duration of KT application can be an important factor and one could expect some endurance enhancement in knee extensors after 24hrs of KT application. Larger studies and additional applications are needed to explore the pathophysiology of these findings. REFERENCES: 1. Chang, H-Y., et al. Ph Therapy in Sport: 122-127, 2010. 2. Cho, H., et al. Am J Phys Med & Rehab: 1-9, 2014. 3. Fu, T-C., et al. J Sci & Med Sport: 198-201, 2008. 4. Wong, O.M.H., et al. Ph Therapy in Sport: 255-258, 2012.

P1-B-20 Shoulder problems in elite adolescent handball players - the Karolinska handball study

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BACKGROUND AND AIM: Shoulder pain and overuse injuries in the shoulders are common in both female and male elite team handball players. Recent studies have showed a 25-33% season-prevalence of shoulder pain among senior elite players, and 12% of male elite players reports substantial shoulder problems. The amplitude of shoulder problems and risk factors for developing shoulder injuries among elite adolescent team handball players are unknown. The overall objective with the on-going cohort study called Karolinska Handball Study is to deepen the knowledge about injuries prevention and the functional status in the neck/shoulder area in adolescent elite handball players. The specific aim of this part project is to describe the prevalence of shoulder injuries in the included elite adolescent handball players. METHODS: 471 male and female players (mean age 16,6 ±0,9, 54% female) from ten handball-profiled high schools completed a pre-season shoulder function screening as well as a baseline questionnaire about handball experience, former and present injuries based on the OSTRC Overuse Injury Questionnaire and a psychometric profile. Cross sectional data from the baseline questionnaire is presented in this abstract. Shoulder problems are defined as pain, ache, instability, stiffness, looseness or other complains related to the shoulder. Substantial shoulder problems are defined as shoulder problems leading to moderate or severe reductions in sporting performance or training volume, or a total inability to

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participate RESULTS: The pre-season questionnaire showed that 41% had a history of shoulder problems, 28% had shoulder problems during the previous season and 12% reported substantial shoulder problems during the previous season. Shoulder problems were most common among female players (OR 1.6 95% CI, 1.1-2.4), backcourt players (OR 2.3, 95% CI 1.3-4.1) compared to wing players and among 2nd (OR 2.6 95% CI, 1.4-5.0) and 3rd (OR 3.6 95% CI, 1.7-7.6) year high school students compared to 1st year students. Most common onset of shoulder problems was gradual onset (70%), onset due to pulled in the arm (18%) and fall on arm (8%). CONCLUSIONS: The prevalence of shoulder pain among Swedish elite adolescent handball players is high and higher among female players, backcourt players and 2nd and 3rd year high schools students. These results are equal to the prevalence seen in senior male players.

P1-B-21 Shoulder strength among healthy adolescent elite handball players

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BACKGROUND AND AIM: Recent studies have suggested reduced shoulder strength and range of motion to be risk factors for shoulder injuries among handball players. Normative data on adolescent elite handball players are lacking, therefore the aim of this study was to present data for gleno-humeral strength in such a population. METHODS: In this study 342 healthy players, from ten different handball profiled high schools in Sweden (mean age 16.5 ±0.9, 53% female) were tested for gleno-humeral isometric external rotation (IER), isometric internal rotation (IIR) and isometric abduction (ABD) strength and eccentric external rotation strength (EER). The strength tests were performed during the pre-season preparation period 2014 and 2015 with a handheld dynamometer (MicroFet2). The players were tested twice in each position and the maximum values were used for analysis. All the tests were performed with the same test leader. To assure sufficient reliability of the strength measurements we performed a reliability study with 30 study participants and two testers prior to the original study, measuring inter- and intra-tester reliability. RESULTS: The intra-tester reliability in the reliability study was excellent for all of the tests (ICC 0.93-0.99), whereas the inter-reliability was excellent for ABD, IER and IRR (ICC 0.92-0.98) and good for EER (ICC 0.87). Our main results showed significant age and playing position difference among male players but not among female players. When normalized to body weight and BMI, male players were stronger compared to female players. Detailed results stratified by playing position and age as well as results normalized to body weight and BMI will be presented at the conference. Also strength ratios will be presented. CONCLUSIONS: This study describes data on shoulder strength among healthy adolescent elite handball players. This could be helpful for clinicians in the assessment of shoulder strength in healthy and injured adolescent handball players. All of the shoulder strength test showed acceptable reliability for clinical use.

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P1-B-22 Comparison of biomechanical charactertistics of rowing performance between elite and non-elite scull rowers: a pilot study

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BACKGROUND AND AIM: It has been shown that coordination, timing, balance and rhythm of rowing motion are core factors to enhance rowing performance (Baudouin & Hawkins, 2004; Buckeridge et al., 2015; Smith & Spinks, 1995). This study aimed to examine the characteristics of joint kinematics and synchronicity of rowing motion between elite and non-elite rowers. METHODS: Two elite (22 years, 192 cm, 87.4±2.5 kg)and two non-elite rowers (26.5±0.5 years, 185.6±0.2 cm, 91.2±3 kg) performed rowing stroke (3 trials, 20 strokes per each trial) at three different stroke rates (20, 30, 40 stroke/min) on stationary rowing ergometers. The rowing motions of two rowers were captured at once using a 3-dimentional motion analysis system (8-infrared camera VICON system, Oxford, UK). The range of motion (RoM) of knee, hip, and elbow joints on the sagittal plane, the lead time (TLead) and the elapsed time of the drive phase (TDrive) for each joint, the elapsed time for the knee joint to maintain fully extended position (TKnee) during the stroke were analyzed and compared between elite and non-elite rowers. Using mann-Whitney U test, these data were compared between two groups. Synchronicity of the rowing motion within and between groups was examined using coefficients of variation (CV) of the TDrive for each joint. RESULTS: Regardless of the stroke rate, the RoM of all joints were greater for the elite compared with non-elite rowers, except for the RoMs of the knee joint at 30 stroke/min and the elbow joint at 40 stroke/min ($p < .05$). Meanwhile, the TLead at all stroke rates were same between the groups. The TDrive for each joint were shorter for the elite compared with the non-elite. During the drive phase, elite rowers kept the fully extended knee longer than non-elite rowers ($p < .05$). The CV values of the TDrive within each group are smaller for the elite compared with the non-elite, except for the CV values of the hip at all stroke/min and elbow at 40 stroke/min (Table 1). CONCLUSIONS: Based on the results, greater RoM and the same TLead with shorter TDrive were observed for the elite compared with non-elite rowers, indicating that the elite rowers were capable of performing more powerful rowing stroke at the given stroke rate. Consequently, the rowing strategy of elite rowers would be more efficient to transmit higher power and accelerate the boat than that of the non-elite rowers. Regarding the synchronicity of rowing stroke, two elite rowers showed better synchronous performance than non-elite rowers (Table 1.) at the knee and elbow joints. Higher CV values and the larger RoM of the hip joint for the elite compared with non-elite rowers, might indicate that elite rowers use their own coordination strategies linking the lower and upper body motion at the hip-trunk region.

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P1-B-23 Effect of cryotherapy on eccentric exercise-induced muscle damage: a randomized clinical trial.

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INTRODUCTION AND AIM: Exercise-induced muscle damage provokes the installation of an inflammatory process that results in a sensation of pain and discomfort in individuals. Recently cryotherapy has been used as a strategy to recover from exercise-induced muscle damage, such as after training or competition. Thus, the present study aims to assess the effect of cryotherapy on eccentric exercise-induced muscle damage. METHODS: This is a randomized clinical trial composed of 40 women (22.8±2.2 years), randomly divided into two groups: control group and cryotherapy. Both groups underwent three assessments, all composed of algometry, dynamometry (peak torque normalized by body weight) and electromyography (root mean square and median frequency). After initial assessment, all the participants were submitted to an eccentric exercise protocol on an isokinetic dynamometer (2 series of 10 maximum eccentric contractions of non-dominant elbow flexors at 60°/s). Next, participants were submitted to the interventions, according to the pre-determined group: the control group did not undergo any intervention and remained at rest for 25 minutes; the cryotherapy group remained seated on the isokinetic dynamometer and a 1kg ice pack was strapped over the entire brachial biceps muscle and adjacent muscles of the arm under study using a bandage. Application lasted 25 minutes and a digital thermometer (Salvterm® 1200K, Brazil) with interface was used to measure cutaneous temperature and ensure cooling level. After the interventions each subject underwent two re-assessments: immediately (post) and 48 hours after the interventions, identical to the first one. SPSS for Windows (version 20.0) was used for all statistical analyses. A mixed design ANOVA (3x2) was used to investigate changes in algometry, peak torque normalized for body weight, median frequency and RMS. A 5% significance level was used ($p < 0.05$). RESULTS: In relation to algometry, a significant difference was observed for the control and cryotherapy groups, with a statistical difference at 48hr compared to pre and immediate post ($p<0.01$). However, no intergroup difference was observed ($p=0.15$). Analysis of peak torque normalized for body weight had altered values for both groups, demonstrating a difference at pre to immediate post and 48hr ($p<0.01$), but no intergroup difference ($p=0.77$). Analysis of electromyographic variables shows that median frequency was a significant difference in cryotherapy group, demonstrating an intragroup difference at post to pre and 48hr and intergroup difference between post ($p<0.01$). The electromyographic amplitude revealed no significant difference between pre, immediate post and 48hr after intervention in the two groups assessed ($p>0.05$) or any intergroup variation ($p=0.76$) (Figure 1). CONCLUSIONS: The cryotherapy with ice pack do not interfere in the response to eccentric exercise-induced muscle damage to any variable analyzed to brachial biceps.

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P1-B-24 Effect of whole body vibration on isokinetic performance and muscle activation of the quadriceps femoris: a randomized controlled trial

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Background and aim: Whole body vibration (WBV) has become a popular practice in training and rehabilitation centers. It works by a mechanism that produces vibrations in a combination of frequencies and amplitudes that are transmitted to the body in the form of mechanical energy in order to cause an increase in muscle recruitment by reflex triggered contractions. Despite being a widely used resource, there is a gap to be filled in the literature about the acute neurophysiological responses in skeletal muscle after WBV. This study analyzed the immediate effects of WBV with two distinct frequencies on neuromuscular performance of the quadriceps femoris of healthy subjects. Methods: 60 physically active women were submitted to an evaluation of isokinetic performance and surface electromyography of knee extensor muscles of the non-dominant limb. The variables analyzed were total work, average power and the root mean square (RMS) of vastus lateralis muscle. Immediately after the evaluation, intervention protocols were carried out. Subjects were randomly divided into three groups: group 30 Hz - performed an exercise protocol which consisted of staying barefoot in unipodal support on the non-dominant limb in the center of the vibrating platform, with 40o of knee flexion, while the upper limbs were extended at shoulder level and the trunk was kept in the upright position. The participants performed a total of 10 sets of 30 seconds, with rest intervals of 30 seconds between sets. The angle of the knee was monitored throughout the protocol with a universal goniometer to ensure that there were no changes in the amplitude. The vibrating platform was configured at a vibration frequency of 30 Hz and a vertical displacement amplitude of 4 mm; 50 Hz group - performed the same exercise protocol, but with the platform programmed at a frequency of 50 Hz and 4 mm of amplitude and control group - performed the exercise protocol with the platform off. The software SPSS (20.0) for windows was used for statistical analysis. A one-way ANOVA test was used to investigate baseline differences between groups. A two-way ANOVA for repeated measures was calculated to identify differences within and between pre- and post-tests. In the case of significance, post hoc comparisons (Bonferroni) were calculated additionally. A significance level of 5% was chosen. Results: No significant differences in anthropometric measures or variables analysed were observed in the baseline between the groups. There were no significant differences in total work, average power nor in the value of the RMS in any of the groups. Conclusion: The results of this study suggest that the exercise protocol associated with WBV is not able to significantly improve the neuromuscular performance of the quadriceps femoris of healthy subjects.

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P1-B-25 Immediate effects of stretching exercises on the electromyographic activity of hamstring muscles, before and after performing physical activities: a randomized controlled trial

Manuele Jardim Pimentel[1], Rodrigo Marcel Valentim da Silva[1], Daniel Tezoni Borges[1], Liane de Brito Macedo[1], Jamilson Simões Brasileiro[1]
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Background and aims: The realization of stretching before physical activity, training or sports competition is widely used in protocols in order to increase muscle flexibility and reduce the risk of injury. This study compared the acute effects of static stretching before and after isokinetic exercise, on electromyographic activity of the hamstrings. Methods: Eighty volunteers of both genders (age: 22.52 ± 2.6 years, BMI: 23.86 ± 3.2 kg / m) were randomized into 4 groups: control group (CG) just held the isokinetic exercise protocol (EP) for flexion-extension of the knee; Experimental Group 1: stretching (2 sets of 30 seconds of static auto-stretching of the hamstrings muscles) before the EP; Experimental Group 2: stretching after the EP and experimental group 3: stretching before and after the PE. To record the electromyographic activity, electrodes were placed according to the recommendations of the SENIAM for the biceps femuris (BF) and semitendinosus (ST) muscles. All subjects were positioned in the dynamometer and submitted to 5 maximal concentric contractions of knee flexors. The analyzed variable was the root mean square (RMS). A Kolmogorov-Smirnov test was applied to verify the normality of the data. A two-way ANOVA with Turkey post-hoc tests was applied to identify differences between groups. A significance level of 5 % was considered. Results: The electromyographic activity of Biceps Femoris (BF) and Semitendinosus (ST), after the intervention, presented a significant decrease in all the groups ($p<0,01$), but without significant differences between them. Conclusion: The realization of static stretching before and after an isokinetic exercise, does not alter the electromyographic activity of the hamstring.

P1-B-26 Examination of Lower Limb Ambidextrous Execution of the Snap Down Technique in Folk Style Wrestling

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BACKGROUND AND AIM: Folk style wrestling is the most popular form of wrestling in U.S high schools and universities. An important skill in folk style wrestling is the snap down, a skill that allows the wrestler to takedown the opponent from a standing position effectively.

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However, there is a lack of scientific literature that examines the kinematic motions of the snap down technique bilaterally. Understanding athletic ambidexterity is an important factor in athletic performance and injury prevention, particularly in wrestling as it enables athletes to coordinate and perform the skill from both sides of the body efficiently and safely. Therefore, the purpose of this research study was to bilaterally examine the kinematic motions of the lower extremity in the snap down technique. METHODS: Five male college wrestlers volunteered to participate in the study and signed a University-approved consent form. Joint reflective markers were placed on both sides of lower extremity at the shoulder, hip, knee, ankle and toe. The participants performed five snap downs with the dominant (right) arm and another five snap down with the non-dominant (left) arm against an opponent who was equipped with wresting gear. A camera captured the sagittal view of the snap down motion and a standard two-dimensional kinematics analysis was conducted using Ariel Performance Analysis System software. RESULTS: A paired sample t-test was conducted at á = 0.05 to examine differences between the kinematics of right and left hip, knee and ankle joints. The results of the study showed no statistically significant differences between right and left legs in hip, knee and ankle joint angles and velocities at the point of head impact with the mat. The only significant difference (p = 0.02) was in the angular acceleration of the ankle between right (1186.9 ± 498.9 °/s/s) and left (-380.8 ± 568.2 °/s/s) legs. Additionally, on the right leg, the wrestlers showed a positive angular velocity and positive angular acceleration in all three joints, indicating that the motion of the snap down was extending and speeding up. Conversely, the wrestlers showed a positive angular velocity but a negative angular acceleration in all three joints (i.e. extending but slowing down) on the left leg, indicating that the execution on the left non-dominant leg did not continuously accelerate through the point of impact, suggesting a lack of follow through on left leg. CONCLUSIONS: This finding suggests there may be a lack of muscle strength deficit and/or a level of unfamiliarity with non-dominant (left side) execution of the snap down. Hence, emphasis on ambidextrous execution of motor skills should focus on the non-dominant limb for sports performance improvement. Future studies are warranted to further examine similar sports skills and provide a comprehensive understanding of ambidexterity in sport skills.

P1-B-28 Kinesio Taping promotes neither immediate nor delayed changes in neuromuscular performance in healthy, active women

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BACKGROUND AND AIM: Kinesio Taping (KT) is an elastic bandage that aims to improve neuromuscular performance, although there is no consensus as to its benefits. In practice, this technique has been widely used by healthy people in order to prevent injuries and

increase neuromuscular performance, seeking better performance during physical activities, whether at the professional or amateur level. Thus, the purpose of the present study is to analyze the immediate and delayed effects of KT application on electromyographic activity of the vastus lateralis and isokinetic performance (total work) in healthy subjects. METHODS: This is a randomized controlled trial. Sixty women with a mean age of 22.2±3.6 years and BMI of 22.5±2.3 Kg/m2 were divided into three groups: control, with ten minutes of rest (control, n=20), application of Kinesio Taping without tension (placebo, n=20) and with tension (KT, n=20) on the quadriceps. The primary outcome was the electromyographic activity (root mean square) while secondary outcome was isokinetic performance (work). An 8-channel signal conditioning module with 16-bit resolution (TeleMyo Transmitter, Noraxon Inc., Scottsdale, AZ, USA) was used for signal acquisition and common mode rejection ratio (CMRR) >100 Db. Signals were captured on a sampling frequency set at 1500 Hz, filtered at a frequency between 10 and 500 Hz and amplified 1000 times. A computerized isokinetic dynamometer (Biodex Multi-Joint System 4, Biodex Medical Systems Inc., Shirley, NY, USA) was used to isokinetic performance evaluation (total work). The evaluations were performed at five distinct time points: before the intervention protocol (pre), immediately after (post), and 24h, 48h, and 72h after the intervention protocol. The last evaluation (72h) was performed 24h after the removal of KT. Estimates of average effect (differences between groups) for all variables were calculated using the ANOVA mixed model. This analysis model incorporated the intervention groups (control, placebo, and kinesio taping), time (pre, post, 24h, 48h, and 72h), and the group × time interaction. A significance level of 5% was adopted for all statistical analyses. RESULTS: No difference was detected between the groups in the assessments for the variables: VL muscle RMS (F=1.226, p=0.28) and total work (F=0.534, p=0.76). The results indicated that the application of KT does not promote immediate or delayed changes to electromyographic amplitude of VL or the average power of knee extensors. CONCLUSIONS: KT promotes neither immediate nor delayed changes in muscular performance of the femoral quadriceps in healthy women.

P1-C-29 Quantification of the expression of the flexion synergy using reach kinematics in pediatric hemiplegia

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BACKGROUND AND AIM: Pediatric hemiplegia (PH), which results from an early brain injury including pediatric stroke, causes weakness and movement impairments primarily on one side of the body. Based upon the developmental progression of the nervous system, injury timing may impact the presentation of motor impairments due to altered descending nervous system control. Previous isometric work has demonstrated weakness and the

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expression of upper limb synergies based upon timing of injury. Earlier injuries (pre-natal) may result in the maintenance of usable direct corticospinal connections for motor control whereas later injuries (post-natal) may lead to the reliance on more diffuse brainstem pathways such as the reticulospinal tract which may result in abnormal coupling of shoulder abduction with elbow, wrist, and finger flexion. As a result of this coupling, reaching and hand opening while lifting the weight of the limb is expected to be compromised more in those with post-natal injuries compared to those with pre-natal injuries. Limitations to accurate control of the limb to complete a task such as reaching can sizably limit a growing child's ability to interact with the world. Deficits in elbow extension, a main functional limitation to reach in PH, have been observed using 3D kinematics of the grasp and reach cycle. However, previous methods have not explored the factors contributing to the observed deficits. The aim of this study is to quantify the kinematics of the shoulder, elbow, and fingers during a dynamic reaching/grasping task as a function of shoulder abduction loading. METHODS: Using an admittance-controlled robotic device supporting the forearm, shoulder abduction loading is modulated by a percentage of maximum voluntary torque while the subject reaches forward and attempts to open the hand. Shoulder, elbow, and finger range of motion are recorded throughout the reach at each load level. By increasing the neural drive required to complete the task, this experiment probes at the limitations and differences in motor control between subjects who were typically developing and those with pre- and post-natal brain injuries resulting in PH. RESULTS: Preliminary findings show a significant reduction in reaching range at higher shoulder abduction loading levels in a prenatal individual. It expected that similar reduction in reaching range of motion will be seen at lower abduction loading levels in post-natal individuals. CONCLUSIONS: Quantifying reach and hand kinematics as a function of shoulder abduction loading enriches the understanding of altered motor control in PH as a function of time of injury. This is an imperative step for the development of more targeted and effective interventions to improve functionality in the subsets of this population.

P1-C-30 Priming the motor cortex by electrical stimulation of back muscles

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Peripheral electrical stimulation (PES) of limb muscles enhances excitability of the corticospinal pathway and is thought to aid motor learning. This may have application in rehabilitation of back pain, but has not yet been studied for trunk muscles. Recent research suggests differential effects of PES on the corticospinal excitability when applied to muscles of the leg and hand and for different muscles in the leg. For instance, unlike other leg muscles, excitability of spinal, but not cortical, inputs to the soleus muscle is increased after

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PES. This differential response suggests the mechanisms that regulate plasticity are muscle-dependent, and might be explained by the functional role of the muscles. For example, corticospinal inputs to postural muscles may be less affected by PES than muscles generally involved in voluntary tasks. As back muscles share an important role with soleus in postural control is possible that corticospinal inputs to lumbar muscles might be less amenable to the effects of PES than arm muscles. This study aims to investigate whether PES of back muscles changes excitability of corticospinal inputs to back muscles. 12 volunteers with no history of LBP. Pairs of intramuscular fine-wire were used to record myoelectric activity from deep multifidus (DM) and erector spinal at level of L3 (LES). Surface electromyography electrodes were used on lumbar multifidus at L5 (LMs), erector spinae at L3 (LESs), obliquus internus abdominis (OI), obliquus externus abdominis (OE). Transcranial magnetic stimulation was used to test corticomotor excitability (single pulse) and the short-interval intra-cortical inhibition (SICI) and long-interval intra-cortical facilitation (LICF) of corticospinal projections to DM. Active motor threshold (aMT) to evoke a motor evoked potential (MEP) in DM was determined and stimulation applied at 120% of this intensity. PES was provided via electrodes placed over the right multifidus. 20-min application of PES was set at intensity to induce a muscle contraction, 30 Hz of frequency and ramped at a rate of 6 surges-per-minute to mimic functional activation of the muscle. Mean aMT for DM was 42.7 + 10% of maximal stimulator output. Pairwise comparisons of MEP amplitude to single pulse paradigm did not indicate statistically significant effects for all trunk muscles examined. The effect sizes for DM and LES were found to be either ?neglegible? or ?small? for the rest of the muscles assessed muscles. No evidence also of changes in SICI or LICF; conditioned MEP amplitude was not different between trials after PES. This study show that PES of the paraspinal muscles seem less prone to induce changes in excitability of corticospinal inputs to the trunk muscles or modulate cortical facilitatory and inhibitory mechanisms. This suggests PES might be difficult to be used to ?prime? the paraspinal muscle system for motor learning. We propose a reduced efficacy of PES to influence cortical inputs to postural muscles

P1-C-31 Effect of Movement Velocity on Hip and Knee Muscle Onset Latency During a Single Leg Squat in Sunjects with and Without Patellofemoral Pain Syndrome

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BACKGROUND AND AIM: Patellofemoral pain syndrome (PFPS) is one of the most frequent diagnosis and it is described as an orthopaedic enigma. Several studies have evaluated lower limb muscle activity and onset latency during functional movements, but they have not considered movement velocity as an influential factor in movement performance. Therefore,

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the aim of this study was to find differences on hip and knee muscle onset latency between subjects with and without PFPS, and if these are accentuated at different velocities of a single leg squat (SLS). METHODS: In this case-control study participated 22 women (11 PFPS and 11 healthy). Surface electromyography (EMGs) was used to evaluate muscle onset latency of gluteus maximus (GM), anterior gluteus medius (AGm), posterior gluteus medius (PGm), rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL), and biceps femoris (BF) during 3 repetitions at high velocity (HV) and low velocity (LV) of a SLS. A two-way repeated measure ANOVA with factors: velocity (2 levels) and diagnosis (2 levels) was performed to each muscle onset latency. When statistical differences were observed, Bonferroni corrected t- tests was used. A paried t-test was used between levels when differences of a single factor (velocity or diagnosis) were observed. An alpha level < 0.05 was considered. Partial eta squared (ηp2) and Cohen´s d were used to calculate effect size. RESULTS: No interaction effect was observed between velocity and diagnosis for any muscle onset latency, although statistically significant differences were found to velocity factor for GM (F1 = 11.634; P = 0.035; ηp2 = 0.538) and AGm (F1 = 10.337; P = 0.045; ηp2 = 0.508), with a large effect size in both cases. Statistically significant differences were found between LV and HV for GM in PFPS group (P = 0.004; d = 1.016) and healthy group (P = 0.0215; d = 1.124), and for AGm in healthy group (p=0.0345; d= 0.849), with a large effect size for each case. CONCLUSIONS: GM and AGm showed an earlier onset latency at LV of a SLS for healthy and PFPS groups. Therefore, SLS performance velocity could affect hip onset latency regardless of subject condition. This could be considered by physical therapist and health professionals to evaluate the neuromuscular condition of these muscles in clinical field. Future studies should include a larger sample, another EMGs measures like muscle amplitude or recruitment order, that allow to explain the absence of differences between PFPS and healthy subjects.

P1-C-32 Contributions of vestibular and somatosensory systems to quiet standing in sighted and congenitally blind people

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BACKGROUND AND AIM: Congenitally blind people may have a different strategy to maintain balance in quiet standing, but the mechanism has not been fully explored. This pilot study was conducted to compare the contributions of the vestibular and somatosensory systems to quiet standing in blind and sighted people. METHODS: A total of 4 young adults (2 sighted (eyes closed) and 2 congenitally blind) participated in the study. Each subject stood (30 sec / trial, 3 trials / condition) bipedally under the following 4 conditions: hard floor with neutral head position (HN), hard floor with head extension (to reduce the input from the vestibular system, HE), soft floor (to reduce the input from the somatosensory

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system) with neutral head position (SN), and soft floor with head extension (SE). The head stability and center of pressure were measured using an accelerometer attached to the head and a force plate, respectively, in the anterior-posterior and mediolateral directions (Acc-AP, Acc-ML, COP-AP and COP-ML), and root mean square (RMS) amplitude of these signals were analyzed. RESULTS: At baseline (HN), most of the signals were similar between groups, but some were smaller for the blind subjects than those of the sighted subjects. For example, the Acc-AP was 0.057 (0.040 and 0.074), mean (2 subjects) m/sec and 0.107 (0.106 and 0.107) m/secc for the blind and sighted subjects, respectively. When the values from the 3 conditions (HE, SN and SE) were divided by the corresponding values from HN, the clear between-group difference was found only in the Acc-AP. Sighted subjects were able to maintain the head stability even at the most challenging condition (Acc-AP at SE = 1.01 (0.79 and 1.24)) although the COP-AP greatly increased at SE (2.47 (2.42 and 2.53)). In contrast, both the Acc-AP and COP-AP increased in the blind subjects (Acc-AP = 2.47 (2.44 and 2.50) and COP-AP = 4.26 (3.75 and 4.76)). CONCLUSIONS: These data suggest that blind people can maintain balance comparable to that of sighted people with no vision by depending more on the remaining two sensory systems, and the priority for head stabilization may differ for sighted and blind people.

P1-C-33 Decomposition of gyroscopic trunk sway for clinical assessment of standing balance

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It has been shown that movement of centre of pressure (COP) measured with a force plate during quiet stance can be decomposed into a low (rambling, Rm) and a high frequency component (trembling, Tr). The trembling component is highly correlated to the horizontal forces on the force plate (Fh), whereas the rambling component is not (Zatsiorsky, 1999). This suggests that they originate from different sources, a supraspinal and a spinal reflex, that each give clinically important information about balance (Solnik, 2014). The aim of this study was to develop and evaluate a method to decompose gyroscopic signals measured at the trunk during quiet stance to increase the clinical applicability of the method. Standing balance was measured repeatedly (n=6) on eight healthy subjects (age 41±7 years, weight 71±3 kg, 4 males). Measurements were simultaneously performed on a force plate and using a gyroscopic equipment mounted at the lower back close to the centre of mass (COM) measuring trunk sway in anterior-posterior direction. Rambling (plate_Rm) and trembling (plate_Tr) were decomposed from the stabilogram according to (Zatsiorsky, 1999, 2000). Trunk angular acceleration ($\ddot{x}$) was derived from the gyroscopic angular velocity ($\dot{x}$) and trunk angle (x) by integration of $\dot{x}$. A decomposition was based on $\ddot{x} = 0$, where the sum of all forces

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on the subject was considered to be zero. Gyro_Rm was constructed by a cubic spline between each point in x where ẍ =0, and gyro_Tr was x minus gyro_Rm. ẍ was filtered with a 4th order zero-phase Butterworth low pass filter at 2Hz. The cross correlation between Fh and plate_Tr was high, reproducing the results of (Zatsiorsky, 1999) with a mean corr. coef. of 0.90±0.04. The corresponding result for the gyro system was 0.17 ±0.20 and the corr. coef. between plate_Rm and gyro_Rm was 0.45±0.46. Also the agreement of RMS was low both for Rm and Tr with corr. coef. 0.46 resp. 0.25. The RMS amplitudes from the force plate were significantly higher for Rm and Tr compared to the gyro, two and six times respectively. If the human body movement during quiet stance could be completely modelled as an inverted pendulum, information from the balance control process should be found by measuring trunk sway as well as forces on a force plate. The low correlation between plate_Rm and gyro_Rm show that movement only at the trunk level inadequately describes the COM trajectory. For some persons the correlation was high, but in others knee and hip joints are likely to have impaired the pendulum movement. The amplitude of gyro_Tr was also much lower than that of plate_Tr. Thus, frequencies above 0.4 Hz are damped at the trunk. The movement of COP and COM have been found to correlate well when estimating COM from the whole body (Winter, 1995). Our study shows that a single wearable sensor on the back is not sufficient, but additional sensors on other body parts might enable better estimates of the Rm and Tr components of standing balance.

P1-C-34 Relationship between center of pressure and medio-lateral directions in the functional reach test: clinical projection in spinal cord injury

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BACKGROUND AND AIM: Individuals with a Spinal Cord Injury (SCI) often experience various degrees of motor or sensory impairments that can affect their trunk as well as their Upper Extremities (U/E) and lower extremities depending on the neurological level and the completeness of the injury to the spinal cord [1]. Postural balance is characterized using the displacement of the center of pressure (COP), in standing or sitting position [2,3]. Postural outcome measures commonly used to quantify postural balance include time and frequency domain parameters to measure the displacement, velocity, area and frequency characteristics of COP fluctuations over time [4]. Interpreting the results of postural balance assessment can be difficult to manage in clinical environments, particularly within SCI rehabilitation programs due to the large data set that can be extracted from the COP. A simple method that allows for straightforward interpretation is needed for quantifying seated postural balance in clinical populations. Modified Functional Reach Test (mFRT) was designed to assess sitting balance in individuals with SCI [5]. The aim of the current study was to evaluate the relationship

between seated balance function parameters based on COP and the mFRT in individuals with SCI complete. METHODS: Cross-sectional study. Twelve (individuals with SCI, according to American Spinal Injury Association (ASIA) grade A (11 males/1female; range 20-42 years; 2 tetraplegia, 4 high paraplegia and 6 low paraplegia). Individuals were tested using a force platform (AMTI OR67 and processing with Matlab R2012) during the quiet sitting position and the mFRT with/without force plate in the anterior, right lateral and left lateral directions. The sway parameters investigated were the area COP sway (COP-Sway), the average velocity of COP displacements along the anterior-posterior (COP-VAP in), and medial-lateral (COP-VML) directions and standard deviation in both directions (SD-AP and SD-ML). COP units and mFRT were expressed in centimeters, respectively. Pearson correlation test was used, ($p \leq 0.05$). RESULTS: The statistical analysis revealed moderate and large correlations between COP and mFRT in the medio-lateral directions (p less than 0.01). COP-Sway (r=0.64), SD-AP (r=0.60), SD-ML (r=0.64) and COP-VML (r=0.69) with mFRT right lateral direction. COP-Sway (r=0.82), SD-AP (r=0.58), SD-ML (r=0.74) and COP-VML (r=0.71) with mFRT left lateral direction. CONCLUSION: mFRT medio-lateral direction can be used as a clinical assessment instrument of the seated postural balance in people with SCI complete. [1] Sprigle et al. J Spinal Cord Med. 2003 Fall;26(3):236-43. [2] Galli et al. Mult Scler Relat Disord. 2015;4(6):594-7. [3] van Dieën et al. Gait Posture. 2010;31(1):42-6. [4] Grangeon et al. J Bioengineer & Biomedical Sci 2013;3: 124. [5[Harel et al. J Spinal Cord Med. 2013;36(2):127-33.

P1-C-35 Effect of body weight support on muscle activities during walking and running using a lower body positive pressure treadmill in healthy adults

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BACKGROUND AND AIM: Lower body positive pressure treadmills that can unload body weight have been recently used as a rehabilitative and training tool for individuals after sports injury and patients with gait disorders. In this study, the changes in muscle activities during walking and running on the treadmill with various levels of body weight support were investigated in healthy adults. In particular, we focused on the differences between gait modes (walking and running) at a given speed and among various muscles in terms of the effectiveness of body weight support on the muscle activity. METHODS: Healthy adult subjects performed walking and running at the same speed (6 km/h) on a lower body positive pressure treadmill at 5 levels of body weight support (100%, 80%, 60%, 40%, and 20% of their body weight). The level of body weight support was computer-regulated by changing the air pressure in the chamber of the treadmill. The body weight support conditions were randomly changed. The duration of each body weight support condition during walking and running was set for 2 minutes. To assess the level of muscle activity

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during treadmill exercise, surface electromyographic (EMG) activities in the muscles of the lower limb and trunk were recorded by a wireless system. RESULTS: The muscle activation pattern in each muscle was largely preserved at all 5 levels of body weight support during the exercise of walking and running. In the soleus muscle, significant difference was observed in the muscle activation level between the gait modes and among the body weight support conditions. Increased levels of body weight support caused greater decreases in the muscle activity in both gait conditions. In contrast, the EMG activities in the medial gastrocnemius muscle were not significantly affected by body weight support, although there was a significant difference in the muscle activities between the gait modes. The EMG activities in the latissimus dorsi, gluteus maximus, rectus femoris, and vastus medialis muscles were also decreased by increased body weight support. In the vastus medialis muscle, a marked decrease in the muscle activity caused by the body weight support was observed during running. In contrast, increased body weight support to 60% during both gait modes did not decrease muscle activities in the biceps femoris and tibialis anterior muscles. CONCLUSIONS: These results showed that the effect of body weight support on the muscle activation level differed among the muscles and between the gait modes at a given speed. These data might be useful for designing effective rehabilitation programs.

P1-C-36 The effect of acute pain and motor learning on sensorimotor integration and accuracy using a motor tracing task

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[1]UOIT

BACKGROUND AND AIM: Previous work demonstrated differential <changes in early somatosensory evoked potentials (SEPs) when motor learning occurred in the presence of experimental cutaneous pain, however the learning task was insufficiently complex to determine how these underlying neurophysiological differences impacted learning acquisition and retention. In order to address this limitation, we have developed and validated a novel and complex motor tracing task to be used in this study. Thus, the overall aim of this study was to investigate the interactive effects of acute pain on motor learning and sensorimotor integration (SMI) using a novel and complex motor tracing task. METHODS: Two groups of twelve participants (N= 24) were randomly assigned to either an intervention (capsaicin cream) or control (inert lotion) group. SEP amplitudes were collected at baseline, post-application and following motor learning. Participants performed a motor tracing task followed by a pain-free retention task within 24-48 hours while accuracy data was recorded. RESULTS: The P25 SEP peak differed significantly ($p<0.05$) following the application of capsaicin cream. For the control group, the N20 SEP peak significantly increased ($p<0.05$) while the amplitude of the N24 SEP peak significantly decreased ($p<0.001$) following motor learning. The N30 SEP peak was significantly increased ($p<0.001$)

following motor learning for both groups. Both the control ($p<0.001$) and intervention ($p<0.001$) groups improved in accuracy following motor learning. The control and intervention groups differed from each other at baseline ($p<0.05$), following motor learning ($p<0.05$), and approached significance at retention ($p=0.06$) with the intervention group outperforming the control group. CONCLUSIONS: The improved performance at baseline and following motor learning acquisition in the presence of capsaicin provides support for the enhancement of motor learning while in acute pain. In addition, the changes in SEP peak amplitudes suggests that early SEP changes are markers of SMI alterations accompanying motor learning which are negated with mild acute pain.

P1-C-37 Effect of neuromuscular electrical stimulation on motor cortex excitability upon release of tonic muscle contraction

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BACKGROUND AND AIM: The immediate onset of muscle relaxation following voluntary muscle contraction is a normal process in healthy subjects when they engage in centrally controlled motor activity, and it is important especially in activities (e.g., reaching) requiring precise temporal modulation and force output. Imaging studies have revealed that voluntary muscle release from an active contraction is preceded and accompanied by activation of the primary and supplementary motor areas. However, precisely how these multiple brain activities lead to termination of lower motoneuron activity and mediate muscle relaxation remains unclear. Neuromuscular electrical stimulation (NMES) is commonly used to treat gait disturbance like ?foot drop,? and paresis of the hand muscle with motor neuron lesions. A peripheral afferent input by NMES leads to cortical reorganization and changes in cortical excitability, resulting in compensatory and novel motor functions. Using motor-evoked potentials (MEPs), produced by a single pulse of transcranial magnetic stimulation (TMS), and short-interval intracortical inhibition (SICI), we investigated motor cortex excitability upon the onset of voluntary muscle relaxation, immediately following a period of voluntary tonic muscle contraction. In addition, we studied the effect of afferent input?produced by neuromuscular electrical stimulation (NMES) during muscle contraction?on motor cortex excitation. Two intensities of NMES were tested: 1.2 times the sensory threshold and 1.2 times the motor threshold (MT). METHODS: Fifteen healthy individuals participated in the study. They were asked to execute constant wrist extension and to release this muscle contraction upon hearing an auditory ?GO? signal. MEPs were recorded from the flexor carpi radialis (FCR) and extensor carpi radialis (ECR), while TMS was applied during the tasks at three different time intervals (30, 60, and 90 ms) after the ?GO? signal. The timing, order of auditory signals, and stimulations were varied among subjects using Lab VIEW, ver.7.1.

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(National Instruments Corp.; USA). Electromyography (EMG) activity was simultaneously recorded from the right ECR and FCR muscles with surface electrodes (1.0-cm diameter). The EMG and force transducer signals were amplified using a filtered channel with gain (bandwidth 5?2,000 Hz for EMGs and 0.01?1,000 Hz for the force transducer), which was digitized with an analog-to-digital interface (sampling rate = 5 kHz). The sampling recording time was 800 ms, including the 100 ms preceding the time of presentation of the ?GO? signal (pre-analysis period). RESULTS: Motor cortex excitability was greater during voluntary relaxation of the ECR and FCR with high-intensity NMES, while the relaxation time was shorter. Each parameter showed significant changes between 30 ms and 60 ms. Additionally, in both muscles, SICI was larger during NMES than in the absence of NMES. CONCLUSIONS: We propose that terminating a muscle contraction t

P1-C-38 Trunk muscle activation during position-control tasks in sitting

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BACKGROUND AND AIM: There is conflicting evidence regarding the degree of antagonistic trunk muscle activation required during isometric loading of the trunk. Several studies show prominent agonist/antagonist co-activation in situations with direction specific loading to the trunk whereas others report negligible co-activation. Furthermore, it is difficult to predict the potential for directional preference of activation of the deeper trunk muscles, in particular transversus abdominis, largely due to the lack of extensive bony attachment and varying fibre orientation within the muscle. This study aimed to compare activity of a range of trunk muscles in an unloaded upright sitting position and between directions of tangentially applied external loads. METHODS: Healthy participants sat in an unloaded upright semi-seated position. Intramuscular EMG was recorded from eight abdominal and back muscles on the right side. Recordings were made at rest and while resisting moderate inertial loads applied to the trunk in eight different directions. EMG amplitude of each muscle was measured for 1 s prior to peak expiration and was normalized to the peak activation for that muscle across loading directions. RESULTS: The median activation of all muscles in the unloaded upright position ranged from 2.8 % to 23.8 % relative the peak across loading directions, and the antagonistic activation (defined as activation in the load direction opposite that of maximum activation for each muscle) for all muscles ranged between 1.7 % - 28.5 %. Deep multifidus had the lowest, and transversus abdominis the highest relative activation, in both the unloaded position and in the antagonist direction. Antagonistic trunk muscle activation above that required to maintain upright sitting, was not significant for any muscle in the loading conditions. Furthermore, all muscles, including the deeper trunk muscles, demonstrated a directional preference of activation. CONCLUSIONS:

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Antagonistic muscle activity of amplitude equivalent to that recorded in unloaded upright sitting is sufficient to maintain control of the spine during predictable and sustained loading tasks of low to moderate magnitude. The activation of all trunk muscles varies with direction of loading.

P1-C-39 Altered integration of proprioceptive information for balance control is linked with prospective falls

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BACKGROUND AND AIM: Compromised postural control contributes to falls risk. Age-related changes in sensory information processing reduce postural stability and could increase falls risk. This has not been tested prospectively. Effective postural control shows adaptable integration of sensory information with changing environmental conditions. Muscle-tendon vibration provides proprioceptive input, which evokes an illusion of muscle lengthening. Postural change to compensate for the muscle lengthening illusion is reflected in a centre of pressure (CoP) shift, and its magnitude depends the weighting placed by the nervous system relative to other sensory information regarding posture. In addition, postural control might be affected as proprioceptive information is less valid due to vibration. We aimed to compare the effect of triceps surea, lumbar and cervical erector spinae muscles vibration on CoP shifts, and CoP dynamics before, during and after vibration between a group of elderly individuals who reported one or more falls (fallers) in subsequent 12 months compared to people who reported no falls (non-fallers). METHODS: Participants (n=102; 75.3±5.5 years; fallers: n=44; non-fallers: n=62) stood on a force plate (blindfolded) for 3 trials of 135s. In each trial, mechanical vibration (60Hz) was applied twice to the calf, back or neck for 15s at 15s and 75s after start of recording. CoP mean displacement and relative displacements when vibrating different muscles were calculated. Windowed recurrence quantification analysis (RQA, size: 15s, overlap: 14s) with fixed recurrence rate (5%) was applied to characterise postural control before, during and after vibration. Differences in the dependent variables between groups were tested using wavelet-based t-tests. RESULTS: Mean and relative displacements of CoP during muscle vibration were similar between the groups. RQA showed lower deterministic structure, lower entropy and lower laminarity in fallers than non-fallers after cessation of the second ankle, and first lumbar vibration periods. Neck vibration did not show differences between groups. CONCLUSIONS: Overall, fallers and non-fallers were perturbed a similar amount by vibration at each location, which implies that there was no reweighting of proprioceptive input from any region. However, structure of CoP motion

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after removal of vibration differed between groups which has several potential interpretations. This result could imply that non-linear measures provide a more sensitive evaluation of weighting applied to the proprioceptive input. Differences after second but not first ankle vibration could imply that fallers are less able to learn from exposure to the perturbing ankle vibration. In contrast, differences after first but not second lumbar vibration suggests the opposite. In summary, measures of structure of COP motion were related to prospectively-identified falls, but additional work is required to resolve the physiological interpretation.

P1-D-40 Spike timing-dependent plasticity in lower-limb muscles after incomplete spinal cord injury

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We previously demonstrated that repeated pairs of pre- and postsynaptic volleys arriving within a specific interval at the motoneuron pool of intrinsic hand muscles increase corticospinal transmission in humans with incomplete spinal cord injury (SCI). The extent to which this effect generalizes to lower-limb muscles is unknown. Here, we examined spike timing-dependent like plasticity (STDP) in the lower limb by targeting tibialis anterior (TA) motoneurones in individuals with chronic incomplete cervical SCI and in a group of control subjects. Two-hundred paired stimuli elicited by transcranial magnetic and peripheral nerve stimulation were delivered at 0.1 Hz. The resulting volleys were timed to arrive at the spinal cord to either facilitate (STDP%2B, presynaptic 2 ms before postsynaptic) or inhibit (STDP-, postsynaptic 15 ms before presynaptic) corticospinal transmission. We found that after the STDP%2B protocol, the amplitude of motor evoked potentials (MEPs) in the TA muscle elicited by magnetic stimulation of the motor cortex and electrical stimulation of the thoracic spinal cord were increased by ~80% ($p < 0.001$) and ~50% ($p = 0.02$), respectively. After the STDP- protocol, MEP amplitudes elicited by magnetic stimulation of the cortex and electrical stimulation of the spinal cord decreased by ~30% ($p = 0.002$) and ~20% ($p < 0.001$), respectively. In an additional experiment, participants produced repeated, brief isometric voluntary contractions of the TA before and after the STDP%2B protocol. Following paired stimulation, mean rectified electromyographic activity in the TA muscle and mean dorsiflexion force increased by ~25% ($p < 0.001$ and $p < 0.001$, respectively) in individuals with SCI. Our findings demonstrate that it is possible to elicit STDP-like mechanisms in residual corticospinal projections targeting lower-limb muscles after human SCI, which may complement therapeutic strategies intended to improve corticospinal control during locomotion.

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P1-D-41 Distributed stimulation to augment force evoked with functional electrical stimulation

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Background and Aim: Functional electrical stimulation (FES) involves artificial activation of skeletal muscle to restore motor function in paralyzed limbs. A major obstacle limiting use of FES, however, is the difficulty of generating sufficient muscle force. For example, FES systems applied to high-level tetraplegics require an external frame to support the arm because stimulation alone is insufficient to elevate the limb against gravity. Such weak contractions are not simply a consequence of muscle atrophy - indeed, the maximum force that can be evoked with electrical stimulation in healthy subjects is markedly less than that which can be generated voluntarily. One factor that might contribute to this force deficit is the highly distributed branching of intramuscular motor nerves. Such dispersion may make it difficult for a single electrode, as often used in FES, to activate the entire array of motor axons within a muscle. Therefore, the aim of this study was to determine whether stimulating a muscle with two current sources could boost force above that achievable with a single source. A secondary aim was to determine whether temporally interleaved stimulation between stimulation sites might reduce fatigue. Methods: Two tungsten electrodes were inserted into the anterior deltoid (~ 2 cm apart) of Rhesus macaque monkeys (n = 2). Monkeys were anesthetized, secured in a seated position with the test arm hanging in a vertical orientation. Shoulder flexion forces were recorded with a force transducer attached to the wrist. Surface electrodes served as return electrodes. Trains of pulses (1 s) were delivered repeatedly to one electrode at 35 Hz with current-pulse amplitude incremented in 1 mA steps until force output saturated. This process was then repeated for the other electrode. We then compared the force exerted during "maximal" stimulation delivered by each electrode individually to that generated by simultaneous stimulation through both electrodes. We then repetitively stimulated with 2-s trains for 4 min using one of three fatigue protocols with stimuli delivered at: 1) 35 Hz synchronously to both electrodes, 2) 17.5 Hz to each electrode but 180 degrees out of phase such that the stimuli to the two electrodes were interleaved, and 3) at 35 Hz to each electrode but interleaved. Only one protocol was tested per experimental session. Results: The two monkeys participated in a total of 29 experimental sessions. Overall, the force evoked by duel-electrode stimulation was 47±22% greater than that elicited with single electrode stimulation. Interestingly, however, there was no significant difference in fatigue across the three protocols (fatigue index: 0.33±0.08 synchronous 35 Hz, 0.29±0.06 interleaved 17.5 Hz, 0.26±0.14 interleaved 35 Hz). Conclusion: Distributed stimulation with more than one electrode offers a means to increase the force exerted with FES but does not appear to significantly reduce fatigue.

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P1-D-42 Long latency responses induced by Robotic Neuromodulatory Rehabilitation System for Paired Associative Stimulation

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BACKGROUND AND AIM: Paired Associative Stimulation (PAS) is a procedure that utilizes synchronously paired stimulation of the peripheral nerve and the brain. PAS can modulate motor cortical excitability and may thus facilitate the regaining of disabled motor function due to brain injury. The standard PAS uses electrical stimulation, but mechanical stimulation can be a better alternative. Since the timing between the central and peripheral nerve stimulations is essential in PAS, the aim of the study was to explore the feasibility of a new PAS modality using mechanical stimulation as the peripheral stimulation by examining the effective time window for synchronization. METHODS: Ten healthy subjects participated in this experiment. Robotic Neuromodulatory Rehabilitation System was designed and developed for applying mechanical stimulation as peripheral stimulation in a time-controlled manner. Mechanical stimulation was applied on the right wrist-flexor tendon. This mechanical stimulation did not induce long-latency stretch reflex by itself. As paired stimulation, transcranial magnetic stimulation (TMS) was applied to the motor cortex in the left hemisphere at various time intervals after the mechanical stimulation. For each time interval, ten neuromuscular responses (surface electromyogram, EMG) were analyzed from the flexor carpi radialis. 'Time window' was defined as the range of time interval in which four long-latency neuromuscular responses were observed out of ten. The number (range) of time intervals used in the experiment was different by each subject because each subject has different physiological characteristic. RESULTS: The time window (i.e. range of time interval that induced long-latency response by paired stimulation) was 55, 15, 15, 15, 30, 85, 100, 145, 80, and 50 ms for each ten-subject. A response was considered as long-latency response if its value was above certain threshold which is different by each. When the mechanical stimulation was replaced with electrical stimulation in one of the subjects (whose time window was 50ms), its time window was 20 ms. <CONCLUSIONS> The human subject experiments show the feasibility of Robotic Neuromodulatory Rehabilitation System for applying mechanical stimulation as a potential new modality in PAS. The range of time interval that induced long-latency response with the paired stimulation was varied for each subject. However there was certain range of time where we can expect long latency response. In looking at one subject data, mechanical stimulation appears to allow wider time window than that of electrical stimulation. A wider time window would indicate less timing constraints between TMS and mechanical stimulation timings. This is because the response to mechanical stimulation is more dispersed in time due to the desynchronized activation of muscle spindles compared to impulsive nerve response induced by electrical stimulation.

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P1-D-43 'Off-the-shelf' foot orthoses change knee load during walking in people with patellofemoral pain and mobile feet

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BACKGROUND AND AIM: Prefabricated or 'off-the-shelf' foot orthoses are frequently used in the management of patellofemoral pain (PFP), with clinical trials demonstrating their efficacy. However, mechanisms by which foot orthoses exert their therapeutic effects at the knee are unclear, especially in pain populations. Our previous work suggests that a subgroup of people with PFP, who have greater foot mobility, have a greater likelihood of success with foot orthoses. It is plausible that this subgroup may be more responsive to a mechanical foot intervention, and thus demonstrate more consistent changes in knee load in response to foot orthoses. This study explored whether people with PFP and mobile feet exhibit different effects on knee load when walking with foot orthoses, compared to shoes alone, than those with less mobile feet. METHODS: 36 people with chronic PFP (duration ≥3 months; 19 females; mean±SD age 36±7 years; BMI 25±4 kg/m2) participated in a within-subject, repeated measures immediate effects study. Midfoot width was measured at 50% of foot length, in weight bearing (WB) and non-weight bearing (NWB), and midfoot width mobility calculated as the difference between WB and NWB measures. K-means cluster analysis was used to classify participants into two homogenous groups based on midfoot width mobility (Group 1: 2.3-9.3mm; Group 2: 9.8-17.4mm). Gait data were collected during level walking under two conditions: (i) sandal (Nike Strap Runner); and (ii) sandal with prefabricated foot orthoses (Vasyli International), using a nine-camera VICON motion analysis system (Oxford Metrics) and three AMTI ground-embedded force plates. Peak external knee adduction moment (KAM; first peak) was calculated for each condition, and the average of three trials used. Paired t tests investigated differences in peak KAM between the shoe and orthosis conditions ($p < 0.05$), for each foot mobility group. RESULTS: Group 2 demonstrated a significant increase in peak KAM when walking with foot orthoses, compared to shoes (mean difference 0.03 Nm/kg, 95% CI 0.01 to 0.05, p=0.015). No significant difference was observed in Group 1 (0.002 Nm/kg, -0.02 to 0.02, p=0.855). CONCLUSION: In people with PFP, prefabricated foot orthoses appear to impart changes in frontal plane knee load during walking in those with greater midfoot width mobility, but not those with less mobility. The direction of change is favourable in a population that typically demonstrates increased dynamic knee valgus. Taken with previous findings, it is plausible that biomechanical factors play a role in therapeutic outcomes with foot orthoses, but only in those with more mobile feet.

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P1-D-44 Activity-dependent axonal hyperpolarization contributes to NMES-induced contraction fatigability

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BACKGROUND AND AIM: There are numerous benefits in using neuromuscular electrical stimulation (NMES) as a rehabilitation tool to improve the quality of life for those living with a neurological disease or motor-impairment. Unfortunately, these benefits are limited by rapid muscle contraction fatigability. Recently it has been suggested that activity-dependent hyperpolarization of motor axons under the stimulating electrodes contributes to this fatigability. After axons conduct trains of impulses they become less excitable (hyperpolarize) and the threshold current required to generate a propagating signal increases. The present study was undertaken to determine the magnitude and time course of activity-dependent axonal hyperpolarization during NMES delivered at three stimulation frequencies. METHODS: NMES was delivered at 20, 40, or 60 Hz to the common peroneal nerve to generate 480 contractions over 8 min, using 200 µs pulse widths and a 0.3 duty cycle (300 ms stimulation, 700 ms rest). Axonal excitability was measured as changes in the stimulation current required to produce a compound muscle action potential of ~30% of maximum, using the QTRAC threshold-tracking program. Axonal threshold current measurements were recorded using 200 µs pulses before and at one second intervals during the 8 min of NMES. NMES was delivered at an intensity larger than the threshold tracking pulse in order to ensure that only fatigued populations of axons were being tested. The rate of threshold change was calculated as the time between 10 to 90% change during the 8 min of NMES. RESULTS: Early results from one participant show that there was an increase in axonal threshold current during NMES, and this change was larger at higher frequencies. Threshold increased ~15% with 20 Hz stimulation, and ~25% with 40 and 60 Hz stimulation. Threshold change during fatigue occurred fastest with 60 Hz NMES (3.58 min) and at a slower rate with 20 and 40 Hz NMES (5.97 and 6.08 min, respectively). CONCLUSIONS: Activity-dependent axonal hyperpolarization plays a role in NMES-induced contraction fatigability and the magnitude and time course of threshold current change is frequency dependent. The magnitude of threshold current changes were larger and the time course was faster with higher NMES frequencies than with lower NMES frequencies. The results of these experiments provide insight into the biophysical changes that occur in axons during NMES. The results may be useful to improve the efficacy of NMES by minimizing contraction fatigability, particularly for those individuals that use it as a therapeutic tool, and thereby helping to improve their quality of life.

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P1-D-45 Performance and brain activation during slow speed and anatomical motion movie observation

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BACKGROUND AND AIM: A motion observation is one of the therapeutic options for rehabilitation of physical dysfunction to acquire a new motor skill. Previous studies indicated the motion observation facilitates motor learning of a novel motion and activates the motor cortex similar to performing an actual movement. For a systematic motion observation, it is necessary to produce the apparent movement imagery induced by the motor imagery, and it is important to choose the efficient viewing material. Motion movies: natural and slow speed; a first-person perspective anatomical and inversion view, are used for the viewing material of the motion observation. However, the best movie speed and the method of displaying the motion video for motion observation, influencing the motor cortex activations and the acquisition of motor skill, are currently unclear. The objective of this study was to assess the effect of motion observation from different directions, magnitude and distribution of elicited brain activation. METHODS: Seven right-handed healthy adults who had no experience of performance task joined our study and performed a multi-joint separate motor task considered of 45 trials by their dominant and non-dominant upper limbs. All trials were divided into three practice blocks (each consisted of 15 trials), and the number of successful trials was collected. Motion movie's speed was five times slower than the normal one, and the motion observation was performed under three different conditions: a first-person perspective anatomical view (model 1), inversion of model 1 (model 2) and non-motion (model 3). During the task, we measured the hemodynamic responses oxygenated hemoglobin around the primary motor cortex (M1) on both hemispheres using functional near-infrared spectroscopy (fNIRS). The successful trials and the hemodynamic responses for the three different models was compared. Results: Observing Model 1 showed a significant increase in the number of successful trials and hemodynamic responses in M1 areas on both their dominant and non-dominant upper limbs in compared with Model 2 and Model 3. CONCLUSION: This finding revealed that the slow motion movie's speed and a first-person perspective anatomical view is more effective during motor learning.

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P1-D-46 Evidence-based prescription of shoulder rehabilitation exercises as determined by EMG

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BACKGROUND Implementation of overhead activity, a key component of many professional sports, requires an effective and balanced activation of the shoulder girdle muscles, particularly during forceful external rotation (ER) motions. Study aimed to identify activation strategies of 16 shoulder girdle muscles/muscle segments during common shoulder ER exercises. METHOD Thirty healthy subjects were included in this study, and 16 shoulder girdle muscles/muscle segments were investigated (surface electrode: anterior, middle, and posterior deltoid; upper, middle, and lower trapezius; serratus anterior; teres major; upper and lower latissimus dorsi; and upper and lower pectoralis major; fine wire electrodes: supraspinatus, infraspinatus, subscapularis, and rhomboid major) using a telemetric electromyography (EMG) system. Five ER exercises (standing ER at 0° and 90° of abduction, with underarm towel roll, prone ER at 90° of abduction, side-lying ER with underarm towel) were studied. Exercise EMG amplitudes were normalized to EMG at maximum ER force in a standard position. Univariate analysis of variance and post hoc analysis applied on EMG activity of each muscle were used to assess the main effect of the exercise condition. RESULTS Muscular activity differed significantly among the ER exercises ($P < .05$ to $P < .001$). The greatest activation for anterior and middle deltoid, supraspinatus, upper trapezius, and serratus anterior occurred during standing ER at 90° of abduction; for posterior deltoid, middle trapezius, and rhomboid during side-lying ER with underarm towel; for lower trapezius, upper and lower latissimus dorsi, subscapularis, and teres major during prone ER at 90° of abduction; and for the clavicular and sternal part of the pectoralis major during standing ER with underarm towel. CONCLUSION Key glenohumeral and scapular muscles can be optimally activated during specific ER exercises, particularly in positions that stimulate athletic overhead motions.These results enable sports medicine professionals to target specific muscles during shoulder rehabilitation protocols while minimizing the effect of others, providing a foundation for optimal evidence-based exercise prescription. They also provide information for tailored muscle training and injury prevention in overhead sports.

P1-D-47 The effect of circumferential pressure on soleus muscle stiffness

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Circumferential pressure (CP) has been shown to decrease muscle activity in subjects without neuromuscular disorders and in individuals with spinal cord injury or cerebrovascular accidents. The mechanism for this decrease is unknown although it has been hypothesized to be spinal in origin. Spinal mechanisms of Ia reciprocal inhibition, pre-synaptic inhibition, nerve ischemia and nerve compression have all been studied and shown not to be involved. These results suggest CP's affect on the reflex arc may not be on the motoneuron (MN) reflex arc but rather on the mechanical properties of the muscle itself. Therefore, it is possible that the air splint simply "clamps" the muscle down, making it unable to stretch. Because the H-reflex is transmitted by Ia afferent fibers which monitor the velocity of a muscle's stretch, a decrease in stretch would result in a decrease in H-reflex amplitude. This decrease in a muscle's ability to stretch can be measured by looking at that change in force production during a quick stretching force applied to the muscle (muscle stiffness). The purpose of this study was to investigate the effects of CP applied to the leg on plantar flexor muscle stiffness. A positive result will explain the decrease in H-reflex amplitude found in previous neuromuscular studies. METHOD: Thirty-two healthy volunteers participated in this study. All subjects read and signed an informed consent form approved by the University's IRB. Subjects laid prone on a table with their knee flexed to 90º with the shank and foot secured. A pneumatic air splint was placed around the calf. Subjects then performed 3 maximum plantar flexion contractions. The mean force of these isometric contractions were converted to torque (maximum produced isometric torque-MPIT). The experiment began with the participant isometrically pressing against a stationary footplate and ramping up their contraction strength at 50NM / sec. until 60% of MPIT was reached. While the subject was maintaining their contraction level, a Kin-Com dynamometer randomly moved the foot in a dorsiflexion direction at 240º/ sec. stretching the posterior calf muscles. The muscle response to this stretch was recorded and saved. The process was repeated 10 times at 5 sec. intervals. This procedure was repeated 2 times; once before and again during CP. During the pressure phase of the experiment the pneumatic cuff was inflated manually to 50-55 mmHg. A one-way repeated measures ANOVA was used to compare stiffness before and during air splint inflation. RESULTS AND DISCUSSION: No statistically significant difference was found in plantar flexor stiffness between the two pressure levels. Therefore, CP does not affect muscle stiffness of the planarflexor muscle group. This suggests that the decrease in muscle activity (MA) observed in previous CP studies were not related CP's affect on muscle. Decrease MA must be due to some other mechanism.

P1-D-48 Effects on cervical spine kinematics following Ergo-Motor intervention: an integrated approach combining motor control training and ergonomics

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Background Work-related neck-shoulder disorders are highly prevalent in the workplace and outcomes of conservative interventions may be varied. With the contributing factors of problems associated with motor control and work-related physical stress, this study examined a new and integrated approach by combining the intensive motor control training and ergonomic intervention for management of people suffered from chronic neck-shoulder disorders. Methods 85 adults suffered from chronic neck-shoulder disorders were randomized into 2 intervention groups, namely the Ergo-Motor (EM) group and Conventional Physiotherapy (CO) group. Participants in CO group received a 12-week conventional treatment for pain relief and general mobilization exercises. EM group received a same period of intervention with individualized programme that integrated motor control training of the neck and shoulder region, advice and modifications of the workplace ergonomics. Cervical and scapular kinematics was examined during self-paced active neck movements test in all three movement planes using the three dimensional motion tracking system, before and after the intervention. The neck movements were performed with and without the setting of scapulae close to the optimal position. Three-way analysis of variance was used to compare the response of the cervical and scapular kinematics for comparisons 1) between CO and EM groups 2) with and without optimal scapular setting and 3) before and after the course of intervention. Results There was no significant difference of the cervical mobility before and after the intervention in both groups. Significant improvement of the cervical velocity and acceleration in all three movement planes was found in all participants when performing neck movement tests with and without the scapula position settings. EM group demonstrated a significantly greater improvement on cervical velocity and acceleration in flexion-extension direction compared to CO group (Figure 1). Significant decrease in the difference of scapular posterior tilting between trials with and without scapular position setting was found only in EM group before and after the 12-week intervention. Conclusions The innovative intervention approach which integrates the tailor-made training of motor control in the workplace resulted in superior improvement in the differential kinematics of the cervical spine during active neck movements compared to conventional group. The significant interaction effect found in the difference of the scapular positions between two scapular settings, before and after the course of intervention implies that modification of the motor control strategy in EM group in terms of the postural awareness and more optimal scapular position. Such change of the motor control pattern found in the neck-shoulder region in EM group may possibly contribute to a more sustainable improvement in work-related musculoskeletal symptoms in the long-term.

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P1-D-49 Validity of estimation of pelvic floor muscle activation through transperineal ultrasound imaging in women

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BACKGROUND AND AIM: Ultrasound imaging (USI) is becoming a popular means for evaluating muscle activation in rehabilitation settings. USI has been used to evaluate pelvic floor muscle (PFM) structure and function in women with urinary incontinence, pelvic pain, and pelvic organ prolapse. Changes in pelvic morphology seen during contraction, Valsalva and coughing tasks have been attributed to PFM contraction and relaxation. However, USI has not yet been validated as a tool to study PFM activation. The purpose of this study was to investigate the relationship between PFM activation, recorded using intravaginal surface electromyography (EMG), and changes in sagittal plane pelvic morphology measured using transperineal USI. METHODS: Eight healthy, nulliparous women without urogynaecological symptoms participated in the study. Each woman performed three repetitions of a PFM maximum voluntary contraction (MVC) while EMG data were recorded at 1000 Hz from both the left and right sides of the vaginal wall using differential suction electrodes, and pelvic morphology was imaged transperineally using a GE Voluson-i USI system using a 4.5-9Mz curvilinear 3D probe. To synchronize the USI with the EMG, a trigger pulse was used on a third EMG channel to mark the time at which the USI began. EMG data were rectified and smoothed using a fifth-order, 3Hz dual-pass low- pass filter and normalized to the peak of each trial. EMG data from the right and left side of the vaginal wall were averaged. USI data were processed through visual inspection. The levator plate length (LPL), the perpendicular distance of the bladder neck (BN) to the levator plate, the distance of the BN to the posterior aspect of the pubic symphysis (PS), and the distance of the urethra to the PS at the point where it passes through the levator plate were identified on each USI frame and motion profiles were computed across each trial. The motion profile data were interpolated to 1000Hz and normalized to the peak of motion of each morphological feature for each trial. The onset of EMG activation (using the averaged EMG from right and left sides) and onset of change in LPL, BN position, BN excursion and urethral excursion during each trial were then determined for each trial through visual inspection using a custom Matlab GUI. The cross correlation coefficients and the relative timing of PFM EMG activation onset were computed for each morphological feature. The relative timing of activation, and the correlation coefficients between PFM EMG and pelvic morphology were compared using one-way analysis of variance models (ANOVAs), and Tukey's pairwise comparisons (α=0.05). RESULTS: In seven of eight participants, changes in pelvic morphology followed closely with PFM EMG activation (Figure 1a), yet in one woman (P2), the BN and urethral motion did not track well with PFM EMG activation although the LPL did (Figure 1b). All correlation coefficients between the PFM EMG signal and motion of the different pelvic morphological features were good (>0.90) and highly significant ($p<<0.001$), even those computed including P2. The

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relative timing of onset of activation was highly variable and was not different between the PFM EMG and changes in morphology. The correlation between PFM EMG and LPL was significantly higher than the correlations between PFM EMG and BN and urethral motion ($F=3.60$, $p=0.009$). CONCLUSIONS: Using sagittal plane pelvic morphology, changes in LPL, BN position relative to the levator plate, and BN and urethral displacement relative to the PS are all highly correlated with PFM activation and can therefore be used to infer PFM activation. Because the BN and urethra are not directly attached to the PFMs their motion may be influenced by other factors, particularly intra-abdominal pressure. Changes in LPL are most closely associated with PFM contraction compared to measures of BN or urethral motion, the latter requiring cautious interpretation.

P1-D-50 System Identification of Two Degrees of Freedom EMG-Force at the Hand-Wrist Using Dynamic Models

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BACKGROUND: Commercial myoelectric hand-wrist prostheses use surface EMG from the residual forearm muscles to control movement, thereby realizing partial function. Traditional prostheses only control 1 degree of freedom (DoF) at a time, regulating the hand or wrist separately. This project studied the feasibility of controlling 2 DoFs--hand and wrist simultaneously. In addition, previous research studies required a large number of electrodes to extract 2-DoF EMG information, which is not practical for commercial prostheses. Our study explored the minimum number of electrodes required for hand-wrist control. METHODS: Ten able-bodied subjects finished the experiment, one of which was excluded due to erroneous EMG values. Sixteen bipolar EMG electrode-amplifiers were equally spaced in a transverse row around the proximal forearm. The hand was secured to load cells that measured 1-DoF hand open-close (Opn-Cls) force and 3-DoF wrist forces/moment. A screen located in front of the subject showed the load cell outputs and a computer-generated random moving target. Subjects used the load cell feedback signals to track the movement of the computer target. Initially, 1-DoF trials separately tested hand Opn-Cls or wrist extension-flexion (Ext-Flx), radial-ulnar deviation (Rad-Uln) or pronation-supination (Pro-Sup). Then, 2-DoF trials tested hand Opn-Cls coupled with one of the three wrist dimensions. Each different movement had four trials; two were used for training and two for testing (RMS error normalized in %MVC). Linear dynamic FIR models were fit using regularized least squares. Backward stepwise selection was used to reduce the number of selected electrodes from 16 down to 1. RESULTS: For 1-DoF models, ANOVA with Tukey post hoc tests showed that at least 2 electrodes were necessary, with no significant difference in error found with more electrodes. With 2 electrodes, the errors for Opn-Cls, Ext-Flx, Rad-Un and Pro-Sup

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were: 11.2±2.0%, 8.2±1.7%, 8.8±1.3% and 8.9±2.6 %MVC. Opn-Cls always exhibited higher error than the other three DoFs (P<1E-4), and Rad-Uln errors were significantly higher than Ext-Flx (P=1E-4). For 2-DoF models, 4 or 5 electrodes were required to obtain an error which was not significantly different from using more electrodes. With 4 electrodes, errors for Opn-Cls combined with one of Ext-Flx, Rad-Un or Pro-Sup were: 8.9±1.8%, 8.9±1.6% and 9.2±1.3 %MVC. Pair-wise sign tests between different motion combinations showed that there was no significant error difference (P>0.8 for all three paired comparisons). CONCLUSION: The results show that 2-DoF control demonstrated similar error levels when compared to 1-DoF control (which represents the current state of the art). Two-DoF prosthesis control with a small number of electrodes may be feasible. Further study including limb-loss subjects is warranted.

P1-D-51 In vivo characterization of muscle viscoelastic properties using shear wave elastography

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BACKGROUND AND AIM: The net force in a muscle can be generated by active and passive components that depend, respectively, on the contractile elements of muscle cells and the connective tissues within and surrounding them. These microscopic structures can each be affected by disease and injury, thus leading to altered muscle mechanics. Presently, there are no non-invasive techniques for quantifying the passive and active contributions to intrinsic muscle mechanics, as would be needed to identify the mechanisms of disease and injury or to track therapeutic interventions targeting them. Ultrasound-based shear wave elastography is a promising technology for characterizing muscle mechanics. Most previous applications have considered only the elastic properties of muscle. However, muscle is viscoelastic, and viscoelastic characterizations in other biological tissues have been used to link microscopic structure to macroscopic properties. The objective of this study was to determine if shear wave elastography could be used to separately characterize the active and passive forces generated within a muscle while considering the viscoelastic properties. METHODS: Ultrasound-based shear wave elastography data were collected from the biceps brachii muscle using a Supersonic Aixplorer system. Data were collected from 7 healthy adults. Biceps active force was regulated by voluntary activation at 0, 10, 20, and 30% of maximum voluntary contraction as measured using electromyography and elbow torque. Passive force was regulated by changing muscle length using elbow flexion angles of 80, 90, 135 and 180 degrees. Shear wave phase velocities were estimated from the ultrasound data over a range 0 - 800 Hz. A Voigt model was fit to the estimated phase velocities and compared between active and passive conditions. RESULTS: An analysis of the group results

showed that muscle elasticity increases significantly with both active contraction ($p < 0.001$) and passive stretch ($p < 0.001$). In addition, the viscosity increases significantly ($p < 0.001$) as a function of activation level when the force is modulated by active contraction, but it shows little increase as a function of muscle length when the force is modulated by passive stretch. CONCLUSIONS: Our results agree with previous findings that shear wave elastography is sensitive to muscle force, and that the elastic components of muscle change with passive and active force generation. Our main contribution is demonstrating that viscosity is much more sensitive to actively generated muscle forces than to passively generated forces. This result is likely due to the microscopic structures transmitting force within a muscle, and how those structures are differentially stressed during active and passive loading. Future work will explore the mechanistic relationship between these structures and the macroscopic properties accessible with elastography.

P1-D-52 Reorganization of neuromuscular coordination when learning new cycling tasks

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BACKGROUND AND AIM: Cycling training in combination with biofeedback can be used to promote neural plasticity in subjects with neurological injury. Our principal aim was to test the effectiveness of a new and simple biofeedback technique, based on online visualisation of EMG activity, in modifying the neuromuscular coordination of lower limb. In order to measure the neuromuscular coordination, we used muscle synergies analysis, which has been demonstrated as a valid technique to describe most the variance of EMG of healthy and neurologically injured people during cycling. In particular, we were interested in investigating how the number and structure of muscle synergies and their activation coefficients will change when the subject is learning to modulate the timing of one specific muscle activity. METHODS: We included four healthy subjects in the experiment. The protocol consisted in three separate training sessions. In each session the subject was asked to change the peak of activation of one muscle, whose EMG envelope was extracted online and displayed visually at the end of each cycle, during four trials of 60 cycles each. The three training session were targeted to three different muscles, i.e. tibialis anterior (TA), gastrocnemius medialis (GM) and vastus lateralis (VL). We extracted muscle synergies and activation coefficients from eight lower limb muscles, and analyzed the differences between pre and post training session. RESULTS: Preliminary results showed that the biofeedback technique was effective in changing the timing of the target muscle. We also observed changes in the neuromuscular coordination, especially in the activation coefficients, whereas the muscle synergies were not visibly affected by the learning process. We also observed that the changes in the activity of

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the target muscle induce effects on other muscles not belonging to the same synergies. Whether this comes from a neural or biomechanical coupling should be clarified. CONCLUSIONS: Online biofeedback on EMG during cycling demonstrated to be effective in modulating the neuromuscular control of cycling, and in particular in modifying the timing of muscle synergies while preserving a modular control. Future work will be devoted to clarify the mutual effects between the changes in the target muscle and the other muscle synergies. These results support the use of cycling in combination with biofeedback as a potential new technique to restore coordination in people affected by neurological injury.

P1-E-53 Changes in the respiratory and the stomatognathic system caused by idiopathic scoliosis

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AIM: Scoliosis produces deviations of the physiological curves in the frontal and sagittal planes, leading to spinal deformities, changes in the respiratory and ventilatory mechanics, and pathophysiological imbalance in the stomatognathic system. The present study aimed to analyze the changes in the respiratory and stomatognathic system caused by acute idiopathic scoliosis. METHODS: Twenty women, aged 18 to 30 years (23.80 ± 2.94 years) were divided into two groups: Scoliosis Group (n=10) with acute idiopathic scoliosis and Control Group (n=10) with healthy participants. The masticatory muscle activity and the muscle activity of the spine were evaluated by means of EMG. A manuvacuometer was used to measure the respiratory muscle strength to understand how the disorders caused by severe idiopathic scoliosis in the spinal system can affect the performance of both the stomatognathic and the respiratory system. EMG and respiratory muscle strength data were tabulated and submitted to statistical analysis (SPSS 21.0) using the Student's t test for independent samples, with a significance level of 5% and a 95% confidence interval. RESULTS: The significant statistical difference was found between both groups in conditions of rest for the right temporal muscle (p=0.02), clenching with parafilm for the right temporal muscle (p=0.03), chewing raisins for the masseter muscle (p=0.05), chewing peanuts for the masseter muscle (p=0.03), cervical flexion in neutral posture for the right sternocleidomastoid muscle (p=0.03), lumbar spine in extension for the multifidus muscle (p=0.04), maximal inspiratory and expiratory pressure (p=0.01). The results obtained showed that the convex side of the curve in severe idiopathic scoliosis has produced functional changes in the stomatognathic system, increasing the action potential of the masseter, temporal and sternocleidomastoid muscles. CONCLUSION: The results showed that the

inspiratory and expiratory muscle strength was reduced by the influence of the action potential of the multifidus muscles that create rotational moment between vertebras. It can be concluded that acute idiopathic scoliosis interferes in the clinical conditions of mandibular rest, clenching with parafilm, chewing raisins and peanuts, cervical flexion in neutral, extension of the spine and respiratory muscle strength. ACKNOWLEDGEMENT: FAPESP (2013/22199-3)

P1-E-54 Functional analysis of the stomatognathic system in individuals with fibromyalgia syndrome

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AIM: Fibromyalgia syndrome is characterized by the presence of diffuse pain and chronic symptoms of morning stiffness, fatigue, sleep disorders and presence of tender points. The objective of this research was to analyze the effects of fibromyalgia syndrome in the performance of the masticatory muscles. METHODS: This study was previously approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of Sao Paulo. A sample of 69 women (40-65 years) Were divided in two groups: 34 women health (Control Group) and 35 women with fibromyalgia syndrome (fibromyalgia Group - FG). All Individuals were submitted to EMG test measured on masseter and temporal (right and left) muscles using the EMG-Br1 Myosystem®. These muscles were analyzed during usual mastication and postural movements like rest, protrusion, left and right laterality. The values were normalized by the value of the electromyographic signal of maximum dental clenching, harvested by four seconds. The electromyographic means were subjected to tabulated and statistical analysis using t test (SPSS version 21.0). RESULTS: The results observed in participants with fibromyalgia syndrome showed greater electromyographic activity in the clinical conditions of rest, left and right laterality and protrusion of the jaw for all analyzed muscles. During chewing of soft foods (raisins) and hard (peanuts) there were lower values of masticatory efficiency to the members of the group with fibromyalgia syndrome. CONCLUSION: Based on these results, we can conclude that the participants with fibromyalgia syndrome have compromising conditions of the stomatognathic system that may reflect the facial fatigue and occasional pain in the region of the face and neck, which can compromise the activity of chewing of the stomatognathic system.

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P1-E-55 Effects of regionally selective activation of trunk muscles on dimensions of upper and lower thoraxes during respiration

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BACKGROUND: Chest movements may be categorized into several patterns depended on the skeleton flexibility and trunk muscle activity (Fujihara et al., 2012). We are attempting how these categorized chest movements could be utilized as interventions for respiratory diseases. Here we investigate effects of regional activities of trunk muscles on upper and lower chest movements during respiration to understand the kinetic chain in chest upon selective activation of abdominal and back muscles. METHODS: Subjects were 12 healthy adults (24.0±2.4 yo). Using medical stimulator, mild electric stimuli were applied two ways: one simultaneously onto two regions of bilateral upper back and frontal abdominal muscle group (UAP stimulation) and the other onto two regions of bilateral upper chest and lower back muscle group (ULP stimulation). Using 3-D motion analysis system (ViconMX), chest movements were captured with markers on the midpoint of bilateral 3rd sternocostal joints (R3), xiphoid process (XP) and spinous processes of 4th (T4) and 10th thoracic vertebra (T10). Anteroposterior diameters (APDs) of upper thorax (R3-T4 distance) and lower thorax (XP-T10) were regarded as upper and lower thorax dimensions, and extents of expansions of upper and lower thoraxes were estimated during resting respiration for 1min (control) and test respiration with electrically stimulated muscles for stable 30 sec. Using gas analyzer, tidal volume (TV) was measured simultaneously along above measurements. Tested values were normalized as % of control (mean±s.d.). Paired t-test was used for statistical analyses. Ethics Committee of Bunkyo Gakuin University, approval 2015-0007. RESULTS: APDs of upper thorax, but not lower thorax, at expiratory and inspiratory levels were significantly bigger in UAP stimulation (100.3±0.7 and 100.4±0.8%, respectively) than ULP stimulation (99.9±0.6 and 99.9±0.5%). The extents of thorax expansion were not different between UAP and ULP stimulations. While, ULP stimulation elicited increased values of TV in 9 out of 12 subjects as compared with UAP stimulation, although the mean values were not significantly different. CONCLUSION: The results suggest that regional selective stimulations of trunk muscles produce different effects between upper and lower thorax dimensions. The selective stimulation of UAP was revealed as increases in upper thorax dimension at both expiratory and inspiratory levels, suggesting that UAP stimulation shifts the upper thorax to more inspired levels. Although insignificant in mean values, ULP stimulation seemed to increase in TV in many subjects. The main factor for this TV increase may be the decrease in thorax dimension at expiratory level, presumably leading to the efficient expiration. Though small effects in healthy subjects, UAP and ULP stimulations may be beneficial for patients with respiratory disorders, as expanding and shrinking thorax dimensions by region selective activation of trunk muscles.

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P1-E-56 Evaluation and analysis of respiratory muscle strength of patients with multiple sclerosis

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AIM: Multiple Sclerosis (MS) is a chronic, degenerative and autoimmune disease that affects the central nervous system, characterized by demyelination; and that its signs and symptoms vary by location of injury. Since it affects the motor pathways MS is associated with reduced muscle strength, including the respiratory muscles. The aim of this study was to evaluate through electromyography and manovacuometry the respiratory muscle strength in patients with MS. METHODS: A total of three patients diagnosed with MS and three health patients in the control group, all women aged 24 and 42 who underwent evaluations of maximal inspiratory and expiratory pressures (MIP and MEP) and electromyography of the right serratus muscles (MSD), right intercostal (MID), right sternocleidomastoid (ECOMD) and diaphragm (MD). RESULTS: Through the electromyographic evaluations and respiratory pressures found out the imbalance in the activation of muscle fibers with the occurrence of weakness of the muscles evaluated in patients with MS when compared with the control group. The patient 1 presented MIP: -50 cmH2O and MEP: 40cmH2O; patient 2 MIP: -60 cmH2O and MEP: 40cmH2O and patient 3 MIP: -40 cm H2O and MEP: 40cmH2O. Electromyographic evaluation during diaphragmatic expiration of MS patients showed: patient 1 MSD: 3.11 - MID: 2.10 - ECOMD: 16.42 - MD: 19.09; patient 2 MSD: 1.95 - MID: 2.63 - ECOMD: 6,90 - MD: 6.86 and patient 3 MSD: 2.33 - MID: 3.45 - ECOMD: 6.42 - MD: 13.57. And the control patients showed: patient 1 MSD: 12.62 - MID: 8.35 - ECOMD: 22.83 - MD: 63.33; patient 2 MSD: 17.41 - MID: 8.57 - ECOMD: 14.05 - MD: 69.68; and patient 3 MSD: 14.76 - MID: 4.48 - ECOMD: 17.78 - MD: 43.65. CONCLUSION: We conclude that MS patients have respiratory muscle weakness and respiratory physiotherapy is essential to improve and maintain muscle function, possibly leading to better performance in daily life activities and functionality of the same.

P1-E-57 Analysis of the chewing in women post-mastectomy - pilot study

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BACKGROUND AND AIM: Understanding the factors and disorders that cause changes in the stomatognathic system, especially the masticatory efficiency is of fundamental importance in the clinical setting and scientific. The aim of this study was to analyze the electromyographic activity of right temporal (RT), left temporal (LT), right masseter (RM), left masseter (LM), right sternocleidomastoideus (RS) and left sternocleidomastoideus (LS) muscles, while performing of habitual and non-habitual chewing cycles. METHODS: 10 women with natural dentition were divided into two groups: MG, mastectomy group (n = 5, mean age 48.00 ± 4.54 years) and CG, control group (n = 5, mean age 50.00 ± 5.42 years). The EMG activity was recorded during normal chewing cycles and unusual through electromyography TrignoTM Wireless Delsys EMG System. This research was approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. The habitual chewing was analyzed during chewing peanuts and raisins and non-habitual through flavorless gum (Parafilm M®; Pechinery Plastic Packaging, Batavia, IL, USA). Each condition was examined for 10 seconds. The groups were matched by age subject to subject and body mass index. Data were normalized by teeth clenching in maximal voluntary contraction. The EMG values were tabulated and analyzed using SPSS 21.0 software (t student test; $p < 0.05$). RESULTS: Statistical analysis showed no significant difference ($p<0.05$) during habitual and non-habitual masticatory cycles among the groups, however notes increased muscle activity during mastication in MG. CONCLUSION: It can be seen with this study muscular hyperactivity of EMG by analysis of the chewing cycles, suggesting functional changes in the stomatognathic system in women undergoing mastectomy. ACKNOWLEDGEMENT: FAPESP and CNPq

P1-E-58 Length dependence of the shear elastic properties of the biceps brachii after stroke

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BACKGROUND AND AIM: Hypertonia post-stroke is a motor control disorder associated with poor patient outcome. The etiology of hypertonia is unclear; usually the increase in tone is attributed to enhanced stretch reflex responses, however, the potential role of non-neural mechanisms is relatively uninvestigated. Currently we are examining the hypothesis that altered intrinsic muscle elasticity plays a role in mediating clinical hypertonia. The goal of this project was to determine if the stroke affected muscle has altered elastic properties within the muscle's range of motion. To this end, muscle's elastic properties were non-invasively estimated in the biceps brachii using supersonic shear wave elastography (SWE). METHODS: SWE was used to estimate the elastic properties of hypertonic and contralateral biceps

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brachii throughout a range of elbow flexion angles. The velocity of shear wave propagation is known to be related to the stiffness of a material, so shear wave velocity (SWV) was used as a proxy measurement for muscle stiffness. In 13 hemispheric stroke survivors, SWV was measured in the lateral muscle belly while concurrent EMG activity was monitored on the medial aspect of the muscle belly. Stroke survivors have difficulty relaxing their muscles, so elastograms were eliminated from the analysis if EMG amplitude exceeded a given threshold in the 2 second period prior to image capture. The exclusion threshold was set at 4 times the RMS of baseline EMG. SWV recordings were manually cropped to exclude any connective tissue borders in a region of interest; velocities within the cropped region were averaged to provide one representative SWV value per image. Within a subject, shear wave velocity readings were binned by elbow flexion angle (bin size: 10 degrees). RESULTS: For stroke-affected muscle, SWV increased with elbow flexion angle at joint angles between 100º and 160º. For the contralateral biceps, SWV increased with joint angle at all angles above 120º. At joint angles less than 150º, SWV on the affected side was greater in 15/32 cases. The mean difference in SWV (affected-contralateral) was 0.10±0.68 m/s. At joint angles greater than 150°, SWV on the affected side was greater in 9/12 cases. The mean difference in SWV was 0.40±0.57 m/s. In only 3/13 subjects did the SWV of the affected side exceed the SWV contralateral by 1 m/s or more in the range of motion (for reference, SWV at slack length was approximately 2 m/s). CONCLUSIONS: The magnitude of the differences in shear elastic properties is key to understanding the role of passive muscle mechanics in hypertonia. The magnitude of these differences was limited (<1 m/s) for 10/13 subjects, which may indicate that muscle mechanics are minimally altered for most subjects. However, differences in SWV were large (> 1m/s) in 3/13 subjects, which may indicate that altered muscle mechanics play a role in a mediating hypertonia in a small subpopulation of stroke survivors.

P1-E-59 Acute Intermittent Hypoxia Augments Upper Limb Neuromotor Function in Persons with Spinal Cord Injury

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BACKGROUND AND AIM: Most spinal cord injuries (SCIs) are incomplete, however spontaneous plasticity, mediated via the spared spinal pathways is slow and often insufficient to restore normal function. One unique approach to augment plasticity in spinal networks is via intermittent brief exposure to mild hypoxia i.e. brief bouts of low oxygen in the inspired air (also known as acute intermittent hypoxia or AIH). AIH induces rapid neuroplasticity, and has been shown to enhance volitional somatic motor output in the lower extremity within 60 minutes in persons with incomplete SCI. Whether AIH induced neuroplasticity is equally prevalent in spinal motor pathways regulating upper limb muscular function is not known.

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Accordingly, in ongoing studies our aim is to test the hypothesis that AIH will augment upper limb neuromotor function in humans. METHODS: In two sets of experiments, we quantified the effect of a single session of AIH (15, 90-second episodes of 10% oxygen) on voluntary elbow flexion and grip strength, respectively. First, we measured isometric flexion force at the elbow joint during maximal voluntary contraction (MVC) in three subjects (two able-bodied, and one incomplete cervical SCI). Muscle activity from the biceps brachii was also recorded using a 128 channel high density EMG grid. The root mean square (RMS) value for each channel was calculated to generate average RMS muscle activity maps. MVC was done before, immediately after, and 60-minutes post-AIH. Sham trials were done one week later in the same individuals with intermittent normoxia (room air). In the second set of experiments, we quantified the effect of AIH on grip strength in three individuals with chronic incomplete SCI. A baseline assessment of grip strength was made before administration of AIH, immediately after AIH, and then again at 60 minutes post-AIH using a hand-held dynamometer. RESULTS: We found that isometric MVC at the elbow joint increased by 45±5% in the two able bodied individuals, and by 30% in the SCI patient, at 60 minutes post AIH. This increase in strength correlated with increased activation of the biceps brachii muscle. Average RMS value increased from 198 ± 11uV to 350 ± 3uV, and from 351uV to 392uV following AIH, in the healthy subjects and SCI patient, respectively. Sham AIH resulted in no change. We also found that grip strength increased by 26±4% from baseline at 60 minutes post AIH in the three subjects with SCI. In comparison, there was a 5±3% change after normoxia in the same individuals with sham AIH. CONCLUSIONS: These preliminary observations demonstrate the potential for AIH to rapidly increase upper limb strength in persons with incomplete SCI. This modality could eventually be developed to induce spinal plasticity, either as an alternative to prevailing therapies, and as an adjunct to bolster the effectiveness of superimposed rehabilitative training in individuals with chronic incomplete SCI.

P1-E-60 Evaluation of the masticatory and cervical muscles in women post-mastectomy - pilot study

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BACKGROUND AND AIM: Breast cancer is considered the type that affects more women worldwide and the mastectomy is the surgical procedure for the treatment of tumor and adjacent tissues, and may cause in multiple functional and physical changes to the patients, such as lymphedema, limitation of range of motion, muscle and postural change. This study

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aims to analyze the EMG activity of right temporal (RT), left temporal (LT), right masseter (RM), left masseter (LM), right sternocleidomastoideus (RS), left sternocleidomastoideus (LS) muscles, under different conditions postural jaw. METHODS: Were evaluated 10 women with natural dentition, divided into two groups: MG, mastectomy group (n = 5, mean age 48.00 ± 4.54 years) and CG, control group (n = 5, mean age 50.00 ± 5.42 years). This research was approved by the Ethics Committee. The registration of the EMG activity was performed through the electromyography TrignoTM Wireless EMG System Delsys, the postural condition of the jaw: protrusion (10s), right laterality (10s), left laterality (10s), mandibular rest (4s) and teeth clenching in maximal voluntary contraction with and without Parafilm M® (Pechinery Plastic Packaging, Batavia, IL, USA) (4s in each condition). The groups were matched subject to subject by age and body mass index. The data were normalized by teeth clenching in maximal voluntary contraction with Parafilm M®. The EMG values were tabulated and analyzed using SPSS 21.0 (t student test; P <0.05). RESULTS: There was no statistically significant difference (P <0.05) between the MG and CG, although it can be observed muscle hyperactivity in all conditions analyzed in MG. CONCLUSION: The authors concluded that this study suggests that women undergoing mastectomy show increased EMG activity of masticatory and cervical muscles, when compared at the healthy control group. ACKNOWLEDGEMENT: FAPESP and CNPq

P1-E-61 Effect of total knee arthroplasty on balancing capacity after sudden perturbation in patients with bilateral knee osteoarthritis

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The present study is a follow up analysis of dynamic balance of severe knee osteoarthritis (OA) patients who have undergone total knee arhtroplasty. The study introduces new parameters on sudden perturbation tests during bipedal stance of which characterization capabilities have been evaluated for future applications. 48 patients participated in the study (f:m, 34:14, 69,6±6,5 years, 81±17 kg, 165±10 cm), of which 32 suffered under sever bilateral OA, 5 of severe unilateral OA and 11 where part of the control group. Measurements were held directly before surgery and postoperatively in the second, sixth, twelfth and twenty-fourth week. Dynamic balance was assessed by PosturoMED© platform which consist of a rigid plate connected to a rigid frame by springs. The plate can move in plane and can be fixed on one end in the mediolateral direction. Release of the plate causes sudden perturbation in the person's balance standing on it. Subjects' compensation results a damped oscillation. Motion of the platform was recorded using a ZEBRIS CMS10 (ZEBRIS, Medizintechnik GmbH, Germany) computer-controlled, ultrasound-based motion analysis system. The resulting damped oscillation was characterized by Lehr's damping ratio (D),

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orientation ratio (R) defined by the ratio of path lengths in anteroposterior (AP) and mediolateral (ML) directions, oscillation peak frequency (f), settling time (t), total path length (S), maximal velocity (v_max), and maximal accelerations (a_max). On the calculated parameters correlation analysis, between groups t-tests were applied. In the control group strong negative correlation was found between t and D (c=-0.7854) and strong correlation between t and S (c=0.8117). In the unilateral group these parameters show weaker correlation (t-D: c=-0.4565; t-S: c=0.73364). In bilateral group both correlations coefficients are under 0.15 in absolute terms. Neither of the parameters showed significant differences compared the preoperative results to the postoperatives, except for D in the 24th week in the unilateral group. Comparing the values to the control group D was significantly lower, S and t were significantly higher in both OA groups. Oscillation frequency in the bilateral group was significantly higher compared to the rest. Improvement of D in the unilateral group was observed after 6 months. Bilateral patients did not show postoperative improvement presumably due to the other affected OA knee. Correlation analysis suggested that D is the most prominence parameter to assess dynamic balancing in all groups, however at healthy adults and athletes t and S can be an alternative. R, v_max and a_max is better for characterizing the balancing method itself. The curves of v and a can indicate extra muscle movements, and conscious balancing, which can be utilized by athletes. R shows a good parameter to characterize balancing strategy; it might be useful for rehabilitation purposes and training.

P1-E-62 Spastic Semitendinosus Muscle of Cerebral Palsy Patients Tested Intra-operatively Does Get Affected by Epimuscular Myofascial Force Transmission but Shows no Abnormal Mechanics

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BACKGROUND AND AIM: Measuring the forces of knee flexor muscles with respect to knee angle (KA) intra-operatively [1] allows determining capacity of individual muscles of spastic cerebral palsy (CP) patients to affect joint mechanics. Recent separate testing showed no abnormal muscular mechanics (i.e., no narrow operational joint range of force exertion and no supreme active resistance capacity to stretch at low length) for spastic gracilis (GRA), semitendinosus (ST) and semimembranosus (SM), if the muscle was stimulated alone [e.g., 2]. However, co-activation of also an antagonist did change mechanics of spastic GRA [3]. We aimed at testing the following hypotheses: (1) inter-synergistic and antagonistic epimuscular myofascial force transmission (EMFT) [4-5] affects forces of spastic ST and (2) causes abnormal mechanics. METHODS: Isometric ST forces of children with CP (n=7, mean (SD)=8.7 years (5.1 years); GMFCS scores: level II-IV; 12 limbs tested) were measured intra-operatively

as a function of KA from flexion (120°) to full extension (0°). Four conditions were tested. Spastic ST was activated: (I) alone, (II) simultaneously with its synergists GRA and SM, (III) simultaneously with its antagonist vastus lateralis (VL) and (IV) simultaneously with GRA, SM and VL together. In order to eliminate length history effects [1], the measurements were started in flexed knee position. Testing was completed for each condition before attaining a different knee angle (in 30° increments). Mean of ST forces of tested limbs per KA were assessed across conditions. RESULTS: ANOVA (factors: KA and condition) showed significant main effects on spastic ST forces, but no significant interaction. Condition I: ST forces attain (mean (SD)) the minimal value at KA=120° 3.1N (3.4N), peak value at KA=15° 84.3N (30.4N) and decrease at KA=0° to 78.0N (29.7N). Condition I vs. others: Post hoc tests showed that, co-activation of the synergistic and the antagonistic muscles caused spastic ST forces to increase substantially (the mean force increase equaled 30.8%, 34.5% and 34.4% for conditions II, III and IV, respectively). However, in none of the conditions spastic ST force-KA curves showed abnormal mechanics. CONCLUSIONS: Our first hypothesis is confirmed, but not the second. Therefore, the present study shows solid evidence for EMFT in human subjects and in conditions close to those in vivo. However, the findings indicate that mechanics of spastic ST remains normal also in conditions involving co-activity of synergistic and antagonistic muscles. This suggests strongly that spastic ST does not have the capacity to cause the pathological knee joint condition of CP patients. [1] Yucesoy C.A. et al. J Biomech, 2010 [2] Ates F. et al. Clin Biomech, 2013 [3] Ates F. et al. Clin Biomech, 2014 [4] Yucesoy C.A., Exerc Sport Sci R, 2010 [5] Yucesoy C.A & Huijing P.A., J Electromyogr Kinesiol, 2007 TUBITAK grant 113S293 is acknowledged.

P1-E-63 Influence of the ataxia on the masticatory efficiency

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BACKGROUND AND AIM: Ataxia is a neurological disorder of the cerebellar region which manifests itself in motor pathways causing loss of coordination of movements, disturbances in the control of body posture, changes in voice control and loss of articulation of words and dysphagia. This study evaluated the efficiency of masticatory through the ensemble average of the masticatory cycles in individuals with ataxia compared to healthy individuals. METHODS: 16 individuals aged 20 to 60 years of both genders were divided into two groups. GI ? Individuals with ataxia: 8 individuals were selected by a convenience sample. GII - Control: 8 healthy individuals were selected. The groups were matched subject to subject by

age and body mass index. They were submitted to electromyographic evaluation in right masseter (RM), left masseter (LM), right temporalis (RT) and left temporalis (LT) muscles in the clinical conditions of non-habitual chewing of flavorless gum (Parafilm M®; Pechinery Plastic Packaging, Batavia, IL, USA) and during habitual chewing of peanuts and raisins. The EMG analysis was performed using EMG-Br1 Myosystem®. The data were tabulated and entered into the statistical analysis (t Test) using SPSS version 22.0 for Windows. The Ethics Committee in Research of the School of Medicine of Ribeirão Preto, University of São Paulo, previously approved this study. RESULTS: The comparison of the efficiency of masticatory cycles for habitual and non-habitual chewing between the two groups didn?t show statistic difference ($p<0.05$) (Table 1). CONCLUSION: According to the results of this research it can be concluded that the masticatory efficiency was not affected by ataxia.
ACKNOWLEDGEMENT: FAPESP

P1-E-64 Characterization of Passive Muscle Viscoelastic Properties in Hemiplegic Stroke

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BACKGROUND AND AIM: We are investigating changes in passive mechanical properties of skeletal muscles in chronic stroke. Our objective was to quantify the altered viscoelastic characteristics of upper-extremity muscles post-stroke using the ultrasound shear wave elastography in a passive state. We hypothesized that post-stroke alterations in muscle properties include changes in tissue elastic as well as viscous properties. Furthermore, we also hypothesized that clinically observed hypertonia and increased muscle stiffness can be quantified using ultrasound shear wave velocity METHODS: We generated shear waves in biceps brachii muscles of stroke survivors and estimated the propagation speed using the supersonic imaging (SSI) ultrasound system. We collected ultrasound data from both arms of two hemiplegic chronic stroke survivors (modified Ashworth scale-2 for both participants) at three different elbow joint angles (90, 120, and 150 degrees). The electromyogram (EMG) was also recorded from the biceps muscles to ensure a passive condition during imaging. The ultrasound data were processed to estimate group and phase shear wave propagation velocities. The elastic properties were quantified by the group velocities while the viscous properties were estimated from the phase velocity data. In a purely elastic medium, the group and phase velocity values should be the same. The phase and group velocities are generally related to the local mechanical properties through mathematical models including, Maxwell, Kelvin-Voigt or the Zener model. RESULTS: We observed that the shear wave group velocities increased linearly with the elbow joint angles for both arms of tested stroke survivors ($p<0.001$). In terms of a comparison between stroke-affected and contralateral arm,

we observed significantly higher shear wave group velocity values on the stroke-affected side in both stroke survivors ($p<.0001$). Furthermore, in terms of viscous properties, we found that stroke-affected muscles had significantly higher phase velocities in the whole estimated frequency range (0-800 Hz) in both stroke survivors ($p<.001$). CONCLUSIONS: These results suggest that key parameters of passive muscle mechanical properties, best described by the dynamic modulus (comprised of storage or elastic modulus and the loss or viscous modulus) has undergone alterations due to the upper motor neuron (stroke) lesion. In addition to abnormal neural mechanisms, which are manifested during muscular activation, the intrinsic muscular mechanisms, observed in a passive state, such as connective tissue infiltration and tissue fibrosis may play an equally important role in inducing weakness and disruption of contractile function. Therefore, the clinically observed increases in passive stiffness, in addition to reflex hyperexcitability, in stroke survivors may have resulted from local changes in the material properties of muscle and connective tissue.

P1-E-65 Older and young adults with chronic low back pain present increased back muscle fatigue

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AIM: The purpose of this study was to compare back muscle fatigue of younger and older participants with and without chronic low back pain (CLBP). METHODS: Twenty participants without and 20 with nonspecific CLBP participated in this study. Each group contained 10 younger (50% males; mean age: 31±6 yrs) and 10 older adults (50% males; age mean: 71±7.5 yrs). Two isometric fatigue protocols were presented randomly: (1) to maintain the unsupported trunk at the horizontal position while on a 45˚ Roman chair for a minute, and (2) to maintain a 10% of body weight box close to the trunk in the upright position for a minute. Surface electromyography (EMG) signals from the back (multifidus and iliocostalis) and one hip (biceps femoris) muscles were recorded bilaterally, and the median frequency fatigue estimate from linear regression slopes of the EMG time-series was computed. RESULTS: There were no significant ($P > 0.05$) age effects, and group-by-age interaction in both isometric and functional fatigue tasks. However, the CLBP groups (both younger and old) displayed more back fatigue than people without CLBP in both fatigue protocols ($P < 0.01$; effect size varying of $d = 0.17$ to 0.32). CONCLUSION: This study was sensitive to discriminate that individuals with CLBP did present significantly more pronounced EMG back fatigue than people without CLBP, in both younger and older adults. These results have

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significant clinical implications for low back pain rehabilitation programs with regard to endurance assessment in both younger and older.

P1-F-66 Motor unit firing pattern of vastus lateralis muscle and its association with the strength capacity in the elderly

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The decrease in muscle strength with aging cannot be explained solely by a decrease in muscle volume. This suggests that neural factors, i.e., motor unit activation, markedly contribute to the decline in the strength capacity of the elderly in addition to morphological changes. However, age-related changes in motor unit activation properties remain unclear for locomotor muscles, such as quadriceps muscles, although these muscles are preferentially atrophied with aging and play important roles in daily living activities. The present study aimed to investigate and compare detailed motor unit firing patterns for the quadriceps muscle during isometric contraction at low to middle force levels in the elderly and young. Also, we investigated the association between the motor unit firing pattern and strength capacity. Fourteen healthy elderly men (age: 71.1 ± 5.6 years) and 15 healthy young men (age: 20.6 ± 1.1 years) performed isometric ramp-up contraction from 0 to 70% of their maximal voluntary contractions (MVC) during knee extension. Multi-channel surface electromyograms were recorded from vastus lateralis muscle using a two-dimensional grid of 64 electrodes and decomposed with the convolution kernel compensation technique to extract individual motor units. Only motor units with PNR > 30 dB (corresponding to accuracy in motor unit firing identification > 90%) were used for further analysis, whereas all the other motor units were discarded. In this study, 131 and 114 motor units were considered for analysis for the elderly and young, respectively. Motor units were divided into three groups based on recruitment threshold: motor units recruited at <20% of MVC, 20-40% of MVC, and 40-60% of MVC. Firing rates of motor units recruited at <20% of MVC and 20-40% of MVC in the young were significantly higher (~%2B29.7%) than in the elderly ($p < 0.05$) at 50~60% of MVC force levels. There were significant differences in firing rates among motor unit groups with different recruitment thresholds at 40-60% of MVC force levels in the young ($p < 0.05$), but not in the elderly ($p > 0.05$). Firing rates of the motor units recruited at < 20% of MVC were significantly correlated with MVC force in the elderly ($r = 0.885$, $p < 0.0001$), but not in the young ($r = 0.127$, $p > 0.05$) at 60% of MVC force level. Lower motor unit firing rates and similar firing rates among motor units with different recruitment thresholds in the elderly suggest that motor unit firing patterns in the quadriceps muscle are modified by aging. Also, a strong correlation between the motor unit firing rate and strength

capacity in the elderly may help to explain the gap between decreases in muscle strength and muscle volume with aging by age-related changes in neural factors.

P1-F-67 Effect of posture on motor unit control investigated by decomposition techniques in adults after stroke

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Effect of posture on motor unit control investigated by decomposition techniques in adults after stroke Background and Aim Individuals after stroke often have several impairments such as muscle weakness, spasticity, and balance disorder. Especially, muscle weakness is an important problem related to motor function. Generally, muscle strength is determined by motor unit recruitment and firing rate. Previous studies have reported that the recruitment of high threshold motor units is selectively affected in adults with hemiplegia. However, to our knowledge, motor unit behavior in standing position has not been reported so far. Thus, we assessed the difference in motor unit recruitment and firing rates between standing and sitting positions by using decomposition techniques with surface electromyography(EMG). Methods Thirteen individuals with hemiplegia after stroke (57.1±10.7 years, Brunnstrom recovery stage III:1,IV:8,V:4) participated in this study. EMG signals were recorded on the vastus medialis using surface EMG (dEMG system, DELSYS Inc.). First, maximal isometric voluntary contractions (MVC) were recorded for 3 seconds in the sitting position. Second, isometric voluntary contractions at 25% MVC were performed in the sitting and standing position with visual feedback. In the standing position, participants were instructed to load the weight with the knee flexed at 45° to adapt to the amplitude at 25% MVC. The EMG data were analyzed using decomposition techniques to detect the number of motor unit (NMU) and the average of firing rate(AFR). Two-way repeated analyses of variance were performed to compare the difference between the paretic and non-paretic limbs or between the standing and sitting position. Results The NMU was significantly lower on the paretic side than on the non-paretic side; however, there were no significant differences between the positions. The AFR showed a significant interaction between the limbs and position. The AFR of the paretic side was significantly increased in the standing position, while no difference was observed in the sitting position. Conclusions The recruitment of motor units was limited on the paretic side as previously reported. Moreover, the firing rate of the paretic side differed according to change in the position despite remaining unchanged for the non-paretic side.

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P1-F-68 Evaluation of neuromuscular activation and force tracking accuracy during isometric sine-wave force exertion

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BACKGROUND AND AIM: The force accuracy during constant force exertion for the quadriceps femoris muscle (QF) is related to functional performance (Seynnes et al. 2005) and the force accuracy depends on type and level of contraction (Enoka et al. 2003). The sustained constant force level task has been used in previous studies because of its simple experimental design; however, it is unclear how the neuromuscular system modulates the motor units to control force accuracy against non-constant force level, such as sine-wave. The purpose of this study was to clarify neuromuscular activation and force accuracy of QF during isometric sine-wave force exertion. METHODS: Thirteen healthy men and women (23.0 ± 3.8 year-old) performed maximal voluntary contraction (MVC) during isometric knee extension. They performed force tracking task to match a given sine-wave force signal on a computer monitor. This sine-wave was expressed as a following formula: force = -2%MVC*sin (1/2πt) %2B 6%MVC, where t is time. As shown in this formula, one cycle of sine-wave force signal was consisted of 20 phases (P1 to P20): 1) P1 to P5 is 1st descending stage, 6%MVC to 4%MVC; 2) P6 to P10 is 1st ascending stage, 4%MVC to 6%MVC; 3) P11 to P15 is 2nd ascending stage, 6%MVC to 8%MVC; and 4) P16 to P20 is 2nd descending stage, 8%MVC to 6%MVC. Subjects performed 7.5 cycles (30-sec); one cycle of sine-wave was 4-sec. During the tasks, surface electromyogram (EMG) was recorded from vastus intermedius (VI), vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF). The root mean square (RMS) of EMG signals of each muscle was calculated in every 20 phases. We investigated force accuracy as fluctuation and it was also calculated as follows: (produced force - targeted sine-wave force) / targeted sine-wave force*100. The RMS of the individual muscles was normalized by the RMS of the MVC. We averaged RMS and force fluctuation from 2nd-cycle to 5th-cycle (i.e. 7 sec to 23 sec). Averaged force fluctuation and RMS was compared with eitherP5, i.e. the bottom of sine-wave (at 4%MVC), and P15, i.e. the top of sine-wave (at 8%MVC). RESULTS: Force fluctuation appeared to have inverse pattern to RMS of three vasti muscles. As a result of the cross-correlation analysis between force fluctuation and RMS of each muscle, there was approximately a half cycle lag, i.e. 8 or 10 phases. Force fluctuation at P1 and P10 to P20 was significantly lower than that of P5; however, force fluctuation at P2 to P8 and P18 was significantly higher than that of P15. The differences between phases were found at similar phases in RMS for VI, VL and VM, but not for RF. CONCLUSIONS: These results suggest that force accuracy during isometric sine-wave force exertion was contributed by change in recruitment and/or discharge rate of motor units in the vasti muscles, not RF.

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P1-F-69 Cutaneous post-synaptic potentials from the in vivo cat

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BACKGROUND AND AIM: The discharge of a spinal motoneuron and resultant force generation is regulated by the synaptic drive to and the intrinsic excitability of spinal motoneurons. Understanding these factors will provide insight into the generation of movement in healthy and pathological conditions. Current methods to investigate this activity in humans rely either on global indicators of motor output, such as surface EMG, or detailed analyses of single or pairs of motor units. Recent advances have allowed for the collection of the concurrent discharge of tens of motor unit spike trains. We have recently translated human derived motor unit approaches to the unparalyzed, unanaesthetised decerebrate cat model. Here we use this approach to describe the mixture of excitatory and inhibitory post synaptic potentials across the motor unit populations evoked through transient axonal stimulation. METHODS: During tonic motor activity of the left soleus muscle, either the left sural nerve or a cutaneous branch of the right superficial peroneal nerve are activated with single or brief trains (10 ms; 300 Hz) of electrical stimulation provided at ~1 Hz. Offline, the 64 channel soleus EMG signal is decomposed into corresponding motor unit discharge times using an automated decomposition algorithm. Each motor unit spike train is then triggered to the stimulation onset in order to quantify both the probability and instantaneous frequency of cutaneous evoked discharge, providing an estimate of the post-synaptic potential for each active motor unit. RESULTS: Peristimulus time histograms (PSTH) and peristimulus frequencygrams (PSF) for up to 20 concurrently active motor units consistently reveal excitatory post synaptic potentials evoked through sural stimulation, with PSF cumsum turning points located 50-70 ms post stimulation. These same motor units reveal stark variations in the preceding inhibition. A graded subpopulation of units will demonstrate an initial 10 ms pause in discharge at 25 ms followed at times by a decrease in discharge near 40 ms. A substantial minority of units demonstrate little of this inhibitory period and an earlier onset of excitation. CONCLUSIONS: Such responses vary across contralateral and ipsilateral pathways and are confirmed through concurrent fine wire motor unit recordings and similar PSF reconstructions from the same motor unit, tracked across many minutes. Such data suggest cutaneous evoked inhibition is unequally distributed across the soleus motor pool.

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P1-F-70 Motor unit synchronization during linear motor commands

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BACKGROUND AND AIM: The motor command underlying volitional activation of human motoneurons is unknown, though it is reasonable to assume the motor command is proportional to the resulting muscle force generation. Thus, during symmetrical ramp in torque generation, the net motor command is a symmetrical ramp of excitation. Though its assessment and interpretation remains controversial, the correlated and/or synchronous discharge of two or more spinal motoneurons may provide information regarding the synaptic drive common to both neurons. Because of the 1:1 relationship between the discharge of a spinal motoneuron and the contraction of its associated muscle fibers, we can record the greatly amplified discharge of muscle fiber to quantify the discharge of its associated spinal motoneuron in humans. Recent advances in high-density surface electromyography in combination with automated decomposition approaches can provide an accurate record of the discharge of tens of concurrently active motor units. METHODS: Kinetic and EMG data from four healthy humans were collected with the participants secured to an instrumented standing frame to quantify multiplaniar joint torque of the hip, knee, and ankle during isometric contractions from the right lower extremity. Following a series of maximal dorsiflexion contractions, motor unit discharge patterns were recorded from 64 channel surface arrays during linearly varying (2 deg/s) ramp contractions of the right tibialis anterior muscle to 20% maximal. Population estimates of motor unit synchronization were assess by constructing a composite crosscorrellogram across all unique pairs of motor unit discharges within a given a contraction for both the 10s ascending and 10 s descending phases. RESULTS: During each phase, significant zero-lag peaks in the crosscorrellogram were more evident during the descending phase of a ramp contraction. Our initial composite k' estimates are 1.31±0.25 during the ascending phase and 1.45±0.26 during the descending phase ($p<0.001$) across 31 contractions. Though mean k' values ranged considerably across subjects (1.07 to 1.62 during ascending ramps), values were tightly clustered within subjects with a mean CoV of 5.5 and 5.4% during ascending and descending ramps respectively. In three of these subjects, three separate 40s hold contractions were performed at 20% maximal. In all three individuals, composite k' values during hold contractions were tightly clustered and located midway between the low ascending phase and the high descending phase synchronization observed during ramp contractions. CONCLUSIONS: These preliminary data suggest motor unit synchronization is not static during linearly varying contractions in humans. If such data remain independent of the underlying motor unit discharge characteristics, it would support the hypothesis that the human motor command underlying a symmetric ramp contraction is asymmetric.

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P1-F-71 Motor axon excitability properties of the human gastrocnemius and soleus muscles

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BACKGROUND AND AIM: In animals, motoneuron electrical properties are related to the properties of the innervated muscles, but whether this is the case in humans is uncertain. This relationship can be determined indirectly by recording the excitability properties of motor axons in different muscles. Nerve excitability testing using threshold tracking techniques provides an indirect assessment of nodal and internodal ion channel properties and the resting membrane potential (1). An important feature is it is the only technique that can assess internodal properties in-vivo through the application of prolonged (ie.,300 ms) subthreshold polarizing currents. There are differences in axonal excitability along a single nerve in the human upper limb, even when the nerve is stimulated at one site and recordings are made from different muscles (2). Nerve excitability testing can also detect changes in axon properties in patients including those with cerebral palsy and other disorders (3). In this preliminary study of three healthy subjects, we tested the hypothesis that motor axon properties differ between the fast contracting and fatigable gastrocnemius and the slow contracting and fatigue-resistant soleus. METHODS: The tibial nerve was stimulated according to a standard (Trond + extended threshold electrotonus) protocol, and compound muscle action potentials (CMAP) were recorded over the gastrocnemius or soleus. RESULTS:The results indicate differences in membrane properties between axons that innervate the two muscles. Mean rheobase and the stimulus current required to produce 50% of the maximal CMAP were smaller in the gastrocnemius (3.2 mA and 4.9 mA) than the soleus (4.7 mA and 7 mA) axons. In addition, threshold increases elicited by the strongest subthreshold hyperpolarizing currents (TEhpeak, -100%) were smaller in the gastrocnemius (-358%) than the soleus (-434%) axons, an indication of greater activity of Ih, the depolarizing current that flows through the hyperpolarization-activated cyclic-nucleotide (HCN) channels. Pronounced differences in Ih is consistent with other studies which showed that Ih is an important determinant of differences in axon excitability between individuals and between motor and sensory fibers. CONCLUSIONS: These preliminary data indicate that gastrocnemius axons are more excitable and can accommodate hyperpolarizing currents better than soleus axons. These differences may be related to higher voluntary discharge rates in gastrocnemius compared to soleus motoneurons. 1. Bostock H et al. Threshold tracking techniques in the study of human peripheral nerve. Muscle & nerve. 1998;21(2):137-58. 2. Jankelowitz SK, Burke D. Axonal excitability in the forearm: normal data and differences along the median nerve. Clinical Neurophysiology 2009;120(1):167-73. 3. Klein CS, Zhou P, Marciniak C. Excitability properties of motor axons in adults with cerebral palsy. Front Hum Neurosci. 2015;9:329.

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P1-F-72 Evaluation of the neuromuscular fatigue in long-lasting cardiothoracic surgeries, using multi-channel EMG

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In the last decades it began to be common to evaluate the neuromuscular fatigue through different methods. One of the easiest ways of detection is through the lactate concentration, based in blood samples, however with this process it´s not possible to obtain real time values. So, for get real time values is possible to use electromyographic systems for the detection of the neuromuscular fatigue through measurements of myoelectric activity. This method is used in different areas like sports, health, rehabilitation, and others. In this work we investigate the muscular activation pattern of the shoulder and back, in surgeons during long-lasting cardiothoracic surgeries (approximately three to five hours), in order to detect the moment when the muscle starts to show some kind of fatigue. For that, we use a system of high density electromyography, allowing a better analysis of different regions of the muscle. For the multi-channel EMG analysis, different methods, namely Power Spectral Density (PSD), Short-term Fourier Transform (STFT), EMG signal Conduction Velocity (CV) and others, are tested to find the best method to detect neuromuscular fatigue. Results of applying the experimental protocol to a set of different surgeons are presented, along with the EMG analysis and comparison of the different methods to detect muscular fatigue.

P1-G-73 Feasibility study on effects of free bubble insole for walking

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AIM: Walking for health is currently popular, it should be discussed the types of insoles effect in terms of muscle activities. We adopt insoles composed of freely moving bubbles, expecting the enlargement of sensitivity for muscle fatigue and balance. METHODS: The measurement system was composed of the 16 channels wireless unit with the two-bar active electrodes (Myomonitor IV and DE-2.1, Delsys) for the SEMG signals. Signals were sampled at 2000 Hz at a 16-bit resolution using the attachment software (EMGWorks 3.5, Delsys). The target muscles and the locations of surface electrode were identified with both the muscle synergies at lower limbs and the spatiotemporal distribution pattern measured by 64 channels matrix (2D) electrode (ELSCH064R3S, OT Bioelecttronica). For free bubble insoles and barefoot, we ask participants to walk on the treadmill for 3 min with speed of 3 km/h: Note the quantities of bubble are 18g and 20g with the same bubble size. We focused on

muscles referring to the synergy weights over 0.5. The placement of a two-bar active electrode is determined where the highest change in RMS distribution pattern. RESULTS: From 8 healthy participants (22.6 ± 0.6) the time courses (TCs) of iEMG were estimated every ten strokes for total 100 strokes (Figure 1). Selected muscles among participants were Gas and Amm, TA and ERSP, BF, VL and Gmax based on synergies #1 ? 4, respectively. The time-varying behaviors were similar between barefoot and bubble with more quantity, but one with less quantity was different at ERSP, TA, and Gas. That is, for the first phase and over a task iEMG a little increased at ERSP and Amm and significantly decreased at the pair of TA and Gas and a little decreased at Gmax. DISCUSION: Effects of free bubble were explicit at the time-varying behavior of TCs. For one with less quantity muscle activities were reduced at TA and Gas and increased at ERSP. ERSP was reported to be highly activated in response to perturbations [1]. This might be caused by the instability at the sole of the foot. From the rectified envelop of SEMG at TA and Gas for a standard flexible shoe and a stability running shoe the peak amplitude increased compare to barefoot [2]. Although our results showed different tendencies, freely moving bubble might enlarge the sensitivity for balance stemmed from the effects of stochastic resonance [3]. [1] S. A. Chvatal and L. H. Ting, "Common muscle synergies for balance and walking," Front Comput Neurosci, vol. 7, p. 48, 2013. [2] L. A. Scott, G. S. Murley, and J. B. Wickham, "The influence of footwear on the electromyographic activity of selected lower limb muscles during walking," J Electromyogr Kinesiol, vol. 22, pp. 1010-6, Dec 2012. [3] M. Dettmer, A. Pourmoghaddam, B. C. Lee, and C. S. Layne, "Effects of aging and tactile stochastic resonance on postural performance and postural control in a sensory conflict task," Somatosens Mot Res, vol. 32, pp. 128-35, 2015.

P1-G-74 Mitigating the effect of wrist kinematics on pattern recognition control

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BACKGROUND AND AIM: Pattern recognition-based myoelectric control of upper limb prostheses has the potential to restore control of multiple degrees of freedom. Few studies, however, have evaluated the effectiveness of this control method in partial-hand prostheses. Recent studies have shown that wrist motion, which remains intact in many partial-hand amputees, degrades the ability of pattern recognition algorithms to correctly classify hand motions. In this study, we evaluate the effects of 1) non-linear and linear pattern recognition algorithms, 2) including wrist position information, and 3) training in multiple wrist positions on pattern recognition classification of 4 hand motion classes in different wrist positions. METHODS: Nine bipolar surface EMG electrodes were evenly spaced around the dominant forearm to record extrinsic hand muscle EMG. Four bipolar electrodes were placed on the

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hand to record intrinsic hand muscle EMG. Two electrogoniometers were used to record wrist position. Six non-amputee subjects were prompted by a computer screen to perform 2 functional hand grasps, an open hand posture and a rest posture in 13 static wrist positions. Subjects held each hand posture for 3 seconds: this was repeated 6 times for each hand posture and wrist position combination. Offline classification error was calculated for a linear discriminant analysis classifier (LDA), quadratic discriminant analysis classifier (QDA), and a neural network with non-linear activation functions using data from all wrist positions. Classification error was evaluated using EMG data alone and using a combination of EMG data and wrist position information. An exhaustive search algorithm was used to determine classification error for all possible combinations of wrist positions. RESULTS: For EMG data alone, the neural network performed better than the QDA classifier ($p<0.05$) but there was no significant difference between the NN and LDA classifier ($p=0.49$). When both EMG data and wrist angle data were used to train the classifiers, the NN classifier performed significantly better than both the QDA classifier ($p<0.01$) and the LDA classifier ($p<0.01$). Adding wrist position data to the EMG data set improved only the neural network's performance. Training an LDA classifier with data from multiple wrist positions improved performance ($p<0.05$) but adding data from more than 6 wrist positions did not improve performance ($p=0.13$). DISCUSSION: Wrist position information provides little additional information for distinguishing hand postures though a neural network is able to utilize the wrist position information and improve performance. Our results also indicate that training a classifier in more than six wrist positions has no additional benefit which can greatly reduce the time-consuming and fatiguing process of performing grasps in multiple wrist positions.

P1-G-75 Towards the restoration of hand function using fully wireless cortically-controlled functional electrical stimulation

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Approximately one-third of spinal cord injury (SCI) patients lose hand function. Brain-machine interfaces (BMIs) provide a means to restore this function. We have previously shown the ability to restore voluntary hand function in monkeys during paralysis induced by peripheral nerve block. We used signals recorded from the hand area of the primary motor cortex (M1) to predict patterns of intended muscle activity and to control functional electrical stimulation (FES) of the paralyzed muscles. As in virtually all BMI experiments, these were performed intermittently in two hour-long sessions in the lab, with the monkey entirely normal between sessions. Here we present our work to develop a wireless cortically-controlled FES neuroprosthesis intended for continuous use. Our final objective is to demonstrate the feasibility of restoring hand use for month-long periods of time, permitting

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the monkey to use the neuroprosthesis on demand in its cage as well as in the lab. To extend our model of acute SCI, we have developed a long-term reversible peripheral nerve block using a subdermal infusion pump. The pump delivers tetrodotoxin (TTX), a sodium-channel blocking agent, to a silicone cuff wrapped around any of the three main nerves innervating the forearm and hand muscles. The neuroprosthesis itself uses a full-bandwidth transmitter (Blackrock Microsystems) to stream data from a 96-channel microelectrode array in M1. These data are used to predict intended EMGs, which are converted into stimulation commands sent wirelessly to a 16-channel stimulator (Ripple) stored in a backpack worn by the monkey. This control loop runs every 50 ms, and serves to evoke the voluntary muscle contractions the monkey is otherwise unable to generate. To demonstrate the feasibility of this neuroprosthesis, we performed experiments in rats and monkeys to determine combinations of flow rate and concentration that gave a continuous motor deficit using the subdermal pump. In the monkey, these were 2 ul/h and 250 ug/ml, respectively. The block was successfully reversed after one month in the rat and two weeks in the monkey. We next performed a series of short-term, wireless tests in the lab, restoring the monkey's ability to grasp objects, control grip force, and acquire targets in a 2D center-out wrist task. We are beginning to test this neuroprosthesis while the monkey is in its cage, to restore hand function for activities of daily living, such as foraging, feeding, or playing with enrichment toys. For these experiments, we will build neuron-to-EMG decoders using datasets recorded wirelessly in the cage, comprising a much broader set of behaviors than can be obtained in the laboratory. We anticipate that these decoders will allow more accurate EMG predictions and improve FES performance. These experiments will offer an unprecedented opportunity to explore the monkey's behavioral adaptation to the neuroprosthesis, and the underlying neural changes driving the adaptation.

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DAY 2, THURSDAY JULY 7

P2-A-1 A Systematic Analysis of the Relationship between Fine Wire and Surface Electromyography Onset Detection with and without the Teager Kaiser Energy Operator

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BACKGROUND AND AIM: Muscle onset timing using EMG is a critical measure used to examine temporal relationships between external or internal biomechanical and physiological events (e.g. gait cycle or agonist/antagonist co-activation). Both surface EMG (sEMG) and fine wire EMG (fwEMG) are used to determine EMG onset but the congruency between these two methodologies is not well-defined. Various EMG filtering techniques also exist that may influence this congruency and decrease the generalizability of study outcomes. Preconditioning the sEMG signal with the Teager Kaiser Energy Operator (TKEO) has been shown to improve sEMG onset accuracy in isolation. It is unknown how TKEO preconditioning affects the relationship between fwEMG and sEMG onset detection. The aim is to characterize the relationship between sEMG and fwEMG muscle onset determination using an iterative examination of the standard linear envelope with and without TKEO preconditioning in simple (short head biceps brachii) and complex (vastus lateralis) muscles. METHODS: Eighteen participants (ages 22 - 54 years) were instrumented with fine wire and surface EMG electrodes on the short head of the biceps brachii and on the vastus lateralis. Participants separately performed three elbow flexions and knee extensions with a 2.3 kg mass fixed distally at the wrist or ankle. Surface and fine wire EMG data were collected simultaneously from within the same region of the muscle. The EMG onset was then quantified with systematically varying linear envelope algorithms of differing low-pass filter types (2 Hz - 50 Hz) and detection thresholds (1 - 3 standard deviations in signal amplitude). This analysis was then repeated after EMG signal preconditioning with the TKEO. Pearson correlation coefficients were calculated between sEMG and fwEMG onset detection for all algorithms. RESULTS: Correlation ranges for the linear envelope method were -0.09 - 0.72 and 0.15 - 0.81 for the biceps brachii and vastus lateralis, respectively. The TKEO preconditioning resulted in ranges of -0.05 - 0.39 and 0.14 - 0.83 for the biceps brachii and vastus lateralis, respectively. The highest linear envelope correlation for the biceps brachii was 0.72 with a 25 Hz cutoff frequency and 3 SD threshold and 0.39 at 18 Hz and 3 SD with TKEO preconditioning. The highest linear envelope correlation for the vastus lateralis was 0.81 at 40 Hz and 3 SD threshold and 0.83 at 35 Hz and 2 SD with TKEO. CONCLUSIONS: The results suggest there is high variability in onset detection between algorithms. TKEO preconditioning increased the discrepancy between onset of surface and fine wire EMG in

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the biceps brachii and therefore might not be appropriate. Muscle onset detection in simple muscles may benefit from using the linear envelope with a high cutoff frequency and a 3 SD threshold while more complex muscles may be improved by TKEO preconditioning with a high cutoff frequency and a 2 SD threshold.

P2-A-2 Continuous frequency change of SEMG for a transition period between knee extension and knee flexion during pedaling

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BACKGROUND AND AIM: The aim of this study was to investigate muscle?s energy pattern and spectral properties of lower limb muscle at a transition period between the knee extension and the knee flexion during pedaling movement. Although pedaling movement is a simple dynamic motion which adjusts a physiological function to a mechanical property of crank, the EMG activity on the lower limb muscles is not simple (Hug and Dorel, 2009). METHODS: The characteristics of muscle activity for ten competitive cyclists and eight non-cyclists were compared by using two wavelet transforms of SEMG signals from the rectus femoris (RF), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius medialis (GM). Firstly, the time-frequency map was made by Morlet wavelet analysis to estimate continuous frequency shift of muscle activity. Secondly, to investigate these muscle activities quantitatively, the SEMG signals were subjected to Daubechies-4 wavelet transformation, and mean wavelet coefficients of knee extension phase were compared with the mean coefficients of knee flexion phase in each wavelet level (i.e., j = 1: 250-500 Hz, j = 2: 125-250 Hz, j = 3: 62.5-125 Hz, j = 4: 31.25-62.5 Hz, and j = 5: 15.625-31.25 Hz, respectively). RESULTS: The SEMGs of RF and TA activated during the transition period from knee flexion phase to knee extension phase, and the SEMGs of BF and GM activated during the period of task shift from knee extension phase to knee flexion phase. According to the Morlet wavelet analysis, the peak frequency of SEMG of GM shifted to the higher frequency band during the task shift (Fig.1). For the knee flexion phase, the mean energy of wavelet levels of 2 (125-250 Hz) was significantly larger than that of the knee extension phase for the competitive cyclist group. Though, the frequency bands of muscle activities of RF, BF, and TA were not significant difference between knee flexion phase and knee extension phase for both subject groups. CONCLUSIONS: These results suggested that the muscle coordination, the motor unit (MU) firing frequency, and the firing fiber type of GM is changed with the different characteristics between the knee extension phase and the knee flexion phase in the competitive cyclist. The value of mean wavelet coefficient for SEMG signal of GM may be useful index for estimation of kinesiological motor skills relation to pedaling movement.

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P2-A-3 An Investigation of the Surface Electromyography-to-Force Relationship During Fatiguing Static Elbow Flexion

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BACKGROUND AND AIM: Extreme high pass (HP) filtering techniques, that eliminate up to 99% of raw surface electromyography (sEMG) signal power, significantly improve sEMG based estimates of the rested biceps brachii muscle force [1]. However, as fatigue progresses, sEMG becomes a less accurate means to estimate force, as more effort is needed for a given tension. The purpose of the current study was to explore the potential benefits of extreme HP filtering of sEMG to estimate biceps muscle force during fatiguing isometric flexion of the elbow. METHODS: Fifteen male participants were studied as they completed a series of rested, then fatigued, isometric biceps contractions on a Biodex while following a real-time moment-tracing template at varying intensities between 20% and 100% of their rested maximal voluntary contraction (20% intervals, n=5). sEMG of the biceps brachii was processed with 2 sets of data: 1) rested, 2) whole trial (rested + fatigued data). sEMG was processed using different HP cutoff frequencies (20 to 440 Hz in intervals of 30 Hz, n=15), and each HP cutoff was filtered with six different orders (1 to 6, in intervals of 1, n=6). RESULTS: The results indicate that there was no statistical significant main or interaction effects for either the rested or whole trial data when using the Greenhouse-Geisser correction. As fatigue progressed, extreme HP filtering did not appear to have the same benefit as during rested force prediction. CONCLUSIONS: Although no statistical significance was found with either data set, the data suggest that, for the purpose of force prediction, using a HP cutoff of either 260 or 290 Hz will tend to lower the RMS percent error, challenging the conventional filtering method of 20-500 Hz when estimating muscle force, even under fatigued conditions. References: [1] Potvin, J. R., and Brown, S.H.M., (2004). Less is more: high pass filtering, to remove up to 99% of the surface EMG signal power, improves EMG-based biceps brachii muscle force estimates. Journal of Electromyography and Kinesiology, 14(3), p.389-99.

P2-A-4 Wearable wireless multichannel sEMG acquisition system

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BACKGROUND AND AIM: This work describes a multichannel, wireless and compact 32 channels EMG acquisition system. The system architecture includes: (1) a transmitting unit managing up to 32 monopolar EMG signals sampled at 2048 Hz with 16 bit resolution; (2) a

mobile device (notebook, tablet or smartphone) that receives wirelessly the sampled signals. The transmitter and the receiver can be connected either via a direct link (point-to-point connection) or through a router. The latter type of connection can be useful in applications which need the connection of additional wireless modules (e.g. auxiliary channels) to the system. METHODS: The Intan RHD2132 front-end was chosen in order to minimize the size and encumbrance of the system. The RHD2132 chip is a complete, low-power and ultra-compact (size 9x9 mm) bio-signal acquisition system, which integrate 32 analog front-ends with programmable gain and bandwidth, an analog multiplexer, a 16 bit resolution A/D converter and a SPI communication interface. To achieve the high data throughput required for the wireless link (1 Mbps) and to connect the system to mobile devices without an ad-hoc receiver, the Texas Instruments CC3200 system on chip wireless MCU has been selected. A real-time operative system was used and two different parallel tasks (sampling and transmission) were implemented. The semaphores technique has been used in order to avoid conflicts between the two tasks. The software for the acquisition and online visualization of the EMG signals was developed using the multi-platform Qt libraries (Android, Windows, Linux and MAC). RESULTS: The Intan RHD2132 front-end has been tested using the Intan evaluation board. The relatively low input impedance of the chip does not preclude the possibility to acquire sEMG signals with low 50Hz interference (RMS<20 μV) within a 50Hz controlled field (80 V/m) when the system is battery powered. The performance of the selected Wi-Fi module was tested through a virtual sinusoidal signal generated into the MCU and transmitted to the PC and multiplexed over 32 channels. This setup was necessary to precisely control, off-line, the correspondence between the transmitted and the received signal and, then, check for and count the number of lost data packets. The resulting data throughput of the wireless link was 5.5 Mbps, allowing the transmission of up to 170 EMG signals sampled at 2ksps with 16 bit resolution. CONCLUSIONS: The tests performed on the components selected for the development of the wearable wireless multi-channel sEMG acquisition system showed good performances compatible with the system requirements. The nest steps will be the integration of the components into a single device. FIGURE: Concept of the wearable wireless multi-channel sEMG acquisition system

P2-A-5 Geometry-related variations in CMAP distribution over the soleus: a simulation study

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BACKGROUND AND AIM: We recently demonstrated that the amplitude distribution of H-reflex over the soleus (SOL) is spatially localized over a skin region corresponding to the Achilles tendon [1]. The complex architecture of this muscle was regarded as one potential

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reason for this non-uniform EMG distribution. In SOL, the relative position and orientation between fibers and electrodes changes for different skin locations. Electrodes covering the muscle central portion (i.e., the Achilles tendon) are located in a plane oblique to SOL fibers, which are in-depth pinnate. Electrodes covering the medial/lateral regions, on the other hand, are positioned in a plane parallel to that where fibers reside. In this portion, however, fascicles are oriented in the anterior-posterior direction and therefore misaligned with electrode pairs aligned to the proximal-distal axis. In healthy subjects, this misalignment is variable in a range of 40-70deg. In this study we used simulated signals to quantify the geometry-related variations in EMG amplitude associated to different SOL regions. METHODS: A three-layer volume conductor model [2] was used to simulate compound muscle action potentials (CMAP) sampled from two muscle geometries reproducing the central and medial/lateral SOL regions. The simulated pinnation angle in the central portion was 25deg. Ten misalignment angles (from 0 to 90deg) were considered to simulate potentials detected from the medial/lateral SOL. Monopolar EMGs were simulated as detected by two electrodes with 10 mm IED and then differentiated to obtain single-differential signals. RMS amplitude was considered to quantify changes in monopolar and single-differential CMAP associated with different electrode-fiber arrangements. RESULTS: The RMS of monopolar CMAPs simulated in the SOL medial/lateral region was roughly 70% of that observed for potentials simulated at the muscle central region. Being monopolar derivation an isotropic montage, such difference between detection sites did not depend on the misalignment angle between electrodes and fibers simulated in the muscle medial/lateral portion. For single-differential CMAP, the RMS in the medial/lateral region decreased with the misalignment angle. RMS estimates were progressively smaller than those obtained for the central portion as the misalignment angle exceeded 30deg, with reduction of about 60% for a misalignment angle of 70deg. CONCLUSIONS: These findings confirm the experimental observations of larger H reflexes over the Achilles tendon in both monopolar and single differential derivations and suggest that the complex architecture of SOL is a key determinant of the non-uniform distribution of H reflex over its surface. The presented results have major implications for electrode positioning in applied studies aimed at eliciting CMAP responses in SOL. [1] Botter A. et al. Conf Proc IEEE Eng Med Biol Soc. (2015); 3460-3463. [2] Mesin L. et al. J Biomech. (2011); 1096-1103.

P2-A-6 Spike shape analysis of mechanomyogram during linear torque decrement in fresh and fatigued muscle

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AIM: Spike shape analysis (SSA) is a promising method to analyse electromechanical signals detectable from skeletal muscle surface during voluntary contraction. Both electromyogram and surface mechanomyogram (MMG) can be considered as interferential signals where the motor unit (MU) action potentials and the related transverse twitches of the recruited motor units (MU)are summated, respectively. On these bases SSA can be considered as a tool to study motor control strategies during muscle activation and deactivation. SSA has not been applied in the analysis of non-stationary MMG signal. The aim of the present study was to verify if the changes of MMG SSA parameters during controlled force reduction may provide information about MU deactivation strategy during torque decrement, and its possible changes with fatigue. METHODS: The MMG of the biceps brachii muscle was collected from eleven untrained male participants (mean ± SD for age 22.1 ± 0.9 years, body mass 72.6 ± 8.8 kg, height 181.8 ± 5.6 cm) during static down going ramp contractions (90-0% of the maximal voluntary contraction, MVC) under non-fatigued (DGR) and fatigued (FDGR) settings. The SSA parameters such as mean spike amplitude (MSA), mean spike frequency (MSF), mean spike slope (MSS), mean spike duration (MSD) and mean number peak per spike (MNPPS) were calculated simultaneously on 1 s MMG windows centred on each 10% MVC step for both settings (DGR and FDGR). Fatigue was obtained by the repetition of 6 s long 50% MVC efforts (3 s of rest in between) since the target force was not maintained for the whole requested period. RESULTS: DGR: the SSA parameters decreased from 90 to 10% MVC. At 70% MVC MSA and MSF presented about 40 and 9% of the total delta in 90-10% MVC range. FDGR: the dynamics of SSA parameters decrease with %MVC less steep than during DGR and the differences in the absolute values were significant up to 40% MVC. MNPPS were never statistically different in the two conditions.

P2-A-7 A closed-loop neuromuscular simulation can provide insights into the origins and task-dependencies of force fluctuations.

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BACKGROUND AND AIM: Human voluntary motor control naturally includes oscillations in neural activity and mechanical output. Oscillations in specific frequency bands have become a central tool to understand healthy and pathologic motor control. However, the origin of these oscillations, whether neural, muscular, mechanical, or combination thereof, is intensely debated. This is partially because our understanding of how oscillation amplitude/frequency are modulated by different neural and mechanical factors, even for isometric forces, is limited. Therefore, we used a computational model of afferented musculotendons to investigate whether and how tremulous oscillations can emerge naturally from fundamental neuromuscular interactions during static and dynamic isometric contractions. METHODS:Our

simulations combined previously validated models of musculotendon dynamics, muscle spindles, and Golgi tendon organs, and can be driven in a feedforward or feedback manner. Modulation of force oscillations was tested with both the model and human subjects in various conditions such as dynamic isometric contraction and different fascicle lengths. RESULTS: We found that realistic amplitude modulation of force oscillations emerged naturally in the appropriate phases of dynamic isometric force production. Furthermore, tuning reflex gains affected the phase-dependent amplitude of force oscillations, and modulating force oscillations compatible with those seen in human studies. Lastly, modeling static isometric contractions also matched the dependence of physiological tremor (5-15Hz) amplitude on muscle fascicle length and choice of muscle observed in human subjects. These results suggest that force oscillations between 1 and 15Hz can be well-explained as a consequence of coupling between the muscle-tendon dynamics and spinal reflex activity, even in the absence of oscillatory central drive. Also, these results speak to the asymmetry in stretch reflex response between upper extremity extensor and flexor muscles. CONCLUSIONS: We conclude that straightforward closed-loop simulations of afferented muscle-tendon suffice to replicate oscillations in muscle force. Thus, they critically enable us to disambiguate the neural and mechanical sources of force fluctuations, and explain their context-dependent interactions.

P2-A-8 Evaluation of external anal sphincter innervation asymmetry in obstetrics

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Recent studies suggest that functional asymmetry of pelvic floor innervation exists in healthy subjects, and it is strongly associated with postpartum incontinence when the trauma occurs on the dominant side of innervation. Episiotomy is the most common cause of perineal trauma during delivery, and the surgical incision is usually performed on the mediolateral right side episiotomy. Surface electromyography (sEMG) in obstetrics is a novel method for detecting the innervation zones (IZ) of external anal sphincter (EAS). The aim of this study is to locate the IZs of EAS by the means of sEMG, and to analyse their distribution, in order to evaluate the effect of episiotomy on the external anal sphincter muscle activity. In this prospective observational type study, 225 pregnant primiparous women (age 28.4 ± 4.1 years) were involved and EMG was performed to detect the distribution of IZs and amplitude of EMG signals of EAS. The EMG measurements were performed two times: during the 2nd trimester of pregnancy and 6 weeks after delivery, in order to recognize any changes in the innervation after delivery. EMG signals were detected by a cylindrical probe with 16

electrodes and acquired with a multichannel amplifier (OT Bioelettronica, Turin, Italy). IZ distribution and signal amplitude were detected before and after delivery. The women were divided in two groups according to the EAS innervation asymmetry: left or right dominantly innervated. The changes of signal amplitude were analysed in subgroups according to the delivery mode (no damage, spontaneous lacerations, caesarean sections and right side episiotomies). Out of the 225 women analysed before delivery 149 women returned after delivery and were used for further analysis: (56) (38%) of them had episiotomy on the right side, (44) (30%) had spontaneous lacerations, (20) (13%) had no damage, and (29) (19%) had Caesarean section. The innervation was observed to be heterogeneous with a tendency of asymmetry predominant on the right side 138 (61%) compared to the 87 women (39%) innervated on the left side. None of the women had any sphincter damage before pregnancy or wound complications after delivery. No significant changes in EMG amplitude were observed in women who had caesarean section or delivery with no damage. While a reduction of amplitude was observed in case of spontaneous lacerations or episiotomy. In particular in case of episiotomy, the women with innervation on the right side had a stronger reduction of EMG amplitude after delivery compared to the women with innervation on the left side, suggesting that choosing the right side of episiotomy could have limited the amplitude changes. Superficial electromyography showed to be a promising method for detecting innervation zones before and after pelvic floor surgery, to avoid iatrogenic damage of pelvic floor innervation.

P2-B-9 The Effects of Fatigue in Backward Skating in Ice Hockey

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BACKGROUND AND AIM: A typical hockey shift on the ice lasts between 30 to 80 seconds, and physiological fatigue may affect a skater's skating performance. Bracko, Fellingham, Hall, Fisher, and Cryer (1998) found that an average player spends only 4.6% of a 60 second shift in high intensity skating. Hence, this indicates that the aerobic system also contributes with there being large amounts of low and medium intensity skating. Hagg, Wu and Gervais (2007) evaluated the effects of fatigue in the lower extremities in female ice hockey players and found significantly less ankle flexion in forward skating when players were fatigued. However, how fatigue affects backward skating performance remains unaddressed. Backward skating is particularly an important skill for defense positions in ice hockey because defensive players play close to 50% of the game compared to forwards who play approximately 35% of the game (Twist & Rhodes, 1993). Hence, defensive players are at greater risk for injury because of their increased ice time. Therefore, the purpose of this study was to examine the effects of physiological fatigue in backward ice hockey skating. METHODS: After providing

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University-approved informed consent, five male collegiate ice hockey players participated in the study. Each player was fitted with joint reflective markers at the shoulder, hip, knee, ankle and toe. Players completed five continuous repetitions of backward and forward skating between the goal lines at their highest intensity. The duration of this skating time was approximately 90 seconds, sufficient to promote anaerobic fatigue. A JVC video camera captured their sagittal view of skating motion at 60 Hz in conjunction with a 650W artificial light. A standard two-dimensional kinematic analysis was conducted with the Ariel Performance Analysis System to examine the trunk, hip, knee and ankle angles at the beginning and the end of backward skating. RESULTS: A paired-sample t-test ($\alpha = 0.05$) indicated no statistical significant mean differences between the beginning and the end of the backward skating for the maximum and minimum trunk segmental, hip, knee and ankle joint angles. However, the minimum hip joint angle was 91.5 ± 11.2° in the beginning of backward skating and 104.5 ± 15.2° ($p = 0.051$) at the end of backward skating, which approached significance. CONCLUSION: These preliminary findings suggest that physiological fatigue may change lower limb kinematics in backward ice hockey skating, and particular emphasis could potentially be placed on the hip flexion motion when prescribing a strength and conditioning program. Future studies are warranted to verify the findings from this study with a greater sample size and also conduct a 3D backward skating analysis that will enable understanding of hip abduction-adduction motion that 2D side view analysis could not detect.

P2-B-10 The Effects of Load Mass Variations on Front and Back Squat Movement Coordination Pattern

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BACKGROUND AND AIM: One of the most popular and important weight lifting core exercises is squat. Coaches, personal trainers, physical therapists, and sports physicians prescribe various types of squat exercise to athletes for injury prevention and sports performance improvement. However, without proper body joint coordination, an injury may occur easily when performing squatting exercise. Vakos, Nitz, Threlkeld, Shapiro and Horn (1994) have reported various serious injuries from squatting exercise that includes muscle and ligamentous sprains, ruptured intervertebral discs, spondylolysis, and spondylolisthesis. Previous studies defined coordination as a proper sequence of force production to produce an optimal outcome to achieve a task goal, and the examination of timing and sequencing of the movement using a shared positive contribution technique can provide a fundamental understanding in coordination (Northrip, Logan, & McKinney, 1983; Wu, Gervais, Baudin, & Bouffard, 2012). Therefore, the purpose of this study was to examine the effects of different

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load masses on both front and back squat movement coordination patterns. METHODS: After University-approved inform consents were obtained, male college football players who were experienced in front and back squat exercises participated in the study. Joint reflective markers were placed on the right side of their body at shoulder, hip, knee, ankle and toe. Each subject performed both squat exercises five repetition at 65%, 75% and 85% of one repetition maximum. A JVC camera was used to capture sagittal view of squat motion at 60 Hz. A standard 2D lower body kinematic analysis was conducted with Ariel Performance Analysis System software. RESULTS: A two-way repeated measured ANOVA was conducted at $\alpha = 0.05$ and followed by a t-test with Bonferroni adjustment when a significant difference was found. The results of this study showed no significant difference between two different squat exercises, and also no significant differences were found among all three mass loads. Both pairs of hip and knee and knee and ankle joints showed a strong simultaneous type of movement ranging between approximately 82 ± 11% to 123 ± 30% for the back squat and 87 ± 29% to 117 ± 27% for the front squat. Additionally, all athletes showed predominantly a proximal to distal type of joint coordination pattern. CONCLUSION: This study concludes that experienced athletes demonstrated a simultaneous type of movement in the lower body joints in both squat exercises. Even with increased load mass up to 85% of one repetition maximum, athletes were able to maintain a proximal to distal type of joint coordination pattern. Coaches and therapists may utilize these findings to ensure their athletes and patients have a proper squat joint coordination. Future research is warranted to examine EMG activity under various load masses on front and back squats.

P2-B-11 Effect of whole-body vibration on isokinetic performance and muscle activation in individuals submitted to Anterior Cruciate Ligament reconstruction

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Background and aim: The vibrating platform produces oscillations capable of causing mechanical stimuli and, according to the creators of the method, improve neuromuscular performance, balance and bone density. It is believed that the primary endings of muscle spindle are activated by vibration reaching the muscle belly, and therefore facilitate the activation of the alpha motor neurons, resulting in reflex muscle contraction. This study analyzed the immediate effects of whole-body vibration (WBV) on neuromuscular performance of the quadriceps femoris of subjects submitted to Anterior Cruciate Ligament (ACL) reconstruction. Methods: 44 male participants, between 14 and 18 weeks after ACL reconstruction, were submitted to an evaluation of isokinetic performance and surface electromyography of knee extensor muscles of the affected limb. The variables analyzed

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were total work and the root mean square (RMS) of vastus lateralis muscle. Immediately after the evaluation, intervention protocols were carried out. Subjects were randomly allocated to one of the following groups: WBV group - performed an exercise protocol which consisted of staying barefoot in unipodal support on the non-dominant limb in the center of the vibrating platform, with 40o of knee flexion, while the upper limbs were extended at shoulder level and the trunk was kept in the upright position. The participants performed a total of 10 sets of 30 seconds, with rest intervals of 30 seconds between sets. The angle of the knee was monitored throughout the protocol with a universal goniometer to ensure that there were no changes in the amplitude. The vibrating platform was configured at a vibration frequency of 50 Hz and a vertical displacement amplitude of 4 mm; control group - performed the exercise protocol with the platform off. All participants were reassessed following the same procedure as the initial evaluation. The software SPSS (20.0) for windows was used for statistical analysis. A one-way ANOVA test was used to investigate baseline differences between groups. A two-way ANOVA for repeated measures was calculated to identify differences within and between pre- and post-tests. In the case of significance, post hoc comparisons (Bonferroni) were calculated additionally. A significance level of 5% was chosen. Results: No significant differences in anthropometric measures or variables analysed were observed in the baseline between the groups. There were no significant differences in total work nor in the value of the RMS in any of the groups. Conclusion: The results of this study suggest that the exercise protocol associated with WBV is not able to significantly improve the neuromuscular performance of the quadriceps femoris of subjects submitted to anterior cruciate ligament reconstruction.

P2-B-12 Effects of low level laser therapy on electromyographic activity after muscular fatigue: randomized, controlled, and blinded trial

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Background and aims: The muscle fatigue reduces athletic and funcional performance. The Low Level Laser Therapy (LLLT) acts in cells by promoting structural changes in organelles forming "giant" mitochondrias from the fusion of the neighboring mitochondria membranes, providing high levels of energy in celular respiration. This study aimed to investigate the immediate effects of Low Level Laser Therapy (LLLT) on neuromuscular activity after induced muscle fatigue. Methods: The study included 80 healthy subjects considered active or very active according to the IPAQ - Short questionnaire, aged between 18-28 years, without pain or injury in the dominant upper limb (UL). To record the electromyographic activity, electrodes were placed according to the recommendations of the SENIAM for the muscle

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biceps brachial. Volunteers were positioned seated in the isokinetic dynamometer and submitted to 5 maximal concentric contractions of the elbow flexors. The analyzed variable were the root mean square (RMS) and median frequency of brachial biceps muscle. Immediately after the evaluation, participants underwent the intervention protocol. For the application of LLLT, a single-diode laser device, model Photon Laser III, was used with the following parameters: wavelength of 808 nm, power of 100 mw, total energy of 20 J distributed in 4 points (5 J per point) and application time of 49 sec per point. The volunteers were divided into 4 groups (n=20 each group). The fatigue protocol was standardized for all groups and consisted of 30 concentric contractions for the elbow flexor group, with an angular velocity of 120°/s on the isokinetic dynamometer. The placebo group received a simulation of laser application after initial evaluation; the pre-fatigue group received a laser application before the fatigue protocol; the post-fatigue laser volunteers were underwent laser application after induction of fatigue; and the control group remained at rest for 4 minutes before and after the fatigue protocol. The two-way ANOVA and Turkey post-hoc tests were applied and a significance level of 5 % was considered. Results: There was no difference between groups for the variables Root Mean Square (RMS) and median frequency (Fmed) after the interventions (p>0,05), demonstrating that the application of laser therapy did not significantly interfere in the electromyographic activity of brachial biceps muscle. Conclusion : The use of low level laser therapy did not cause significant effects on electromyographic activity after induced muscle fatigue in the biceps muscle of healthy subjects.

P2-B-13 Relationship between the transverse palmar arch in the hand and the intrinsic hand muscles during reach-to-grasp motion for an object of different size

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BACKGROUND AND AIM: A disorder of the intrinsic hand muscles such as ulnar nerve palsy decreases the distal transverse palmar arch in the hand and may result in hand flattening. Thus, the intrinsic hand muscles have an important role in a formation of the distal transverse palmar arch. The previous study indicated that different shape of an object alters the formation of the distal transverse palmar arch. However, it remains unclear whether the hand intrinsic muscle activities correlate with the formation of the distal transverse palmar arch, and the relationship between the distal transverse palmar arch and the hand intrinsic muscles changes in different object size. The purpose of this study was to examine the distal transverse palmar arch relates to the intrinsic hand muscles, and the alteration in object sizes affect the link between the distal transverse palmar arch and the intrinsic hand muscles during reach-to-grasp motion. METHODS: Ten healthy volunteers without any upper extremity dysfunctions participated in this study and performed a reach-to-grasp motion

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task. We used two different size spheres of small and large: a diameter of 100mm and 150mm. Nine retroreflective cameras motion analysis system (VENUS 3D) was used for recording the transverse palmar arch formation and simultaneously recording the muscle activities of thenar and hypothenar muscle during the task. Two arch angles of thumb and little and wrist extension angle were calculated using the motion analysis data. Root mean square (RMS) of thenar and hypothenar muscle activities were calculated using muscle activities data to evaluate the cross-correlation between the muscle activities and each angle. The angles and RMS were examined during one phase of motion: preshaping. We assessed the pattern similarity between each arch angle and intrinsic hand muscle activities using the cross-correlation coefficient. Further, we compared the average of each angle and the cross-correlation coefficient between two different object sizes while preshaping phase. RESULTS: The cross-correlation coefficient between the thumb arch angle and the thenar muscle activities in small and large sphere were 0.583 and 0.647, respectively. The cross-correlation coefficient between the little arch angle and the hypothenar muscle activities in small and large sphere were 0.671 and 0.656, respectively. There was a significant difference in the wrist extension angle between two object sizes; however, as for the both arch angles of thumb and little, there were no significant differences. The cross-correlation coefficient between thenar and hypothenar muscle activities was significantly higher in large sphere than in small one. CONCLUSIONS: These findings might show even if the object size changes, the relationship between the distal transverse palmar arch and intrinsic hand muscles has maintained; the coordination between intrinsic hand muscles changes in response to wrist extension angle.

P2-B-14 Supersonic Shear Imaging is a non-invasive method to early detect muscle damage

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Eccentric contractions are well-known as a damaging form of muscular exercise. To date, there is no non-invasive marker for early detection of muscle damage. The present study aimed to characterize the relationship between immediate changes in shear modulus (i.e., muscle stiffness) and force decrease 48 hours after eccentric exercise. Delayed onset muscular soreness, maximal strength, shear elastic modulus were quantified in 4 groups: elbow flexors (EF) "control" (i.e. concentric contractions; n=8), EF "mild" (n=12), knee extensors (KE) "mild" (n=12) and KE "severe" (n=10), before, 1 hour, and 48 hours after an eccentric exercise. No significant effect of time was found for "control" group. A significant immediate increase in shear modulus was found for EF (%2B 65.5%) and KE (%2B24.7% and

47.3% for "mild" and "severe", respectively) associated to a decrease of maximal muscle strength 48 hours after exercise (-24%). Significant correlations were found for EF "mild", and KE group ("mild" and "severe" pooled) between the immediate (1 hour) changes in shear modulus and MVC decreases 48 hours after exercise (r = 0.81 and r = -0.81 for EF "mild" and KE, respectively). This result is of great interest for the early detect of muscle damage after an eccentric exercise and, in turn, adjust the intensity of training or rehabilitation program in the next days.

P2-B-15 Effect of unilateral fatigue in the knee extensors on crank power during sprint cycling

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BACKGROUND AND AIM: Power production during sprint cycling is influenced by the force-generating capacity and activation level of lower limb muscles [1]. Because fatiguing unilateral knee extension exercises can reduce the force-generating capacity of the homologous contralateral muscles [2], such exercises could reduce ipsilateral and contralateral production of crank power during sprint cycling. We investigated the effect of unilateral isometric contractions on the force-generating capacities of the knee extensors and the transmission of power to both cranks during sprint cycling. METHODS: 12 adults performed a 4-s cycling sprint before and after a series of 30-s submaximal isometric voluntary contractions of the left knee extensors until isometric maximal voluntary force (IMVF) was decreased by 50%. IMVF of right and left knee extensors, as well as maximal voluntary activation (VA), maximal M-wave (Mmax) and resting twitch force (Qtw) of the left knee extensors were measured prior to and after the series of unilateral knee extensions. Average power transmitted to left and right cranks were calculated over the downstroke and upstroke phases of the cycles, while EMG of vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF) and semitendinosus (HAM) were measured on both legs. RESULTS: Left knee extensors' IMVF (618±149Nm to 292±85Nm), EMG/Mmax (VL: -35.8±17.3%; VM: -24.5±18.6%), VA (92±4% vs. 69±12%) and Qtw (-22±13%) were reduced after the unilateral contractions (all $P<0.05$). Left crank power decreased for downstroke (451±106W to 391±121W) and upstroke (67±32W to 55±29W). EMG of left VL, VM and HAM were reduced ($P<0.05$) but no changes were seen for RF during the sprint performed after the unilateral contractions. No changes in right knee extensors' IMVF and EMG were seen after the unilateral contractions ($P>0.05$), while right crank power was reduced ($P<0.05$) for downstroke (437±89W to 411±94W) and upstroke (72±28W to 64±26W). CONCLUSIONS: Unilateral knee extension exercise caused substantial levels of peripheral and central fatigue that led to large reductions (-52±11%) in the force-generating capacity of the ipsilateral knee

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extensors and relatively small decreases of crank power produced by the ipsilateral limb during downstroke (-14±9%) and upstroke (-21±17%). Despite a lack of reduction in the force-generating capacity and EMG of the contralateral muscles, crank power produced by the contralateral limb was also diminished over downstroke and upstroke during sprint cycling. 1. Zajac, F.E., R.R. Neptune, and S.A. Kautz, Biomechanics and muscle coordination of human walking. Part I: introduction to concepts, power transfer, dynamics and simulations. Gait Posture, 2002. 16(3): p. 215-32. 2. Halperin, I., D. Copithorne, and D.G. Behm, Unilateral isometric muscle fatigue decreases force production and activation of contralateral knee extensors but not elbow flexors. Appl Physiol Nutr Metab, 2014. 39(12): p. 1338-44.

P2-B-16 The effect of external support on force and COP performance after ankle plantarflexors fatigue in athletes with ankle instability during lateral drop landing

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BACKGROUND AND AIM: Ankle sprain commonly occurs in the later period during matches or in prolong training because a constant muscle contraction leads to muscle fatigue. It is common for athletes using external ankle support but the effect under fatigued condition is still unknown. This study was to investigate the immediate changes of kinetics after ankle plantar flexors fatigue with or without external support. METHODS: Thirty-three athletes who had CAIT score less than 24 were identified with functional ankle instability (FAI) and were allocated to the control group (8M3F, age: 22.0±2.8 yr), the ankle brace group (8M3F, age: 22.5±1.9 yr), and the kinesio tape group (n=9M2F, age: 21.6±3.0 yr). All the participants performed single-legged lateral drop landing before and after plantar flexors fatigue protocol. The kinesio tape group applied kinesio tape on tibialis anterior, peroneus longus, and gastrocnemius; and the ankle brace group applied lace-up ankle brace during fatigue protocol and post-fatigue condition. The outcome measures were the difference of vertical ground reaction force (vGRF), the loading time, loading rate, and the range and velocity of center of pressure (COP) between pre-fatigue and post-fatigue measurement. The Kruskal-Wallis Test was performed to test the significance of median values of all dependent variables among the three groups; the post hoc test was then conducted for any group difference. RESULTS: In fatigue condition, the athletes without external support had a decreased peak vertical group reaction force and an increased COP range with faster COP velocity. However, the athletes with ankle brace had an increased peak vertical ground reaction force. For athletes with kinesio tape, they had a decreased postural sway and a decreased peak vertical ground reaction force in fatigued condition. CONCLUSIONS: Fatigue impaired dynamic postural control and the application of lace-up ankle brace provided ankle

joint stability and decreased postural sway. However, the passive constraint put ankle joint to sustain excessive force after landing. The use of kinesio tape provided ankle joint a better postural control and dissipated force during landing.

P2-B-17 The influence of kinesio tape and ankle brace on the lower extremity joint motion in fatigued unstable ankles during lateral drop landing

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BACKGROUND AND AIM: Ankle sprain often occurs after prolong training because of muscle fatigue. It is common for athletes to use external ankle support during training or matches; however, the effect under fatigued condition is still unknown. This study was to investigate the immediate changes of joint motion on lower extremity after ankle plantar flexors fatigue in the conditions with or without external support. METHODS: Thirty-three athletes who had CAIT score less than 24 were identified with functional ankle instability (FAI) and were allocated to the control group (8M3F, age: 22.0±2.8 yr), the ankle brace group (8M3F, age: 22.5±1.9 yr), and the kinesio tape (KT) group (n=9M2F, age: 21.6±3.0 yr). All the participants performed lateral drop landing before and after plantar flexors fatigue protocol. The kinesio tape group applied kinesio tape on tibialis anterior, peroneus longus, and gastrocnemius; and the ankle brace group applied lace-up ankle brace during fatigue protocol and post-fatigue condition. The outcome measures were the difference of maximal joint angle and the difference of range on hip, knee, and ankle joint angles between pre-fatigue and post-fatigue measurement. RESULTS: In fatigue condition, the athletes without external support performed lateral drop landing had greater joint motion. There was a significant group difference among three groups. Smaller difference of maximal hip abduction angle was found in the ankle brace group than that of the control group (p=.011); the KT group had a smaller difference of maximal ankle dorsiflexion than that of the control group (p= .009). In the difference of range of joint angle, there was group difference found in the hip and knee motion. The ankle brace group landed with a smaller difference of hip flexion than that of the KT group (p=.008). The difference of hip abduction in the control group was smaller than the ankle brace group (p=.006) and the KT group (p=.045); the difference of knee flexion was smaller in the ankle brace group than the control group (p=.003) and KT group (p=.014). CONCLUSIONS: Athletes without external support would adapt a flexion landing strategy after fatigue. The use of kinesio tape provided ankle joint a better landing position. With ankle brace, constraint on the distal joint motion could affect the range of motion in the proximal joints and resulted in a more extended landing posture. The changed landing strategy may contribute to the injury.

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P2-B-18 Development of a Diagnostic System for Shoulder Disorder Using Musculoskeletal Simulation

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BACKGROUND: The shoulder joint is quite important for human body, for its usage in wearing clothes, holding stuff or performing multiple daily activities. Shoulder discomfort is a common complaint in orthopedics clinic, and the etiology to younger age is trauma and sports-related injuries. For the old ones, the shoulder problems may relate to degenerative changes in the muscles, tendons, ligaments or cartilage wearing. Common diagnostic tools include history taking, physical examination, ultrasonography, arthrogram or magnetic resonance imaging (MRI). The physical examinations have no consistent results due to its relatively low sensitivity and specificity. Ultrasonography is a non-invasive and easily available tool for diagnosis and treatment, but has its limitations in clarifying complicated motions. Arthrogram is an invasive procedure, which the contrast medium will be injected into the joint for the subsequent X-ray series. MRI could obtain the detailed structure of the studies joint but the medial costs have restricted its utility. Musculoskeletal simulation technology is a convinced method to be applied in many fields, but few studies were focus on shoulder disorder. From the above, now lack of diagnosis method which is accurate can be used in clinic without motion limitation and it will be helpful for the patients who does not need to be arranged MRI. AIM: The purpose of this study is to employ musculoskeletal simulation technology (OpenSIM) to develop a diagnostic system. It is for the patients whose shoulder disorders is not serious, but still causing distress. METHODS: In this study, we used optical motion capture system with cameras to capture motion data. The patients with shoulder disorder are asked to capture their functional motions by these devices. The motion data were used for the musculoskeletal simulation in order to identify possible injured muscle groups. In the simulation, fiber length, tendon-force, moment-arm, etc. can be analyzed. These simulation data were provided to orthopedic doctor who would make diagnose. Finally, we confirm the diagnose with medical images. RESULTS: We captured different motions from subjects. These motion include rotation, flexion, extension, and some provocative tests movements. We find the main muscle in different motion by analyzing muscles length with OpenSIM software. In our study, we used fiber length variance of muscle to assume the degree of muscle injury so that we can give patients the diagnosis. CONCLUSIONS: Based on our result, shoulder disorder can be diagnosed with simulation. We suggested that diagnose shoulder disorder with simulation data is more convenient than traditional methods because our system can provide the accuracy and application in the clinic without motion limitation.

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P2-B-19 Reliability of the CANTAB cognitive assessment battery over short duration repeated measurements

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BACKGROUND AND AIM: Over the last thirty years, automated testing batteries, designed to assess various aspects of cognitive functioning, have become progressively common. One of these neuropsychological assessment batteries is CANTAB (Cambridge Neuropsychological Test Automated Battery). Research regarding the test-retest reliability of the CANTAB has been limited with only one known publication. METHODS: Twenty-three participants were randomly assigned into two groups, control (12 participants) and exercise (11 participants) and attended two sessions at least 5 days apart. An exercise group was included due to previous research in our lab examining the effects of heat stress on cognitive function during treadmill exercise. Five tests were utilized from the CANTAB battery: 1) spatial working memory (SWM), 2) reaction time (RTI), 3) rapid visual information processing (RVP), 4) spatial span (SSP), and 5) paired associates learning (PAL). Following baseline (Cog 1) testing (SWM, RTI, RVP), participants completed SSP and PAL while walking on the treadmill (4.5 km.h-1, 0% grade) and continued to walk for an additional 10 mins and then performed SSP and PAL (Cog 2). Upon completion, participants rested for 5 mins and then remounted the treadmill and walked for an additional 10 mins followed by administration of SSP and PAL (Cog 3). This work to rest ratio continued until participants completed Cog 5, at which time they were seated and completed SWM, RTI, and RVP. Intraclass correlations (ICC) and two-way ANOVA were conducted on all dependent measures. Statistical significance was set at ¦Á ¡Ü 0.01. RESULTS: Of the 28 ICCs determined, 17 revealed values greater than .60. For the two-way ANOVA analyses, only SWM total errors (28.5 ¡À 8.9 and 26.5 ¡À 12.9; 27.6 ¡À 17.5 and 18.2 ¡À 16.9) and RVP total correct rejections (251.9 ¡À 13.2 and 259.0 ¡À 8.3; 256.6 ¡À 11.6 and 260.7 ¡À 9.6) revealed a main effect of trial in the control group while SWM search time (910.4 ¡À 356.3 and 771.8 ¡À 238.5; 736.3 ¡À 198.7 and 658.6 ¡À 124.3 s) revealed a main effect of trial in the exercise group for test 1 and 2 in both sessions, respectively (p ¡Ü 0.01). CONCLUSIONS: Based on the ICC reliability values, the PAL test should be familiarized with up to 5 tests prior to data collection. In addition, SRT and CRT have relatively high reliability that indicate these measures can be used in test re-test comparisons of clinical and research designs. The SSP test provided an overall good reliability while the SWM test should provide enough baseline trials until participants determine an optimal strategy to minimize practice effects before test to test comparisons are made. Overall, to reduce practice effects a double baseline protocol should be implemented when changes in cognitive function over time are being examined. Furthermore, the addition of a non-experimental group will allow to distinguish between observed practice effects and changes due to the specific intervention imposed.

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P2-C-20 The skinny on vibration detection; how to generate skin feedback from the soles of the feet

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Background: The glabrous skin on the soles of the feet contain four distinct classes of cutaneous mechanoreceptors: fast adapting types I and II (FAI & FAII), and slowly adapting types I and II (SAI & SAII) [1]. Each class is sensitive to unique features of tactile stimuli, and may provide different functional cues to aid in the control of posture and gait. There is a growing research and clinical interest in enhancing cutaneous feedback through foot sole vibration [2, 3]. Previous work, which examined cutaneous receptors in the hand found frequency specific ranges of optimum afferent response for each class [4]. We do not currently know the vibration response characteristics of cutaneous classes in the foot sole. Aim: To investigate the vibration sensitivity and firing characteristics of low threshold cutaneous afferents across the human foot sole. Methods: Fifty-nine microneurography sessions in the tibial nerve were performed on 21 healthy subjects to obtain single unit cutaneous afferent recordings. Afferents were classified, and receptive fields mapped (Figure 1) based on previously described criteria [1]. Once identified, two-second vibrations at different frequencies (3-250Hz) and amplitudes (0.001-2mm) were delivered over each receptive field (6mm probe) driven by a vibration exciter (Mini-shaker 4810, Bruel & Kjaer, Denmark). Afferent firing characteristics were calculated from a representative one-second window of each vibratory burst. Impulses-per-cycle (imp/cycle), or entrainment response, was measured to establish the ability of afferent classes to entrain to each vibratory stimulus (fire 1:1). Results: Vibration responses were successfully collected from fifty-five cutaneous afferent recordings; 20 FAI, 10 FAII, 14 SAI and 11 SAII afferents (Figure 1). Each afferent class exhibited a unique capacity to respond at different frequency-amplitude combinations, however a broad overlap in responses was observed and an ability to preferentially isolate firing in each class was not apparent. All afferents were able to entrain at low frequencies (3-10Hz), while both SAs were unable to fire 1:1 above 30HZ. FA afferents had the greatest sensitivity (largest firing rate at low amplitudes) across all frequencies compared to SA afferents (even lower frequencies). Conclusions: Vibration was shown to evoke unique responses (imp/cycle) across the four foot sole cutaneous afferent classes. The ability to selectively activate a particular class in isolation was limited; however the overlapping thresholds and unique response intensities (imp/cycle) observed across classes may prove to have functional implications under loaded conditions. Understanding the interplay of afferent activation in isolation and as a population could lead to more targeted intervention strategies. References: [1] Kennedy, Inglis.(2002) JPhysiol. [2] Kavounoudias et al. (1998) Neuroreport. [3] Hijmans et al. (2007)Int J Rehabil Res [4] Johansson et al. (1982) Brain Res

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P2-C-21 The effects of an 8-week stabilization exercise program on trunk muscle thickness and activation as measured with ultrasound imaging in patients with chronic low back pain

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BACKGROUND AND AIM: Lumbar statilization exercise programs (LSEP) are popular but the underlying mechanisms are not well undestood. The aims were to determine if: (1) an 8-week LSEP in patients with chronic low back pain (CLBP) changed trunk muscle thickness and activation quantified by rehabilitative ultrasound imaging (RUSI); (2) RUSI measures were correlated with a change in clinical outcomes following the LSEP. METHODS: RUSI measures for the abdominal wall muscles [transversus abdominis (TrA), internal (IO) and external obliques (EO)] were taken in supine, at rest and during a contralateral active straight leg raise. Measures for lumbar multifidus were taken in prone, at 3 levels (L5S1, L4L5, L3L4), at rest and during contralateral shoulder flexion holding a small hand-held dumbbell. The RUSI variables were the resting muscle thickness (e.g., RIO or RL5S1) and percent thickness change due to contraction (e.g., %CIO or %CL5S1). RUSI measures were taken for the CLBP group (n = 34) before (T0) and after (T8) the 8-week LSEP (3 days/week %2B home exercises), along with Oswestry Disability Index (ODI) and Numeric Pain Rating Scale (NPRS) scores. RUSI measures were also taken for control subjects (n=30), at the same interval, but without treatment. Two-way ANOVAs (GROUP × TIME) were conducted to test for differences between patients and controls, and between measures collected at T0 and T8. Pearson correlations were carried out between RUSI measures at baseline (T0) and the change (d = T8 - T0) in clinical outcome measures (dODI and dNPRS). Partial correlations were also performed between the change of RUSI measures (e.g., dRIO) and the change in clinical measures, controlling for baseline RUSI measures. RESULTS: Patients reported a significant reduction in pain (NPRS; Cohen's d: 1.53) and improvement in function (ODI; d: 1.36). The ANOVA, however, showed no statistically significant GROUP × TIME interactions for RUSI measures, and only %CL5S1 (bilaterally) showed GROUP main effects (patients < controls). Significant and consistent (bilaterally) correlational analyses were only for thickness measures at rest: dREO (bilaterally) and dRIO (bilaterally) were correlated with dNPRS (r from 0.36 to 0.45); RL5S1 (bilaterally) were correlated with dODI (r = 0.43 and 0.46). CONCLUSIONS: The LSEP did not produce systematic changes in RUSI measures in the patients, relative to controls. Findings from the correlational analyses, however, first suggest that low LM thickness at baseline (RL5S1) may be prognostic for a reduction in perceived disability (dODI). Also, considering the distribution around zero of dREO and dRIO, suggesting muscle hypertrophy in some patients and atrophy in other, their positive correlations with dNPRS suggest that atrophy is related to decreased pain while hypertrophy is related to a less

decreased pain. This may reflect how successful the patients were at specifically recruiting the TrA, relative to EO and IO, during LSEP.

P2-C-22 A joint coordinate system to describe relative 3D motion between the front and head body segments of rodents: application in the study of neurodegenerative diseases

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SIGNIFICANCE: Parkinson disease (PD) is a neurodegenerative disorder where only recently instrumented motion analysis has been used to track progression and the effects of surgical or pharmaceutical treatment paradigms. However, because most drug trials for PD and other neurodegenerative diseases involve pre-assessment in models of the disease, translatable and accurate motion capture methods need to be developed for mouse models.
To the best of our knowledge, our group was the first to report, firstly on the feasibility of using an optical motion capture system to study aging-related changes on a mouse while walking, and secondly on a three body-segment rodent model comprised of the head, the anterior and hind body segments with application to PD. This model provided the ability to quantify and study the distinct 3D motion of each body segment relative to laboratory coordinates, using an Eulerian approach. However, much like when human motion is considered, it may be of greater interest if the motion of the rodent's body-segments are described relative to each other. Consequently, the purpose of this study is to expand on our previous work and propose a model to describe the 3D motion of the head of the rodent relative to the anterior body-segment.
METHODS: The development of the model has been described previously. Briefly, for the purposes of this report, one GDNF+/- mouse and a wildtype littermate (WT) were anesthetized and 2mm diameter retro-reflective markers were fixed to their hair via hypoallergenic double-sided tape. The markers were placed on the greater tubercle bilaterally, the middle of the back at the level of L4 to define the anterior body-segments. A marker was placed at the top of the head and two other virtual markers were created to define the head segment. A non-orthogonal joint coordinate system was created from the orthogonal systems of each body segment.
A 6-camera VICON optical capture system recording at 240Hz captured the 3D position of each marker. Each marker trajectory was low-pass filtered with a zero lag 6th order butterworth. Rodents walked freely in a 4 feet constrained walkway. For the purpose of this report, the model ultimately determined the relative angles between the anterior body-segment and the head assessing flexion/extension, tilting and spin in the sagittal, transverse

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and frontal planes, respectively. The overall velocity of forward progression was estimated from the marker at L4.
RESULTS: The normal aging rodent walked almost twice as fast as its parkinsonian type counterpart. The sagittal and transverse motion of the WT was greater than that of the GDNF+/-. These results correlate well with the current knowledge about the motor deficits of individuals with PD.
CONCLUSION: The model presented, to the best of our knowledge, is the first to describe the relative 3D motion between the head and upper body of the rodent. The coordinate systems "ride" with the rodent and the angular displacements are not sequence dependent. Finally, our results appear to be clinically valid.
ACKNOWLEDGEMENT: Supported by NIH grant AG023630 and partly by the South Carolina Spinal Cord Injury Research Fund.

P2-C-23 Does continuous visual feedback mediate motor learning and consolidation? Insights into landing strategies based on extrinsic and intrinsic information

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Background: Landings may induce high impacts at collision with the ground, and thus, without feedback and without experience a single landing could have potential harming results (e.g., in elderly people). Impact forces at landing could be reduced by anticipation and control of joint stiffness (i.e., modulation of spring-like muscle properties), whereas proprioceptive mechanisms are relevant. We focus on these mechanisms and enhanced their use by precluding visual input before, during or after a series of landing trials. Using a drop-landing paradigm, we attempted to test the hypotheses that learning without vision enhances the use of joint proprioceptive control and, in turn, it would result in a better immediate performance and better memory consolidation one day after training. We expected reduction of impacts (impulse at collision) to be accompanied by concomitant changes in joint kinematics and dynamics (changes in stiffness), with a particular focus on the knee joint. Methods and Experimental Design: Twenty healthy female volunteers (age=23.45±1.9ys, height=163±6cm, weight=54±0.75kg) performed 30cm drop landings on both feet. Participants were randomly assigned to either Vision (V) or No Vision (NV) learning groups (10 blocks x 6 landings; 30sec rest between blocks), followed by a 6-min mental rehearsal and re-test sessions immediately after and in the following morning. Peak-Forces (PF), Time-to-Peak-Force (TP), rate of change of Force, knee joint-stiffness (K) and angular knee joint-kinematics were calculated and compared at different timelines (baseline, post-intervention, follow-up) in both groups ($p \leq 0.05$). Results: Learning was observed regardless of visual condition (lower impacts post-training), but baseline and follow-up differences were

only significant for the NV group in all measures. These effects were accompanied by concomitant modifications in knee kinematics and dynamics, with NV subjects learning faster and reaching lower impact forces at collision, also during the consolidation phases. Conclusion: Practice with no visual feedback may induce positive changes in daily performances where landings are required (sports, rehabilitation, jogging), with a reduction of the risk of damage (impacts at touchdown may be lower and strategies of control may be retained better). Modulation of joint stiffness may have been the (alternative) underlying strategy used when vision was precluded.

P2-C-24 Unaware motor response induced during biological movement visual stimulus -Physiological effects of an augmented reality system for therapy in sensory-motor disorders-

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BACKGROUND: We have developed a novel therapeutic system that administers an augmented reality for the recovery of sensory-motor function among patients with neurological conditions. Exposure to visual stimuli in this system induces a vivid impression as though one?s own body is moving or the intention of voluntary movement without actual movement (kinesthetic illusion induced by visual stimulus: KiNVIS). We have previously reported on the cerebral network activity (Kaneko et al. 2015) and increased corticospinal tract excitability (Kaneko et al. 2007) during KiNVIS. To elucidate the physiological mechanisms underlying KiNVIS, the present study examined involuntary motor response following exposure to the augmented reality system. METHODS: Eighteen subjects participated in five sessions a day for 5 days. Each testing day included one control session for static hand observation and four training sessions with moving hand observations. While in a comfortable chair with a headrest and wearing a head-mounted display, participants watched a real time picture (static condition) or a recorded movie (moving condition) of their right hand. The movie consisted of consecutive flexion-extension movements of the hand. The subjects were instructed to keep their hand relaxed at a semi-pronated position on a hand rest and to continue watching the display. Each session lasted a total of 5 minutes. Before and after training, the participants answered a questionnaire on self-body ownership and KiNVIS. Participants indicated their agreement with a presented sentence on a seven-item visual-analog scale ranging from ?agree strongly? (%2B3) to ?disagree strongly? (-3). To detect the involuntary hand movement, EMG was recorded from the flexor carpi radialis (FCR) and extensor carpi radialis (ECR) during each session. Root mean square (RMS) value and synchronicity of EMG movement patterns were calculated to quantify muscle activity. RMS amplitude was the sum of average RMS in the two muscles. High synchronicity values

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indicated cyclically repeated muscle activity synchronized with movement in the movie. RESULTS: Ownership was induced in 56% subjects before training. KiNVIS significantly increased after the training within each day compared to it before. However, 56% of subjects reported KiNVIS during the moving condition after the last testing session. The synchronicity increased as trials proceeded within each testing day. The main effect of day was significant among RMS values; it became smaller depending on the days. All subjects, from whom EMG was appeared, were not aware of their own response during the moving condition. CONCLUSIONS: The augmented reality system we developed induces automatic muscle activity of which the participant is unaware. This motor response corresponded to the represented movement with neither intension nor muscle co-contraction.

P2-C-25 Low back skin sensitivity has minimal impact on active lumbar spine proprioception and stability in healthy adults

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BACKGROUND AND AIM: To complete motor tasks and ensure stability of the lumbar spine, sensitivity of the proprioceptive and kinesthetic systems is necessary. Sensory feedback is relayed to the central nervous system with details relevant to the motor task being completed. In pain states, such as chronic low back pain (CLBP), research suggests that there is a deficit in tactile acuity [1]. Furthermore, these tactile acuity deficits have been suggested to predispose to the guarded/encumbered motor strategies associated with CLBP [2]. With this evidence, newer research has begun to investigate the efficacy of tactile acuity re-training as a potential means to alleviate pain and mitigate the sensorimotor effects of CLBP [e.g. 3]. The question remains however; do these observed deficits in tactile sensory acuity with CLBP (and their associated link with spine motor control) manifest through primarily peripheral or cortical mechanisms? The purpose of this research study was to assess the effects of peripheral tactile insensitivity alone on the motor control of the lumbar spine. METHODS: To reduce peripheral tactile sensitivity a topical lidocaine-prilocaine based anesthetic (EMLA®) was used and compared with an inert topical cream (PLACEBO). 28 healthy participants were divided equally into matched EMLA and PLACEBO treatment groups. Each treatment was applied to the skin of the low-back region; representing the region reportedly affected in CLBP [4]. Individuals completed tactile minimum monofilament and two-point discrimination (TPD) threshold assessments, assessments of sagittal and axial active lumbar spine repositioning error, seated balance control and repeated lifting dynamic stability. These assessments were administered both before and after the application of the EMLA or PLACEBO treatment. RESULTS: Low-back minimum monofilament and TPD thresholds were significantly increased within the EMLA group, demonstrating that EMLA

effectively reduced sensory inputs originating from the skin. Skin sensitivity remained unchanged in the PLACEBO group. In the EMLA group, decreases in low-back tactile sensitivity did not result in any consistent decline in lumbar spine proprioception (active sagittal and axial repositioning error) or dynamic stability (seated balance and repeated lifting). CONCLUSIONS: Decreases in peripheral tactile sensitivity observed here are similar in magnitude to those reported in CLBP patients (~60 mm TPD threshold, [1]). Within this healthy population, decreased tactile sensitivity of the low-back had minimal influence on active lumbar spine motor control. These results suggest that peripheral tactile insensitivities alone do not manifest in the observed motor control changes associated with CLBP. References: [1] Catley MJ et al. J Pain 15, 985-1000, 2014; [2] Luomajoki H & Moseley GL. Br J Sports Med 45, 437-40, 2011; [3] Wälti et al. BMC Musculoskelet Disord 16, 83, 2015; [4] Moseley GL. Pain 140, 239-43, 2008.

P2-C-26 Split-Belt Treadmill Adaptation in Transtibial Amputees

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BACKGROUND AND AIM: Split-belt adaptation paradigms have successfully been used to investigate sensorimotor learning in healthy control participants as well as patient populations. These studies suggest that both adaptation and de-adaptation (or washout) are strongly affected in the case of altered sensorimotor information ? experimental or pathologic. The current pilot study investigated split-belt adaptation in a group of transtibial amputees donning an intrinsically controlled, powered ankle-foot prosthesis in comparison to a control population. METHODS: Three transtibial amputees (2 unilateral, 1 bilateral) and three control participants took part in the study. During the trial, all amputees wore the BiOM ankle-foot prosthesis. Participants walked on a dual-belt instrumented platform and performed two baseline recordings at speeds of 0.5m/s and 1.0m/s (2mins respectively). Subsequently they performed a 10minute adaptation trial with the two belts running at speeds of 0.5m/s and 1.0m/s respectively (higher speed on affected side). This was followed by a 5minute wash-out phase with both belts set to 0.5m/s. Movement kinematics, ground-reaction forces, and electromyographic data were recorded. RESULTS and CONCLUSIONS The results of this pilot study illustrate that all amputees were able to successfully adapt their gait to the split-belt treadmill. Their data are discussed with respect to a) the performance of the control group, b) the (altered) neural mechanisms involved in sensorimotor adaptation as well as c) the importance such motor learning paradigms for the evaluation of prosthesis performance and as a potential indicator of successful prosthesis embodiment.

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P2-C-27 No gender effect in pinch grip coordination after lateral transfer in brain among stroke survivors

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No gender effect in pinch grip coordination after lateral transfer in brain among stroke survivors Seyed Hadi Salehi, Na Jin Seo University of Wisconsin Milwaukee BACKGROUND AND AIM: Within the concept of interhemispheric connectivity, technical modulation of the excitability of motor areas in the contralesional and ipsilesional hemisphere has been applied in an attempt to enhance recovery of hand function following stroke. Previous studies demonstrated that post stroke loss and recovery of sensorimotor function is associated with acute deterioration and subsequent retrieval of interhemispheric functional connectivity within the sensorimotor system. METHODS: The objective of this study was to determine the effect of gender on lateral transfer from non paretic to paretic hand in pinch grip coordination among stroke survivors. A total of 26 persons with stroke, 13 women and 13 men, participated in this study (57.61 ±9.42). The change in the paretic grip coordination before vs. immediately after learning the coordination with the non-paretic hand will be measured and compared between men and women post-stroke. The grip coordination was quantified from (1) The standard deviation of force value during pinch grip (std force); (2) The standard deviation of angle value during pinch grip (std angle); (3) The average angle of the force computed from the magnitude of shear force to normal force (average angle); and(4) the Maximum of the angle (max angle).The grip force coordination variables were computed for the 2 sec window at which the mean total force was the highest for that period. RESULTS: ANOVA was performed for all the variables in two methods in order to determine if Gender (women vs. men) significantly affects the improvement of pinch grip coordination after using non paretic hand grip. Std force and std angle were significantly dependent upon the interaction between gender and lateral transfer (ANOVA, $p<.01$). Std force for males was 23% significantly greater compared to females in pre lateral transfer phase (Tukey post-hoc, $p<0.01$). Std force significantly decreased 26% after lateral transfer in males (Tukey post-hoc, $p<.01$), whereas females did not significantly differ post lateral transfer ($p>.05$). std angle for males was 12 % significantly greater compared to females in pre lateral transfer phase (Tukey post-hoc, $p<.01$). Std angle decreased 23 % after lateral transfer in males (Tukey post-hoc, $p<.05$), whereas females did not significantly improve post lateral transfer ($p>.05$). CONCLUSIONS: The Stability of the pinch grip force among male significantly improved after learning from the non paretic hand trial compare to female. However, due to the significant difference in pinch grip coordination before lateral transfer among two groups, we failed to demonstrate any significant difference in gender on improvement of pinch grip coordination after lateral transfer in brain.

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P2-C-28 People with chronic low back pain show reduced movement complexity during daily activities

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BACKGROUND AND AIM: The quality of movement changes in people with low back pain (LBP). Most studies, however, have been conducted in laboratory conditions thus information about the complexity and variability of spinal movement during daily activities is largely unknown. Non negative matrix factorization (NMF) is used in multivariate analysis to describe a family of algorithms that aims at reducing the dimensionality of an observed dataset, and enhance its sub-structures and hidden regularities and thus provides an indirect measure of the complexity of a set of variables. Here we characterize the movement habits and the differences in movement complexity during daily activity between asymptomatic individuals and people with chronic LBP continuously measured over a 24-hours interval. METHODS: Thirteen people with mild chronic non-specific LBP and eleven age and gender-matched healthy individuals participated in this study. Spinal motion was detected using Epionics SPINE (Epionics Medical GmbH, Potsdam, Germany), a device consisting of two flexible sensor strips which are fixed paravertebrally to the spine to provide a dynamic assessment of spinal motion in a rapid and subject-specific manner based on strain gauge technology and acceleration sensors. After recording a brief quiet standing trial for calibration, the system was set to record for 24 hours consecutively and the participants were encouraged to engage in their normal activities. The orientation of the accelerometers was used to detect when the subjects were lying down and those intervals of time were marked as "resting". Accelerometric data was also used to detect movements and to mark the periods of the day where physical activity was maximal. RESULTS: The total resting time, the amount of movement, the average movements per hour and the percentage of time spent in each resting position (prone, supine, on left or right side) were computed. In addition, the inherent complexity of angle data was investigated during the 60 minutes of highest activity through NMF. Patients and controls spent a comparable amount of time lying down over the 24h period (average resting time 457,73 ± 103,83 and 448,26± 113,43 minutes for controls and patients, respectively, P = 0,95). People with LBP tended to move, in total, less than controls while lying down (controls 517,55 ± 391,36, patients 327,46 ± 256,27 movements, respectively, P = 0,04). The movements per hour also differed between groups (P = 0,015). The NMF highlighted a significant difference in the dimensionality of control for asymptomatic and LBP individuals, the latter showing an inherently less complex angle signal (controls: dimensionality 13,0±2,8, patients dimensionality: 10,2±2,6 modules, P = 0,002). CONCLUSIONS: The complexity of movement, investigated by means of NMF revealed that patients tend to use more stereotypical movements with limited relative independence across spine segments.

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P2-C-29 The potential functional consequences of the distribution of fat infiltration in the neck muscles

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BACKGROUND AND AIM: The temporal increase in neck muscle fat infiltration (MFI) has been shown to be related to poor functional recovery following whiplash. However, the complexity and time constraints of a quantitative analysis of MRI images may hinder translation into radiology clinical practice. In this study we employed a qualitative metric for grading MFI in the cervical multifidus muscle to assess its ability to detect changes in MFI in Whiplash-Associated Disorders (WAD). The results are used in a computational model to understand biomechanical consequences of MFI in the neck. METHODS: 31 subjects (14 male, 17 female, age 41.5 +/ -10.6, range 22-61 years) and 31 age and sex matched healthy controls were recruited from an ongoing randomized controlled trial at baseline. The inclusion criteria included neck disability index (NDI) scores that indicate at least mild pain-related disability of > 20% between 3 months and 3 years after a motor vehicle collision (MVC). The participants with whiplash were divided in two groups: mild to moderate disability (NDI 20 - 40%), and severe disability (NDI > 40%). The local ethics committee approved the study, and written informed consent was obtained from all participants. Phase sensitive reconstruction of the data was performed and the multifidus was identified and segmented by a blinded operator in the fat/water images (C4-C7), using Analyze 11.0 (AnalyzeDirect, USA). For each cervical level the multifidus muscle was manually divided in eight equally sized regions in two rows, with regions 1 and 5 closest to spinous process, and row 1-4 closest to the vertebra (see attached figure). MFI was assessed on a visually based on the fat images, according to: 0 for no or marginal MFI, 1 for light MFI, and 2 for distinct MFI. The mean regional MFI was subsequently compared between the healthy controls and each of the WAD groups. Statistical analysis was performed in SPSS 19 (IBM, 2010). RESULTS: Twenty-one (68%) of the patients had mild to moderate disability and 10 (32%) of the patients had severe disability. Statistically significant differences in the overall frequency of a grade '2' were found between healthy controls and severe WAD ($p=0.03$) and between healthy controls and mild/moderate WAD ($p=0.03$). Additionally, statistically significant differences in MFI were detected between the severe WAD group and healthy controls at the C4 level, but not for the mild/moderate WAD group when compared to the control or severe WAD groups. CONCLUSIONS: This study provides further evidence of higher amounts of MFI in the deep extensor muscles of participants with severe WAD when compared to those with mild/moderate WAD and healthy controls. The spatial distribution of MFI agreed with previous quantitative work showing higher fat percentages along the medial and anterior regions of the multifidus muscle in all groups, with globally elevated MFI magnitudes in the severe WAD group. The overall frequency of '2' scores turned out to best predict group

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membership. The biomechanical consequences of the specific distribution of lost contractile tissue is currently being explored by altering maximum force production of deep neck muscles in a computational model of the neck.

P2-C-30 Measures of local dynamic stability at the ankle joint before and after a fatiguing protocol reveal subsets of polarised behaviours in young healthy adults

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BACKGROUND AND AIM Movement variability is an important construct in the field of human movement that is not very well understood, particularly in relation to fatigue. This study sought to investigate the effect of a fatiguing treadmill running protocol on local dynamic stability at the ankle. METHODS Eight healthy males (age: 21.8yrs±3.53; height: 181.4±6.13cm; mass: 76.7±6.59kg) training at least three times per week participated in this study. Participants first performed 10 minutes of steady state running at 60% of maximum heart, then completed 8 x 1 minute intervals at 80% maximum heart rate with 30 seconds recovery, followed by another 10 minutes of steady state running at 60% maximum heart rate. Sagittal plane ankle angle data were recorded for 2 X 180 second periods (1-3 minutes and 5-8 minutes) during both 10 minute steady state runs. Fifty consecutive strides of data were selected from each trial to create a time series of ankle angle data. The Lyapunov Exponent (LyE), a measure of local dynamic stability, was computed. A paired t-test was used to investigate the stability of the two "baseline" (i.e. pre fatigue) recordings. A one-way repeated -measures ANOVA was carried out to examine the effect of fatigue and recovery at three different time points i.e. baseline, post fatigue 1 and post fatigue 2. RESULTS No differences were observed between baseline measures, indicating the LyE was a stable measure in this population. A one-way repeated-measures ANOVA resulted a non-significant effect of fatigue ($p=0.9$). On visual inspection it was noted that half of the group demonstrated a marked increase in variability due to fatigue, while the other half demonstrated a marked decrease, resulting in a mean cancellation effect across the group. Further analysis was performed on the sub-groups, finding that the increased variability group yielded a significant difference ($p=0.014$) between baseline and post fatigue 1 ($p=0.043$) and post fatigue 1 and post fatigue 2 ($p=0.022$). A significant difference ($p=0.024$) was also shown in the decreased variability group between baseline and post fatigue 1 ($p=0.039$). CONCLUSIONS Fatigue is an organismic constraint that results in diverse adaptations within a group of healthy athletes. It is not possible to conclude what strategy is "better" in this instance: increasing or decreasing the LyE. The results of this study require us

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to acknowledge that group analyses of movement strategies adopted in the presence of fatigue may mask important information.

P2-E-31 Impact of amyotrophic lateral sclerosis in the system stomatognatic

Ligia Maria Napolitano Gonçalves[1], Jaime Eduardo Cecilio Hallak[2], Bárbara de Lima Lucas[1], Wilson Marques Júnior[2], Marcelo Palinkas[1], Sandra Valéria Rancan[1], Paulo Batista de Vasconcelos[1], Marisa Semprini[1], Selma Siéssere[1], Simone Cecilio Hallak Regalo[1]
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BACKGROUND AND AIM: Amyotrophic lateral sclerosis (ALS) is a neurodegenerative and progressive disease that affects the neuromotor system preventing the proper muscle function. This disease has in 10% of cases genetic characteristics, and the other 90% are sporadic. So that the human being has the quality of life it is necessary to a harmonious development of the skeletal muscular system and any changes in this complex system will cause imbalance in the stomatognathic system. This research evaluated the effects of ALS on EMG activity of masseter and temporalis muscles. METHODS: 30 individuals of both genders, with a mean age of 30.3 ± 5 years, matched individual to individual and distributed into two groups with 15 subjects each: GI with ALS and GII healthy control. This study was approved by the Ethics Committee of the Ribeirão Preto Dental School, University of São Paulo. The evaluation of EMG activity was carried out by EMG recordings of the right masseter (RM), left masseter (LT), right temporal (RT), left temporal (LT) during postural condition of rest (4s); dental clenching (4s); right laterality (10s,) left laterality and protrusion (10s). Surface EMG was performed using the Myosystem-Br1. Individuals with ALS were diagnosed by medical experts of the Department of Neuroscience and Behavioral Sciences at the Faculty of Medicine of Ribeirão Preto / USP. The mean values were normalized by the value of the EMG signal of dental clenching in maximal voluntary contraction (4s). The average EMG were tabulated and submitted to statistical analysis by the independent t-test (SPSS 21.0). RESULTS: The normalized EMG activity was significant ($P < 0.05$) for the rest: RM = [(I = 0.16 ± 0.06), (II=0.05 ± 0.01)] and LM= [(I = 0.18 ± 0.06), (II = 0.05 ± 0.01)]; protrusion: LM= [(I = 0.45 ± 0.07) (II = 0.12 ± 0.02)]; RT = [(I = 0.19 ±0.03), (II = 0, 09 ± 0.01)] and LT = [(I = 0.23 ± 0.06) (II =0.10 ± 0.02)]; left laterality: RM = [(I = 0.31 ± 0.06) (II = 0.09 ± 0.02)]; LM = [(I = 0.41 ± 0.08), (II = 0 09 ±0.02)] and LT = [(I = 0.32 ±0.07) (II = 0.17 ± 0.03)]. CONCLUSION: According to the results it can be concluded that there were significant changes in the activation pattern of the masticatory muscles in patients with ALS, as they possessed greater muscle activity when compared to healthy individuals. ACKNOWLEDGEMENT: FAPESP

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P2-E-32 Acupuncture applied to the branches of the facial nerve for the rehabilitation of bell's facial paralysis

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[1]University of São Paulo, [2]Claretiano University Center

AIM: The peripheral facial paralysis is caused by a nervous influx interruption in any one of the segments of the facial nerve due to the invasion of exogenous pathogenic wind and cold, leading to an obstruction in the movement of energy and blood in the face. This condition results in malnutrition of the muscle tissues and consequently motor impairment. The objective of this study was to evaluate the effects of acupuncture on the branches of the facial nerve using electromyography and facial expressions. METHODS: A 45-year-old man diagnosed with Bell's facial palsy on the right side participated in this study. The patient was submitted to surface electromyography with the electrodes being positioned on the orbicularis oris and the orbicularis oculi muscles, and to facial expressions to obtain images prior to and after rehabilitation, which consisted of 10 sessions once a week of acupuncture along the facial nerve, using tsing needles. RESULTS: The comparative analyses of the electromyographic images showed an increase in the action potential of both oris and oculi orbicularis muscles on the affected side, following the acupuncture sessions. For the upper orbicularis oris (UOO) and the lower orbicularis oris (LOO) muscles, the results were obtained during clinical conditions of rest (UOM: pre=7.18; post=27.44), (LOO: pre=69.83; post=312.46), beak (UOO: pre=106.80; post=127.13), (LOO: pre=554.38; post=747.59) and lip pressure (UOO: pre=86.04; post=253.76); (LOO: pre=512.31; post=872.36). For the upper orbicularis oculi (UOO) and the lower orbicularis oculi (LOO) muscles, the results were obtained during the clinical conditions of rest (UOO: pre=18.38; post=31.09); (LOO: pre=3.23; post=4.59) and blinking (UOO: pre=15.55; post=31.99); (LOO: pre=2.65; post=37.16). In relation to the visual feedback provided by the obtained images, the facial symmetry was restored compared to the hemi-faces. CONCLUSION: The results showed that acupuncture applied to the branches of the facial nerve can provide greater muscle action potential and recruitment of the muscle fibers in the affected side by clearing the normal flow of energy, improving the function of the movements, and providing better symmetry and positive responses in the stomatognatic system.

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P2-E-33 Finger movement control and associated brain activity responses post-stroke

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BACKGROUND AND AIM: Impaired finger dexterity is common after stroke, often affecting activities of daily living. Knowledge of kinematic characteristics and of underlying neurological mechanisms of such impairments is important to understand functional recovery. This study aims to investigate finger movement control and related brain activity patterns post-stroke (PS). METHODS: Data from a subsample including 9 participants PS with residual hemiparesis affecting manual dexterity (M age- 66; 3 female) and 12 able-bodied control (C) participants (M age- 65; 3 female) were analyzed. Two series of self-paced cyclic finger extension-flexion movements in random order were performed for each hand (4 series with vision, V, and 4 without vision, NV). Optoelectronic cameras monitored the 3D movement of markers affixed to the fingertips. Motion data was used to calculate each finger's Individuation index (II), reflecting movement independence, each finger's Stationarity index (SI), reflecting the ability to keep the finger still while another moves [1] and Movement frequency (MF). Functional magnetic resonance imaging, with simultaneous movement recording, was used to investigate brain activity patterns in relation to the kinematic parameters. II, SI, MF and the effect of vision were analyzed for the 4th digit. RESULTS: A factorial ANOVA 2 [group] x 2 [condition] x 2 [side] x [index type] showed an effect for group ($p < .0001$; PS < C); condition ($p < .01$; NV < V); side ($p < .0001$; affected/non-preferred < non-affected/preferred); and index type ($p < .0001$; SI < II). An interaction between group and side ($p < .01$) showed that indices of the affected side were lower compared to the non-affected side within the PS group and compared to both sides in the C group. No significant effects were apparent for MF but significant correlations were found between the indices and MF that were restricted to the PS group alone (over all conditions- $r = -0.22$; $p < .01$; within the NV condition- $r = -0.19$; $p < .01$; within the affected side $r = -0.15$; $p < .05$; and within the SI categorization $r = -0.14$; $p < .05$). Furthermore, within NV for the non-affected hand on the SI alone ($r = -0.54$; $p < .05$). All indicate that slower movements had higher indices. DISCUSSION: The associations between slower MF and higher index values within the PS group were located to conditions with increased difficulty (NV, affected side, and SI). Thus, reducing speed may be a selected strategy to increase control of finger movements PS when the demand on motor control is high. Further, with the applied calculation of finger movement independence we were able detect group differences, side differences within the PS group, and a positive effect of vision of the hands during performance. This indicates that this calculation is a sensitive measure that could be used to study the effects of stroke and to monitor progression in motor recovery. [1] Häger-Ross & Schieber, 2000, J Neurosci 20:8542-50

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P2-E-34 Concentric and isometric torques are affected by diabetes but the eccentric remains unchanged due to diabetes or polyneuropathy

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Introduction: The properties of muscle contraction of diabetic patients is poorly described and understood. Different from the sensorial losses, muscle weakness is only observed in the most compromised patients, while the early alterations are not addressed at all. Many movements disorders are described in the literature and, nowadays, are a public health issue, such as foot ulcers, amputation, and falls, yet insufficient information are available that refers to muscle impairments and their relationship with those severe complications. Since preserved muscle function is vital to maintain balance and stability during daily living tasks, it is necessary to understand muscle behavior in different status of the disease. Aim: Investigate knee and ankle joint torques during concentric, eccentric and isometric contractions in diabetic and neuropathic patients comparing them to non-diabetic individuals. We hypothesized that torques will be diminished in diabetics and even worse in neuropathic patients; also the ankle losses would be greater than the knee, because the polyneuropathy is supposed to have a distal to proximal involvement. Methods: The peak torques of flexion and extension for both joints were acquired using an isokinetic dynamometer in sitting position. During concentric and eccentric contractions, the joint speed was set at 60°/s. Five maximal voluntary contractions were acquired for concentric and eccentric and 2 for isometric, with a rest interval of 1.5 minutes. The sequence of the tests was randomized and verbal and visual feedback were standardized and delivered to all subjects. Three groups of adult males were evaluated (1) Control group (healthy non-diabetic individuals, n=33), (2) Diabetic group (patients with diabetes mellitus, n=31), (3) Neuropathic group (patients with diabetic polyneuropathy, n=28). The Neuropathic group was defined according to a fuzzy model of signs and symptoms. Differences between groups were calculated with ANOVAs for parametric knee variables (α of 5%) and Mann Whitney and Willcoxon for non-parametric ankle variables (adjusted α of 1.6%). To describe effect sizes, Hedges' g coefficients were calculated. Results and Discussion: Irrespective of polyneuropathy, both diabetic groups presented lower knee and ankle flexion-extension torques, both for isometric and concentric contractions. Other factors beside the polyneuropathy and early diabetes onset may be influencing the muscle strength production. The eccentric contraction was not different between any group that may suggest that passive muscle structures, which act on strength production, may not be affected by neuropathy or by diabetes. Other surprising finding was that knee and ankle torques presented a similar decrease between them, with greater effect sizes for the knee flexion and extension. This result does not support the hypothesis of a distal to proximal impairment, which was already demonstrated for the sensorial component of polyneuropathy.

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P2-E-35 Effect of back pain on trunk strength capacity and muscle activity patterns during isokinetic and sudden trunk loading in adolescent athletes

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BACKGROUND AND AIM: Maximum strength, trunk muscle activity and compensation of sudden trunk loading are regarded important factors in achieving core stability, with respect to back pain prevention. The purpose of this study was to evaluate differences between adolescent athletes with (BP) and without back pain (NBP) in maximum trunk strength and muscle activity during isokinetic (ISO) and sudden trunk loading (STL) situations. METHODS: 9 adolescent athletes with load induced back pain (BP: m/f 2/7; 15.6±1.2 y; 177±9 cm; 67±13 kg; 22.5±9.8 h/week training in canoe, rowing or triathlon) and 9 matched athletes without back pain (m/f 2/7; 15.7±1.4 y; 177±12 cm; 65±9 kg; 16.5±8.0 h/week training) were included in the study. Maximum strength in right-sided trunk rotation (ROM: 31°) as well as flexion/extension (ROM: 55°) was assessed on an isokinetic dynamometer (isometric; concentric/eccentric 30°/s). Sudden trunk loading (STL) was measured during eccentric extension and rotation (30°/s) with an additional dynamometer induced novel perturbation (acceleration from 30°/s to 330°/s within 120ms for rotation and to 150°/s within 250ms for extension) as a marker of core stability. Trunk muscle activity was assessed using a 12 lead-EMG including 6 ventral (Mm rec. abd., obl. ext. abd., obl. int. abd, left and right side) and 6 dorsal (Mm erec. spinae thoracic and lumbar, latis. dorsi, left and right side) muscles. Peak torque [Nm] and MVC normalized EMG-amplitudes (RMS) were calculated for each test condition and all single muscles as main outcome measures. Additionally, the mean EMG-RMS for four areas of the trunk was calculated (right and left ventral area (Vr / Vl), right and left dorsal area (Dr / Dl)). Descriptive statistics (mean±SD) were followed by interferential statistics using t-test (á<0.05). RESULTS: BP showed reduced peak torque for ISO and STL in extension and flexion, but not for trunk rotation (e.g. STL for BP/NBP: extension: 251±57/336±73Nm p<0.05, rotation: 144±45/138±37Nm p>0.05). EMG amplitudes were increased for back muscles (Dr, Dl) during concentric, eccentric and STL trunk rotation as well as extension/flexion compared to NBP (STL for BP/NBP: extension (Dl): 72±13/97±31% p=0.065, extension (Dr): 66±15/87±21% p<0.05; rotation (Dr): 48±26/137±86% p<0.05, (Dl): 39±25/74±43% p<0.05). No differences between groups were present for the abdominal (Vr / Vl) muscles (p>0.05). CONCLUSIONS: Adolescent athletes with back pain present characteristic trunk reaction pattern with reduced extension/flexion strength and higher back muscle activity in all test conditions. Therefore, the evaluation of strength and muscle activity in sudden trunk loading is suitable to assess altered trunk function which might be discussed in the background of reduced core stability. Training interventions focusing not only on trunk strength capacity but also on improving neuromuscular function should be recommended for affected adolescent athletes.

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P2-E-36 Complex Shoulder Instability - Chicken or Egg?

BACKGROUND AND AIM: The pathophysiology of type II/III shoulder instability using the Stanmore Classification System is not fully understood. This is the first study to approach this group of patients with complex shoulder instability from a muscle activity analysis perspective. The aim of this study is to identify whether the dysfunctional muscle patterning caused (egg) the instability or was part of a compensatory strategy (chicken).

METHODS: A total of thirty two patients including sixteen patients with Polar type II/III shoulder instability and sixteen age-matched controls were recruited. Polar type II/III shoulder instability was confirmed jointly by a senior upper limb surgeon and specialist physiotherapist. Activation of several muscles around the shoulder girdle including anterior deltoid (AD); middle deltoid (MD), posterior deltoid (PD), upper trapezium (UT), serratus anterior (SA), biceps brachii (BB), teres major (TM), latissimus dorsi (LD), pectoralis major (PM), supraspinatus (SSP), infraspinatus (ISP) and subscapularis (SUB) was assessed by EMG during forward flexion and abduction in the standing position. Each movement was divided into Phase 1 (up-swing) and Phase 2 (downward stroke). Both the patients and the controls also completed a number of questionnaires including the Western Ontario Shoulder Instability Index (WOSI), Oxford Shoulder Instability Score (OSIS) and Beck?s Depression Inventory.

RESULTS: Forward Flexion - The level of activation (%EMGmax) for all muscles was significantly higher in the patient group as compared the control group. In the patient group, it ranged from 86-112% in phase 1 and 78-103% in phase 2, as compared to 38-73% in phase 1 and 8-71% in phase 2 for the control group. There was a profound difference in the activation patterns of muscles in the patient group, with much greater variation and increased activation.

Adduction - In phase 1, activation of AD, MD, UT, TM, LD, BB and ISP was delayed in the patient compared to the control group. Furthermore, the peak activation of PD, SA and PM in patients occurred earlier that in the control group. In phase 2, AD, MD, PD, UT, SA, LD, BB and ISP showed delayed activation in the patient group.

The WOSI and OSIS showed a dramatically different score in the patient group compared to the controls.

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CONCLUSIONS: It is important to remember that the shoulder structure is intact in this group of patients. This is different to other shoulder pathologies such as rotator cuff injuries, where the compensatory strategies arise from structural abnormalities. Widespread aberrant muscle activation was seen in the patient group. We propose the activation patterns seen in these patients simultaneously demonstrates dysfunction and the compensatory strategies they employed to achieve even simple shoulder movement ? both chicken and egg!

P2-E-37 Functional analysis of lower limbs in individuals infected with the human immunodeficiency virus

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AIM: Acquired Immunodeficiency Syndrome (AIDS) is a chronic, incurable, viral disease complex transmitted by the blood, semen, breast milk, and vaginal fluids of infected patients. We aimed to investigate the physical, biological, and psychosocial factors relevant to the development of musculoskeletal diseases in patients with the human immunodeficiency virus (HIV), and to analyze the relationship between these factors and the symptoms of AIDS. The objective is to understand how HIV type 1 affects the function of the lower limb muscles. METHODS: Sixty men and women aged 22 to 57 years (mean of 36.77± 9.33 years) were selected and divided into two groups: 30 individuals with HIV subtype 1 (experimental group), and 30 healthy individuals (control group). Muscle activity was evaluated using electromyography. In order to analyze daily habits, measurements were made while the subjects assumed the following positions: orthostatic, squat (normalization factor), chair lift, seated on a chair, climbing and descending steps bilaterally, and mono support bilaterally. The final data were statistically analyzed by t-test using the Statistical Package for the Social Science, Version 21.0. RESULTS: Normalized electromyographic data of static posture in relation to lower limb support revealed to HIVG, a predominance of muscle activation to the right semitendinosus and left gluteus medius with left and right unipodal support. For the CG, the prevalence of muscle activation was observed on the left and right rectus femoris. For electromyographic analysis of functional activities of lower limbs revealed a predominance of muscle activation to the left rectus femoris and left gluteus medius during left and right climb "step", left and right lower "step", and chair lift and sit. For the CG, predominance of muscle activation was observed in the tensor fasciae latae. CONCLUSION:

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Analysis of functional muscle activity of the lower limbs in AIDS patients revealed a predominance of muscle activation to the left rectus femoris and left gluteus medius. Thus, in this study it is possible to observe that individuals with HIV demonstrated changes in the functional activity of the lower limbs.

P2-E-38 A systematic review of torso motor control impairments in adolescents with idiopathic scoliosis (ais) with implications for the planning of conservative interventions

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Fiber type abnormalities affect AIS. However, because of the conflicting knowledge on muscles in the etiology and progression of AIS, a review is needed. Scoliosis exercise schools have not stated their rationale based on deficits of torso muscles. Such evidence could inform exercise prescription.To systematically review the literature on differences in EMG activity of the erector spinae (ES) and abdominal muscles in AIS compared to healthy controls.A search was done in EMBASE, MEDLINE, CINAHL, Pedro, and Web of Science. Free text and indexed terms on scoliosis or spinal deformity were combined using AND with: strength, endurance, fatigability, muscle fatigue, latency, co-activation, EMG activity or timing. The references of included articles were checked. Two reviewers screened abstracts, then full-text articles using the inclusion criteria: in English or French; AIS; on torso motor control. Exclusion criteria were: post-operative or post-exercise; or <10 subjects. The Newcastle/Ottawa (NO) scale and ISEK EMG criteria were used for quality appraisal. PRISMA guidelines were used.The search yielded 10887 hits (6534 unique). After screening abstracts, 98 full-texts were reviewed and 12 included. Agreement for abstracts screen was Kappa = 0.79. Only 1 study had high (>80%) quality on ISEK criteria. Studies often missed electrode size (68%), or type (59%). Only 3 studies had high (>80%) NO quality. Most samples were <25 (10 to 394). Comparing groups, limited evidence from 2 low quality studies shows longer latencies in ES for a drop step test and to neck extension in progressive curves. Limited evidence from 1 high quality study shows no difference in normalized ES activity during 2min of isometric extension using 3 intensities and 2 sitting positions. Limited evidence from 1 low quality isometric hyperextension study shows lower EMG on the concave side and no difference in fatigue index. For dynamic lateral bending and rotation voluntary tasks in sitting or standing, there is limited evidence from 2 low quality studies of higher activity in ES and from 1 study in obliques and rectus. Limited high quality evidence (2 studies) shows higher activity or hetero to homolateral ratios in ES and bicep femoris during forward and backward perturbations. During walking, there is limited evidence (1 high, 1 low quality) of prolonged duration of ES and quadratum activity with conflicting evidence about

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duration in gluteus maximus. From low quality isokinetic flex-ext. studies at 20-90o/s, there is limited evidence of decreased median frequency in ES on the right thoracic side, of more symmetrical activity for the Lumbar ES and of increase thoracic ES activity on the dominant side in large curves.Patients with AIS present latency, endurance, and EMG deficits possibly more important in patients with progressive curves. Future studies should determine if deficits predict progression and if modifying these deficits with exercises can prevent curve progression.

P2-E-39 Effects of low vision and blindness in complex postural

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BACKGROUND AND AIM: Posture is characterized as being a position maintained with automatic and spontaneous characteristics, requiring little muscular activity to keep it. The visual system is responsible for 80% of the information sent is essential to motor development. Low vision or its absence limits the life experience and influences the development. Electromyography (EMG) is a technique that allows the recording of electrical signals generated by muscle cells. This study evaluated the EMG activity of the masticatory muscles, cervical and shoulder girdle of individuals with low vision and blindness, compared to a healthy group. METHODS: 30 individuals analyzed between 18 to 40 years, divided into two groups: those with low vision and blindness (GI, n = 15) and healthy control (GII, n = 15). Exclusion criteria were: the presence of disorders of systemic or local origin, using medications or treatments that may interfere with the muscular activity, under the age of 18 years and people with cognitive problems. EMG examination were performed (Myosystem-Br1) for right masseter (RM), left masseter (LM), right temporal (RT), left temporal (LT), esternocleidomastoideo right (RECOM), left sternocleidomastoid (LECOM), top right trapezius (TRT), top left trapezius (TLT), right middle trapezius (RMT), left middle trapezius (LMT), along the right chest (ARC) and along the left chest (ALC), the following conditions for the masticatory muscles : dental clenching in maximum voluntary contraction (4s), dental clenching in maximum voluntary contraction with Parafilm M®; placed on both sides of the dental arch (4s), right laterally (10s), left laterally (10s), chewing of peanuts (10s) and chewing of raisins (10s). For the cervical muscles: cervical flexions (10s), shoulder flexion (10s), shoulder abduction (10s) and stem extension (10s). The EMG data were tabulated and submitted to statistical analysis (SPSS version 21.0). This study was approved by the Ethics of

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the University of São Paulo / School of Dentistry of Ribeirão Preto. RESULTS: The EMG activity was significant (P<0.05) in the mandibular rest: LM= [(I = 5.47 ± 1.25), (II = 9.28 ± 1.01)], LT = [(I = 1.57 ± 0.16), (II = 5.41 ± 0.81)], right laterality: LT = [(I = 2.77 ± 0.16) (± 5.71 II = 0, 81)]; the shoulder flexion: TRT = [(I = 91.80 ± 13.58) (± 12.95 139.72 = II)], TLT = [(I = 162.01 ± 47.56), (II = 390.67 ± 63.04)]; the shoulder abduction: LMT = [(I = 11.14 ± 0.97) (± 18.33 II = 2.61)]; in the extension of the spine at rest: ALC = [(I = 7.78 ± 1.65), (II = 17.51 ± 3.94]. CONCLUSION: Based on the results, there was greater potential for action of muscles of the face, indicating change in biomechanics of the stomatognathic system, and a reduction of responses of automatic adjustment of the posture, referring to individuals to a compensatory attitude. ACKNOWLEDGEMENT: PIBIC / USP / CNPq.

P2-E-40 Superficial tissue compression effects in muscle tone of patients with encephalic vascular accident

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AIM: The spastic hypertonic is a common clinical manifestation in patients with cerebrovascular alterations, resulting in motor disability, during the daily life activities. The objective of the present study was to analyze the effects of a tissue compression device (TCD) in the muscle activity of upper hemiparetic limb in patients with stroke (ST). METHODS: This study was previously approved by the Ethics Committee in Research of the School of Physical Therapy of Bebedouro, UNIFAFIBE. Fourteen male individuals, aged 60 to 80 years (72,33± 2,36 years) and clinical diagnosis of ischemic stroke (STi), were selected and divided in two groups: ten individuals with right spastic hemiparesis and four individuals with left spastic hemiparesis (Ashworth 2 and 3). All subjects underwent muscle activity, through surface electromyography, pre and post immediate application of TCD. For the application of the device the individuals remained with a "float" that promotes a compression in the tissue surface of the member, in a period of 15 minutes, maintaining the orthostatic position and with upper limbs held in neutral position (according to the spastic pattern). A pressure control, kept in a nominal scale 1,0psi, controlled with a pressure gauge. Surface electromyography was performed using the EMG-Br1 Myosystem®, during the clinical condition of rest (10s). The values were normalized by the value of the electromyographic signal of isometric contraction of each muscle evaluated, harvested by ten seconds. The electrodes were placed on the following muscle: biceps brachii (BB), triceps brachii (TB) and brachioradialis (BR) of the affected side (hemiparetic). The electromyographic means were tabulated and subjected to statistical analysis using t test (SPSS version 21.0). RESULTS: After

applying the TCD based on a descriptive analysis, showed that all the muscles evaluated presented a lower muscle activity. However the results were not statistically significant, as regards the comparison of the two periods (t-test p > 0.05). CONCLUSION: The TCD was effective in reducing the spastic muscles activity, for the muscles BB, TB and BR, due the device cover the entire length of the upper limb, acting directly on muscle fiber and promoting direct stimulus to mechanoreceptors. It is believed that with the spastic reduction, the patients may acquire standard major functions in daily activities, thereby improving their quality of life and preventing possible complications such as bone and muscles deformities.

P2-E-41 Investigation of Oxygenation Difference during Sternocleidomastoid Isometric Contraction for Clients with Mechanical Neck Disorder

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BACKGROUND AND AIM: Previous study demonstrated that 66% of people have experienced neck pain during their lives. Mechanical neck disorder (MND) has become one of the most severe musculoskeletal symptoms. The clinical symptoms of MND include neck pain, muscle imbalances and restricted activity. Furthermore, patients with MND may easily experience the over-activation of EMG signal on the upper trapezius muscle and the sternocleidomastoid, which lead to fatigue of the superficial neck muscle groups. The oxygen in blood played an important role on ameliorating fatigue led by over-activation of muscle. However, it remained no data available for the condition of oxygen-hemoglobin in MND patients. In this study, we explore oxygen-hemoglobin concentration of sternocleidomastoid muscle during execution basic actions in MND patients. METHODS: The study was carried out by 27 adults, including healthy participants without neck-related symptoms (n = 13; 9 males and 5 females, 24.0 ± 5.1 yr) and MND clients with Neck Disability Index (NDI) more than mild disability (n = 14; NDI: 9.23 ± 4.00, 7 males and 6 females, 23.6 ± 4.2 yr). The participants were requested to remain supine position on the bed. The concentrations of oxygen-hemoglobin/total hemoglobin were measured triplicate on sternocleidomastoid muscle belly by near-infrared spectroscopy when performing 25%/50% maximum voluntary contraction of neck flexion (30 sec of each). Hyperbolic tangent method (tanh) was applied to analyzed the parameters of oxygenation kinetic. The differences of the tissue oxygen saturation (ÄStO2) were calculated from the baseline contraction to the minimum blood oxygen saturation, and the inflection time (IF) was defined as the half time of the oxygen concentration descending to the minimum. The oxygen consumption (depletion rate) explained the isometric contraction oxygen consumption rate. RESULTS: Our results showed

that there are no statistical differences on the baseline,ÄStO2 values and IF between two groups. The ÄStO2 values of 25% and 50% contraction for the healthy participants were 21.45% and 21.38%, respectively. Similarly, for the MND patients were 21.40% and 23.57%, respectively. In addition, the IF of 25% and 50% contraction for the healthy participants were 10.06 and 10.78 sec, respectively; similarly, for the MND patients were 11.63 and 9.77 sec. CONCLUSIONS: Our study provided the evidences of no differences on muscle oxygen under low isometric intensity between healthy and MND adults.

P2-E-42 Functional analysis of the stomatognathic system in individuals with multiple sclerosis

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AIM: Multiple sclerosis is one of the major diseases affecting the central or peripheral nervous system. This disease is characterized by a chronic inflammatory process that acts in the destruction of myelin sheaths of the nervous system. The objective of this research was to analyze the effects of multiple sclerosis in the performance of the masticatory muscles. METHODS: This study was previously approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. Twenty two individuals of both genders, aged 18 to 45 years, were divided into two equal groups: Group MSG, individuals with multiple sclerosis and Group CG, healthy individuals. All individuals were evaluated on the basis of the electromyographic activity of the right and left temporal (RT, LT), right and left masseter (RM, LM), during postural jaw conditions (rest, protrusion, right and left laterality). Surface electromyography was performed using the EMG-Br1 Myosystem®. The values were normalized by the value of the electromyographic signal of maximum dental clenching, harvested by four seconds. The electromyographic means were tabulated and subjected to statistical analysis using t test (SPSS versão 21.0). RESULTS: Normalized electromyographic activity was significant ($p<0.05$) for right laterality: RM= [(MSG = 0.36 ± 0,02), (CG=0,13 ± 0.03)]; LM= [(MSG = 0.29 ± 0,11), (CG=0,14 ± 0.02)] and left laterality RT= [(MSG = 0.36 ± 0,01), (CG=0,07 ± 0.01)]; RM= [(MSG = 0.27 ± 0,06), (CG=0,11 ± 0.02)]; LM= [(MSG = 0.38 ± 0,07), (CG=0,12 ± 0.04)]. CONCLUSION: Based on the results of this research, it can be concluded that individuals with multiple sclerosis showed muscular changes related to the stomatognathic system, especially concerning EMG activity of postural jaw conditions.

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P2-E-43 Midfoot Kinematics During Adult Gait

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AIM: The midfoot segment is a complex structure that provides mobility and stability as motion is transferred from the rearfoot to the forefoot during the gait cycle. Despite its important role, we currently know very little about the mechanics of the midfoot during gait. This is partially due to the difficulties associated with quantifying midfoot mechanics. As a result, this segment is often excluded from kinematic models and is often assumed to act synergistically with the forefoot. However, this assumption has not been adequately tested. To further our understanding of midfoot mechanics in typical and atypical populations, this study quantified the 3D kinematics of the midfoot during walking at various speeds in adults. METHOD: Twenty-one adults (11 female, 12 male) aged 18 to 28 years were recruited to participate in the study (age = 23.0±2.6 years; height = 1.73±0.1 m; weight = 72.1±10.1 kg). Participants were asked to perform gait trials at 5 different walking speeds. A 12-camera Vicon T160 motion capture system (Oxford Metrics Group, UK), sampling at 100 Hz, was used to track the three-dimensional trajectories of 34 reflective markers placed on the participant. The rigid body model consisted of five segments: 1) the shank, 2) the total foot (single rigid segment), 3) the calcaneus, 4) the midfoot, and 5) the forefoot. Euler angle data was analyzed using custom software created in Matlab (Mathworks, Inc, USA). An ANOVA and post hoc analyses were conducted using SPSS (IBM, USA) to test for significant differences in maximum relative joint angles across 5 walking speeds (very slow, slow, free speed, fast, and very fast). RESULTS: The motion of the midfoot relative to the calcaneus is relatively small across all walking speeds in adults (Figure 1). A similar pattern of motion was exhibited between the forefoot and calcaneus. Range of motion between the midfoot and forefoot was greatest in the sagittal plane and reached a mean peak of 6.4°±1.5 during the very fast walking speed. Small but significant changes ($p<0.002$) in mean maximum plantarflexion of the midfoot relative to the calcaneus were found across walking speeds. The maximum plantarflexion of the midfoot-calcaneus increased from 8.8°±2.3 at very slow to 10.52°±3.9 at very fast walking speeds. The forefoot with respect to the calcaneus demonstrated similar results. CONCLUSION: Synergistic and differential movement of the midfoot relative to other segments suggests that this segment demonstrates small and complex motions during gait, which should not be ignored. Movement of the midfoot also changes as a function of walking speed.

P2-E-44 The strategies on turning while walking after stroke

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Back ground and Aim Though turning has a high risk of falling among stroke patients, previously there has been little research on turning undertaken using visual cues. The turning in the daily life is difficult to reproduce under the experimental environment. A method that can more clearly and continuously detect the onset of turning while walking, is necessary. The aim of this study is to correctly analyze the strategy for the onset of turning while walking after stroke. Methods Eight patients with a hemiparesis due to a stroke (66.1 ± 10.2 years, left and right hemisphere lesions; 5/3) participated in this study. All patients can walk independently without a cane. After walking 4-5m, participants were visually cued to turn 90° to the left or right. Visual cues were activated in the non-paretic or paretic foot-contact (stance) by using a foot switch. With the stance and the direction, the turning tasks were classified as the ipsilateral turning (non-paretic stance/non-paretic direction: NPS/NPD, paretic stance /paretic direction: PS/PD) or the contralateral turning (NPS/PD, PS/NPD).The movement of Head and Pelvis in response to the turning cue were examined by using an inertial sensor. A paired t-test or Wilcoxon rank test was used to the each turning reaction times. Results Head movement started to turn before Pelvis movement in both the ipsilateral turning ($P<0.05$) and the contralateral turning ($P<0.01$). The mean reaction times were as follows; NPS/NPD: Head=433.8±63.9msec and Pelvis= 547.5±47.6msec, PS/PD: Head=451.3±97.2msec and Pelvis=563.3±101.8msec, NPS/PD: Head=390.4±56.2msec and Pelvis=635.0±82.7msec, PS/NPD: Head=424.2±69.5msec and Pelvis=615.4±79.3msec. Conclusions This study analyzed more clearly the timing of the onset of turning while walking by using the foot switch. The sequence of body segments were observed in both the ipsilateral and the contralateral turning. And this results suggested that stroke patients had a slower Pelvis movement in the contralateral turning than the ipsilateral turning. The strategies of turning are due to the difference in the direction and the characteristics of a hemiparesis.

P2-H-45 Muscle synergies underlying sit-to-stand tasks and their relationship with kinematic characteristics

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BACKGROUND AND AIM: Standing from a seated position is crucial for human activities because standing up on their feet is a vital prerequisite for bipedal walking. In a sit-to-stand (STS) task, the body's center of mass has to lift and balance itself on narrow feet. Therefore, a

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STS task has unique kinematic characteristics that start with trunk flexion and end with whole body extension. The muscle activities involved in this kinematics are also assumed to be patterned (muscle synergy). However, because not exactly the same kinematic strategies are used to achieve a STS task, we hypothesize that muscle synergies are of various kinds. Thus, the purpose of this study was to investigate various muscle synergies, and to understand how healthy adults achieve STS tasks.
METHODS: In this experiment, 7 healthy male subjects were asked to stand up 7 times in each of the 2 speed conditions, comfortable and fast. A surface electromyogram (EMG) device (NORAXON corp.) was used to collect the muscle activities data from 8 muscles (tibialis anterior [TA], soleus [SOL], gastrocnemius, vastus lateralis, rectus femoris, semitendinosus, and gluteus maximus). Subsequently, a non-negative matrix factorization algorithm was applied to the EMG data for extracting muscle synergies. Correlation of the muscle synergies among the subjects and their speed conditions were assessed using the cosine similarity. A motion capture system (Vicon Corp.) was used to acquire kinematics information of the subject. Subsequently, the following parameters were calculated: 1) the difference of peak timing between the pelvis and shank angles of inclination and 2) the direction of sagittal ground reaction force when the muscle synergies are activated to the maximum (θ).
RESULTS: Two muscle synergies were extracted from every subject and speed condition. One synergy was activated primarily in the seat-off phase, and the other was activated primarily in the extension phase (S_{MID}, S_{LAT}, respectively). The correlation coefficients were high in S_{LAT} (r = 0.83), but not so much in S_{MID} (r = 0.77). Many subjects highly inclined their pelvis after inclination of the shank (12.90 ± 15.47 t/T); however, the relationship between the pelvis and shank was reversed in some subjects(-7.50 ± 7.13 t/T). The S_{MID} of the former subjects was dominated mainly by the TA and to a small extent by the SOL. In contrast, the S_{MID} of the latter subjects consisted of similar activation level of the TA and SOL. For all the subjects and conditions, θ was nearly vertical(-4.61 ± 2.48 °).
CONCLUSIONS: Our results show that muscle synergies underlying STS tasks were modulated by individual kinematic characteristics. These synergies were independent of the direction of the ground reaction force, unlike reported in previous studies on standing tasks. This suggests that muscle synergies underlying STS tasks have a relationship with segmental dynamics.

P2-H-46 The importance of feed-forward control in posture stability

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BACKGROUND AND AIM: The center of pressure (COP) trajectory is always represented by two variables (x and y coordinates, the magnitude and direction of a vector). We proposed a new method of representing the COP sway velocity with one variable. We defined the variable by using the COP vectors to calculate the area of the circularsector. This concept is both similar to "stabilogram diffusion analysis (SDA)" (Collins and De Luca, 1993) and Nagano's analysis (Nagano et al., 2010). SDA calculates the average distance traveled by the COP within a certain time interval, and Nagano's analysis evaluates the directional change of COP sway by calculating the cosine of the vectors. While, both SDA and Nagano's analysis require two variables to generate a stabilogram, the proposed method can do it with only one variable which includes the amount of comprehensive change in the magnitude and direction of the COP sway. We named the new method "stabilogram fan-shaped analysis (SFA)". The purpose of this study was to investigate the influences of feed-forward and feed-back control on posture stability using SFA and Nagano's analysis. METHODS: Nine healthy young subjects participated in this study. Stabilographic examinations were performed during the trials with both open and closed eyes on a force platform. The time-series data for the COP were acquired at 100 Hz with a 30-s sampling time. Using the SFA method, the area of the circular sector was defined by the velocity vector after a certain time interval (ΔT) was calculated. The area was then averaged over the number of time intervals that made up the COP time series. This process was repeated for increasing values of ΔT. A plot of the mean area of the circular sector versus ΔT was called an SFA plot. The FFratio(Feed-Forward ratio) was defined as the ratio of the integrated value of the SFA plot up to 0.10 s to the integrated value up to 3.0 s. Additionally, the FBratio(Feed-Back ratio) was defined as the ratio of the integrated value of an SFA plot from 0.20 s to 0.70 s to the integrated value up to 3.0 s. RESULTS: The FFratio and the directional change of COP sway in the feed-forward phase was significantly larger for the open eyes condition. This implies that the COP sway for the open eyes condition displayed a random-like nature as one would expect from predictive postural control in the feed-forward phase. Meanwhile, there was no significant difference for either conditions with regard to the FBratio and the directional change of the COP sway in the feed-back phase. CONCLUSIONS: These results suggest that feed-forward control rather than feed-back control play an important role in posture stability.

P2-H-47 Threat of perturbation effects on anticipatory postural control

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BACKGROUND AND AIM: When individuals are required to perform a voluntary movement at the edge of an elevated surface, the amplitude and rate of the required anticipatory postural adjustment (APA) is reduced (Adkin et al., 2002; Yiou et al., 2011). While this change

may be attributed to a threat-related response (i.e., fear, anxiety and arousal) to standing at height, it is possible that the altered pattern reflects a strategy where individuals minimize body movement towards the edge of the surface to prevent a fall. In order to differentiate between these factors, this study introduced a different form of postural threat, specifically a potential perturbation to the body, to examine how this threat affects an individual's ability to perform a voluntary heel raise task. METHODS: Fourteen young adults (21±1 y) stood on a force plate while they completed two experimental conditions. For the low threat condition, participants were provided an auditory warning tone followed 2-12 s later by a go tone. Upon presentation of the go tone, participants were required to perform a heel raise as rapidly as possible. For the high threat condition, participants were provided the same warning tone. However, 2-12 s later, participants either heard the same go tone, for which they were required to perform a heel raise, or experienced a support surface translation in the medio-lateral direction (25 cm displacement, 0.9 m/s velocity, 1.7 m/s/s acceleration) that disturbed their balance. Participants were not required to perform a heel raise when they experienced the surface translation. Performance on each heel raise trial was quantified by measurement of the tibialis anterior (TA) and soleus (SOL) electromyographic (EMG) onset latencies and amplitudes, as well as the peak backward and forward displacement of the center of pressure (COP). At the end of each condition, participants reported their perceived fear and anxiety to establish the amount of postural threat they experienced. RESULTS: Participants reported a greater level of fear and anxiety during the high compared to the low threat condition ($p<0.001$), indicating that postural threat was elicited by introducing the possibility of a surface translation. Consequently, participants exhibited larger APAs, as reflected by a 24% ($p=0.01$) larger backward COP displacement and a 39% ($p=0.03$) greater TA EMG amplitude during the high compared to the low threat condition. For the forward and upward movement of the heel raise, a 20 ms earlier ($p=0.05$) and 16% larger ($p=0.03$) SOL EMG activation was observed during the high compared to the low threat condition. CONCLUSIONS: Our results using a threat of perturbation contrast with previous findings of reduced APAs and EMG activity when the postural threat was evoked through changes in surface height. This suggests that the characteristics of the postural threat must be considered to isolate the effects of threat on anticipatory and voluntary movement control.

P2-H-48 Age-related Differences in Neuromuscular and Morphological Characteristics of Plantar Flexors

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INTRODUCTION: Aging is related to the loss of muscle structure and function. Muscle strength and power are important determinants of daily living, functional ability, and

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independence. They are influenced by neuromuscular and morphological characteristics, including the rate of force development (RFD), muscle activation (MA), muscle thickness (MT), pennation angle (PA), fascicle length (FL), and muscle-tendon junction (MTJ). Especially, RFD is defined as the ability to produce large amounts of force rapidly which are directly related to muscle strength and power. AIM: The purpose of this study was to compare the differences of strength and power properties of plantar flexors in younger and older healthy women. METHODS: Fifteen younger females (YG, age: 20.4±0.6 yrs, height: 164.8±4.3 cm, weight: 55.3±5.8 kg) and fifteen older females (OG, age: 66.5±4.3 yrs, height: 153.2±4.9 cm, weight: 57.4±7.4 kg) participated in this study. In order to assess strength and power of the plantar flexors, a custom-built dynamometer, electromyography (Trigno Wireless 8chanel, Delsys, Boston, MA) and Ultrasonography (Aloka, Japan) were used. The subjects performed maximal voluntary isometric ankle plantar flexion at ankle joint angle (10 degree plantarflexion). The rate of force development (RFD), muscle activities (MA) of the lateral and medial gastrocnemius (LG and MG), the soleus (SOL), displacement of muscle-tendon junction (MTJ) and architecture (MT, PA, FL) were examined. Neuromuscular and morphological properties of the plantar flexors were compared between younger and older females. Independent t-test was used to test statistical significance. RESULTS: The rate of force development during fast isometric ankle plantar flexion was found to be significantly different between younger (46.3±14.5 Nm/s) and older (175.2±78.3 Nm/s) females ($p<.05$). The muscle activation of lateral gastrocnemius was found to be significantly different between younger (0.10±0.04) and older (0.07±0.04) females ($p<.05$), but the displacement of lateral gastrocnemius (YG: 1.6±1.2 mm, OG: 1.0±0.4 mm, $p>.05$). The architecture variables of lateral (FL: 11.7±1.7 cm vs 9.6±1.5 cm, MT: 2.9±0.5 cm vs 2.2±0.4 cm) and medial (PA: 18.7±2.6 deg vs 17.0±2.9 deg, FL: 10.4±1.5 cm vs 8.2±1.1 cm, MT: 3.2±0.4 cm vs 2.5±0.4 cm) gastrocnemius and soleus (MT: 2.4±0.4 cm vs 2.0±0.6 cm) were found to be significantly different between younger and older females (YG vs OG, $p<.05$). CONCLUSION: Older females were found to show significantly slowly rising ankle plantar flexion torque values than younger females; which seemed to be largely due to smaller activation of the muscle and muscle size. Suggesting that regular exposure to strength and power training for the maintenance of muscle strength and function for independent life.

P2-H-49 Musculoskeletal Modeling driven by Electromyograms processed via Bayesian Filtering Techniques

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BACKGROUND AND AIM: Understanding healthy or pathological movement necessitates the understanding of the dynamics of the neuro-musculo-skeletal system. A way to do this is

that of recording experimental electromyograms (EMGs), extracting estimates of the neural drive to muscles, and drive forward dynamic simulations of the resulting mechanical forces elicited at the musculoskeletal level, i.e. EMG-driven musculoskeletal modeling [1]. This was validated on the ability of predicting inverse dynamics joint torques, in vivo joint contact forces, or joint stiffness. Indirect neural drive estimates are conventionally derived from EMG amplitude. EMGs are demodulated to recover amplitude information proportional to the neural drive, i.e. high-pass filtering, rectification, and low-pass filtering with a priori chosen cut-off frequencies. The resulting linear envelope bandwidth is directly determined by the chosen cut-off frequency. Cut-off frequencies suited for one motor task may not equally well apply for others. Extracting realistic muscle excitations is central for EMG-driven modeling as predicted musculoskeletal forces are largely dependent on the EMG-extracted excitation patterns. METHODS: An alternative to EMG linear filtering is the Bayesian filtering. This has been shown to provide smooth amplitude estimates while preserving reactive dynamics to rapid changes in contraction force [2]. The advantage is that no a priori defined cut-off frequency limits the tracing of rapid dynamic changes in neural drive but instead the Bayes filter is able to dynamically adapt to new force levels online after only few samples of data. In this study we employ a Bayes-Chapman-Kolmogorov filter with different likelihood functions (Laplace and Gauss). Walking and running data were collected from one subject including EMGs from 16 leg muscles, whole-body kinematics and foot-ground reaction forces. RESULTS: Bayes filters generate muscle excitations that enable accurate prediction of joint torques about six degrees of freedom (DOFs) across hip, knee and ankle joints. Across all trials and DOFs, RMSEs between predicted and reference joint torques were 0.16±0.1Nm/Kg (Gauss) and 0.15±0.09Nm/Kg (Laplace). The R2 was 0.82±0.1 (Gauss) and 0.84±0.07 (Laplace). Torques from linearly filtered EMG displayed comparable metrics but lesser capacity in predicting fast torque transitions. CONCLUSIONS: The reliable determination of EMG-dependent musculoskeletal forces will enable understanding the neuro-mechanical interplay underlying in vivo movement function, pathology and recovery and will facilitate the design of personalized neurorehabilitation technologies. [1] Sartori et al., J. Neurophisiol. 114, 2015 [2] Hofmann et al. IEEE TNSRE 2015

P2-H-50 Shear wave speed measurements during isometric contractions of stroke-impaired medial gastrocnemius and tibialis anterior

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Individuals who have had a stroke have limited mobility and altered gait. Although impaired motor control contributes to limited mobility, changes in muscle properties such as architecture and material properties will also influence the force generation and

transmission. Our previous work has shown, using shear wave (SW) ultrasound elastography, that the passive muscle SW velocity, and indiciation of stiffness, is up to 59% greater in stroke-impaired muscle compared to the contralateral non-paretic muscle. The aim of this study was to build upon this previous work and compare both passive and active muscle in stroke-impaired muscle of the ankle plantarflexor, medial gastrocnemius muscles (MG), and dorsiflexor, tibias anterior (TA), to the contralateral non-paretic muscle. Methods Fifteen stroke survivors participated in this study (age: 58.78 ± 7.34 yrs; height: 1.72 ± 0.08 m; body mass: 85.37 ± 16.55 kg; time post-stroke: 10.65 ± 7.08 yrs.). Subjects were seated upright with their knee in maximum extension and their foot secured to the platform of a dynamometer (System 3 Pro, Biodex Medical Systems, New York) with the ankle positioned at 90 degrees. Subjects performed a series of isometric plantarflexion and dorsiflexion contractions at different activation levels (0, 10, 20, 40, 60% maximum voluntary contraction (MVC) while ankle torque, muscle activity (EMG), and ultrasound images (Aixplorer, SuperSonic Imagine) of the MG and TA muscles were captured in separate trials. Mean SW velocity was calculated from a region of the ultrasound images (12-25 mm by 12mm). A quadratic fit was used to evaluate the relationship between SWS and %MVC. A t-test was used to compare the SWV at rest between the paretic and non-paretic side. SWV values at specific %MVC (10, 20, 40, 60%) were calculated. An AnoVa was used to compare the SWV at the different % MVC levels (quadratic) and non-paretic or paretic side. Results Our main findings show that at rest, there was no significant difference between the SW velocity in paretic MG and TA, compared to the non-paretic, respectively. As muscle activation increased, SW velocity also increased in a quadratic relationship for both muscles. There were no significant differences between the paretic and non-paretic muscles, or between the muscle activation and SWS. Discussion In stroke survivors, it seems that any increased stiffness measured of the passive contractile elements has no contribution to the overall stiffness in active muscle such that contributions to active stiffness, such as short range stiffness which is related to the cross-bridging of actin and myosin filaments. This is contrary to findings from previous experiments done on upper extremity muscles of stroke subjects. We hypothesize that possible explanations for this lack of contribution are linked load sharing and supplemental torque applied by the quadriceps, which will be controlled for during control subject experimentation.

P2-H-51 The interaction of biceps and brachioradialis for the control of elbow flexion and extension movements

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INTRODUCTION:Elbow flexion and extension movements are frequently used in various activities of daily living and require adaption to changes in position, speed, and load of the intended motion. But, how is the control of these movements regulated? From a biomechanical perspective, a muscle could contribute to the overall movement control with a load bearing or a fine-tuning regulating function. The torque of the generated muscular force can either oppose (load bearing function) or be in line (fine-tuning function) with the torque of the movement of the limb. Thus, the aim of this work was to analyze the control strategy of biceps and brachioradialis during a load bearing and a fine-tuning function. METHODS:The surface electromyogram of biceps, brachioradialis and triceps were examined in 15 healthy subjects. With the help of a pulley machine and a visual feedback, dynamic flexion and extension movements of the elbow with different combinations of contraction levels and angular velocities were performed. Thereby the measurements were conducted in two configurations, where the torque due to an external load opposes once the rotational direction of the elbow flexion (movement further referred to active flexion) and once the rotational direction of the elbow extension (movement further referred to active extension). RESULTS:The results showed that during active flexion, when the flexors bear the load, the biceps and brachioradialis act synergistically with a similar muscular activation for all movement conditions. In contrast during active extension, when both flexors contain a fine-tuning function, the muscular activation of both flexors varies. For low external loads the biceps showed highest activation for angular velocities below 50°/s and joint angles above 100°, while the brachioradialis showed highest activation for high angular velocities above 100°/s and joint angles below 50°. For higher external loads the brachioradialis showed no adaptions to different joint angles, while the biceps showed no adaptions to the different angular velocities for flexion angles exceeding 65°. CONCLUSION:The interaction of biceps and brachioradialis is differently expressed for a load bearing or a fine-tuning function. For active flexion movements, where both flexors contain a load bearing function, they act synergistically with a similar muscular activation for all combinations of joint angle, angular velocities and external loads. In contrast, for active extension movements, where the biceps and brachioradialis comprise a fine-tuning function, the muscular activation of both flexors is adapted differently depending on the movement task. The results were linked to the fiber type composition and innervation of both muscles and led to the conclusion that during fine- tuning of the movement, the biceps contributes to the control of different loads, while the brachioradialis contributes to the control of different angular velocities of the performed movement.

P2-H-52 Center of pressure mean velocity predicts single limb stance time in experts and novices

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BACKGROUND AND AIM: Balance tests, such as the BESS test, are used to diagnose concussions and assess safe return to activity. However, they often exhibit ceiling effects,making it difficult to detect mild impairments. Such ceiling effects are more pronounced when testing skilled populations with mild impairments, such as concussed athletes. Our goal is to overcome these ceiling effects by developing a balance test that is sufficiently difficult to identify small differences in balance performance.We hypothesize that behaviors challenging enough to elicit failures can be used to discriminate between expert and novice balance performance. Similarly, Sawers and Ting 2015 showed differences between novices and experts in a challenging beam walking task. Standing balance tasks may be more practical to measure in space-constrained clinical settings. Therefore, as a first step towards developing a more sensitive balance test to distinguish between impaired and unimpaired athletes, we compared balance in ballet dancers (experts) and healthy non-dancers (novices). Our objectives were to: (1) determine if time standing during eyes-closed single-limb stance (SLS) and center of pressure (CoP) metrics distinguished experts from novices, and (2) determine if CoP metrics predict when a loss of balance will occur. METHODS: We calculated mean CoP velocity from six-axis ground reaction forces in 10 professional ballet dancers and 17 novices. Subjects stood on one leg with their eyes closed for 30 seconds or until they lost their balance. Five trials per leg were collected in a randomized order. In trials where a balance failure occurred, the CoP time series was truncated before the loss of balance. We also tested whether mean CoP velocity over different portions of a trial could predict time standing in a trial. RESULTS: Experts maintained balance longer than novices (22 ± 11, 18 ± 12 s; p=0.01) and had lower mean CoP velocities (74 ± 230, 190 ± 1700 cm/s; p=0.03). Mean velocity over the entire trial was correlated to time standing in experts and novices (log-linear fit, R=0.96). Moreover, mean velocity in the first seven seconds was sufficient to predict a loss of balance (R = 0.90). CONCLUSIONS: Despite group differences between experts and novices in mean CoP velocity and time standing during eyes-closed SLS, skill level was not a factor in the predictive relationship between mean CoP velocity and time standing. Moreover, mean CoP velocity was consistent over the entire duration of a trial and could be computed over just a the first few seconds from any portion of each a trial to predict time standing. Our results suggest that eyes-closed SLS may be a simple and robust test of balance ability that is of sufficient difficulty to detect differences between healthy and impaired athletes.

P2-I-54 New Mechanomyogram / Electromyogram Hybrid Transducer for evaluation of muscle contraction during cycling-wheelchair exercise

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BACKGROUND AND AIM : The simultaneous evaluation of muscle contraction and performance with both EMG (electromyogram) and MMG (mechanomyogram) is necessary. The authors previously proposed a wireless displacement-MMG (d-MMG) transducer with two electromyogram (EMG) electrodes. In this study, the new MMG/EMG hybrid transducer with a single supporting leg has been developed and it was easier to attach it on the skin surface. This transducer was applied to evaluate the muscle contraction during cycling-wheelchair exercise. METHODS : The new developed MMG/EMG hybrid transducer (30 mm long × 30 mm wide × 14 mm high, 8.7 g) is composed of a small photo-reflector, two EMG electrodes and an amplifier. The single supporting leg of transducer was firmly placed along curvature of the skin/muscle surface. The resolution of d-MMG measurement and power consumption of the transducer were improved. The transducer was applied to exercise with a cycling-wheelchair (Profund, TESS, Japan). The healthy subject pedaled the wheelchair once in two seconds for ten seconds. The d-MMG and EMG were measured on the muscle surface (RF: rectus femoris, VM: vastus medialis, TA: tibialis anterior, GC: gastrocnemius) of both legs. It was possible for a single paralytic to pedal this cycling-wheelchair easily by himself. In order to increase the pedaling load, the wheelchair pulled a load (heavy: 15kg, light: 10kg). The pedaling period was analyzed by dividing into four phases as the starting point of the maximum flexion angle of the knee. During a subject's pedaling, we measured the d-MMG, the integrated EMG (EMG-ARV) and the crank angle of the wheelchair. The acceleration MMG (MMGacc) was calculated by the second differential calculus of d-MMG. The experiment was performed with approval of the ethic committee of Okayama University. RESULTS : Figure shows the MMGacc and EMG-ARV during cycling-wheelchair exercise with a heavy load (left) and with a light load (right) for the crank angle phase1-4. The sine wave in the figure indicates the crank angle and the phase 1 and 2 mean pushing-down the crank and extending the knee. The phase 3 and 4 mean pulling-up the crank and flexing the knee. In the phase 1-2, the EMG and MMGacc of RF muscle increased but those of VM muscle decreased. As the MMGacc of TA muscle increased and that of GC muscle decreased, the TA muscle dorsiflexed the pedal with GC muscle antagonistically. In the phase 3-4, the EMG and MMGacc of TA and GC muscle increased. The subject drove the pedal by torque, because TA and GC muscle co-worked together and fixed his ankle. CONCLUSIONS : In this study, the muscle contraction was evaluated by the MMG/EMG hybrid transducer during cycling-wheelchair exercise with various pedaling loads. In future, this transducer could be applied successfully in the rehabilitation field. ACKNOWLEDGEMENT : This research was partially supported by a Grant-in-aids for Scientific Research (25350529) from JSPS.

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P2-I-55 Evaluation of Muscle Contraction using 5×5 MMG Array Sensor, 64 Channel sEMG Multichannel Sensor and Ultrasonic Image Equipment

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BACKGROUND AND AIM : The mechanomyogram (MMG) is a muscle vibration caused by muscle contraction. The authors previously developed a 5×5 multichannel displacement-MMG (d-MMG) array sensor, which was composed of 25 photo-reflectors to measure the displacement to a skin surface. In this study, using this array sensor, we have drawn two-dimensional d-MMG map in the range of 40 mm × 40 mm. The 64-channel surface EMG (sEMG) and a pennate angle of the vastus lateralis (VL) muscle were measured during voluntary isometric contraction. METHODS : The VL muscle of healthy subject's right leg during isometric contraction with open kinetic chain was examined and his knee joint was fixed at 65° of flexion angle. The isometric contraction was of 10-100% maximum voluntary contraction (MVC) every 10%. The d-MMG array sensor and the 64 sEMG electrodes were placed on the VL muscle (distal third of the line which links the lateral epicondyle to the greater trochanter). The EMG electrodes (EMG-USB1 64, OT Bioelettronica, Italy) were located every 8 mm two-dimensionally and were measured as bipolar electrodes, and the reference electrode was attached on the knee. The pennate angle was also measured at the same point of the VL muscle surface. The subject sat on the seat (GT-330, OG Giken, Japan) with his knee at flexion of 65 degrees. The subject made a knee extension for three seconds and the averaged signals of d-MMG and sEMG were analyzed for a second while the muscle force was stable. The pennate angles of the VL muscle were measured by B-mode echo of the ultrasonic equipment (Xario 200, Toshiba Medical Systems Co., Japan). The experiment was performed with approval of the ethics committee of Okayama University. RESULTS : Figure (a) shows the 5×5 d-MMG mapping on the VL muscle at 10%, 70% and 100%MVC. The vertical axis indicates the displacement [mm] from the muscle surface. The bigger deformation points (yellow and brown) were close to the internal and distal side. Figure (b) shows the two-dimensional color mapping of 64-channel sEMG and the blue points of the measuring area were identified with an innervation zone of the VL muscle. The measured area of d-MMG array sensor was corresponding to the center of the 64-channel sEMG mapping. The points of bigger sEMG (red) were also found in the internal and distal site and were similar to those of d-MMG mapping. According to the results of pennate angle measurement, the angles increased gradually when the %MVC of the VL muscle increased (Figure (c)). CONCLUSIONS : The two-dimensional d-MMG mapping were drawn using the 5×5 multichannel d-MMG array transducer during isometric contraction. The multichannel sEMG mapping was also drawn using the 64 channel sEMG array sensor. And the increase of pennate angles showed the increase of the volume of the VL muscle. ACKNOWLEDGEMENT : This research was partially supported by a Gant-in-aids for Scientific Research (25350529) from JSPS.

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P2-I-56 Inter-rater reliability of kinematic assessment of upper extremity movement based on inertial sensors ? A pilot study

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Background & aim: Analysis of lower limb movements is well established in clinical research and applications, mostly in form of gait analysis. Reliable and objective assessment of the upper extremity function is important in several neurological and musculoskeletal disorders, i.e. stroke, Parkinson?s disease and shoulder instability. In this study, the aim was to analyse inter-rater reliability of kinematical measures for two tests that are commonly used to assess hand and arm function after a stroke; Finger-To-Nose and Drink-from-Glass test. Methods: Twenty healthy volunteers (39.8 ± 11.6 years, 7 females, height 1.74 ± 0.09m) in the study. In the Finger-To-Nose test, the persons were asked to touch their nose with the index finger and thereafter return the hand to the initial position on the table in front of him/her at self selected speed (n=10). For the Drink-from-Glass test the glass was placed along the midline at a distance of 7, 30 or 50 cm in front of the subject. The persons were asked to lift the glass, take a sip and then put the glass down and return to the initial position at self-selected speed (n=10 per distance). The test session was performed with two different raters, in randomized order, with approximately five minutes rest in between. A portable movement analysis system with five tri-axial inertial sensors, 128 Hz sampling frequency, was used for data collection. Two sensors were placed on each forearm, two on the upper arms, and one on the xiphoid process. The kinematic and temporal measures calculated for each repetition were (i) Elbow Range Of Motion (ROM) in flexion-extension and internal-external rotation, (ii) Shoulder ROM in flexion/extension, abduction/adduction and internal/external rotation and (iii) Cycle time. ICC was calculated between the raters. Results: For Finger-To-Nose (n=386), Inter-rater ICC was excellent concerning Cycle time (0.83) and shoulder ROM in internal-external rotation (0.77). It was fair to good for elbow ROM in internal-external rotation and shoulder ROM in flexion-extension and abduction-adduction directions (0.63, 0.75 and 0.73 respectively), and poor for the elbow ROM in internal-external rotation (0.20). For the Drink-from-Glass test ICC was excellent in all cases (0.81-0.89) but elbow ROM in internal-external rotation (0.29). Conclusions: In this study we aimed at analysing the inter-rater reliability for two tests commonly used in the clinical setting. The inter-rater reliability was high for all selected kinematic outcome measures, except for elbow internal-external rotation. The elbow rotation is known to be more sensitive to errors in sensor placement which was confirmed in this study. The high reliability was probably related to the strictly followed protocol when mounting the sensors, and standardisation of verbally recorded instructions. This shows that inertial sensors could give a valuable contribution to clinical evaluations of arm function.

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P2-I-57 Reliability of helical axis parameters during glonohumeral rotation

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Shoulder instability (SI) is a common pathology defined as symptomatic laxity of the glenohumeral joint. It can limit the shoulder function especially in athlete's who perform overhead gestures, or in workers doing prolonged overhead activities such as painters, storekeepers or in throwing activities. The instability of the shoulder can lead to changes in arthrokinematics of the glenohumeral joint during overhead shoulder movements. The SI diagnosis is based in history and physical examination that included specific provocative tests. There is currently lack of diagnostic procedures aimed to quantify the shoulder instability arthrokinematics. The aim of this study was to evaluate the reliability of finite helical axis (FHA) parameters in the analysis of shoulder rotation. Nineteen healthy subjects (7 males, 12 females, age: 23.2±2.7 years) participated in the experiment. Shoulder kinematics was measured by means of an optoelectric motion capture system (Optitrack) including six infrared cameras. The subjects were sitting on a chair with arm abducted 90 degrees laterally. The arm was fixed in a light wooden frame with velcro straps in order to keep the elbow angle at 90 degrees flexion. The subjects were asked to perform two series of ten shoulder internal and external full range rotations. The two series of movements were separated by two minutes of rest without removing the wooden frame. The protocol was repeated for both arms in randomized order. 3D data were sampled at 120 Hz. Side dominance was asked to the subjects resulting in two left dominant subjects. The data were divided in dominant and non-dominant side in order to evaluate differences in shoulder stability analysis between the two sides. The shoulder rotations were analysed with the FHA technique, using angles of 10 degrees to compute each FHA. The dispersion of the FHA for each of the four conditions was computed using the minimum convex hull (CH) and mean angle (MA). The convex hull area was also computed in the intersection of the vertical plane at the level of the Acromion. The intraclass correlation coefficient (ICC) minimum detectable change and standard error of the means were computed for CH, MA and range of movement (RoM) in both arms. The table summarizes the results of the reliability analysis. The reliability of the helical axis parameters was excellent for both sides. Further investigations are needed to establish the clinical relevance of this technique in patients with SI. Table: Summary of the reliability parameters. ICC, confidence interval (95%) upper and lower bounds, standard error of the measurement (SEM) and minimum detectable change (MDC) are shown for the four variables analysed.

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P2-I-58 Development of Flexible Microneedle Electrodes for Recording of Surface EMG

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BACKGROUND AND AIM Accurate biopotential measurement is important in providing electrophysiological information. Wet electrodes, such as Ag/AgCl electrodes used in surface EMG, ECG and EEG, utilise electrolytic gel to increase conductivity which is limited by a high skin contact impedance. However, associated problems include drying of gel [1], motion artefacts, electro-mechanical instability [2] and perspiration [3]. Alternative electrodes include dry electrodes and dry active electrodes incorporating amplification at the site of signal detection. However these also display sensitivity to motion and are prone to shift during movement [1, 4]. Microneedle electrodes potentially offer an improved means of recording sEMG. Their microscale protrusions may overcome the high impedance of the stratum corneum while not activating pain receptors. Microneedles may also provide mechanical stability during dynamic activity. The limited microneedle electrodes proposed are typically rigid, not conducive to form and constitute a single electrically connected electrode [5]. The aim of this project is to develop flexible microneedle electrodes (FMEs) to overcome the limitations of conventional electrodes. By electrically isolating each individual microneedle, the FME will act as an array with high spatial selectivity. METHODS Microneedle arrays were designed and printed using a 3D stereolithographic (SLA) printer (Ember, Autodesk) and UV-curable polymer (Standard Clear Photopolymer Resin PR48, Autodesk). Design inputs, including microneedle height, base diameter and inter-microneedle distance are easily adjustable for parametric studies (e.g. 400µm ht., 214µm base dia., 1mm pitch). These were compared with microneedle electrodes fabricated using drawing lithography. A hard plastic substrate containing cavities was filled with an uncured polymer. A drawing plate containing micropillars was dipped into the polymer-filled holes and raised upward, drawing the polymer up due to adhesion forces, thereby creating microneedle structures. The polymer was exposed to UV-light for curing. RESULTS Both techniques resulted in the formation of microneedle structures. While 3D SLA created a single microneedle electrode, the microneedle tips themselves were not as sharp as those manufactured using drawing lithography tips. CONCLUSION Both 3D SLA and drawing lithography offer promise in prototyping conductive microneedle EMG electrodes. While 3D SLA allows greater freedom in design, drawing lithography tips tend to be sharper. Repeatability of the drawing lithography method warrants further investigation. Currently the incorporation of conductive fillers and electroplating is being optimised for EMG signal detection for functional assessment. REFERENCES [1]Forvi et al, Sens. Act., A Phys, 2012 [2]Roy et al, Med Biol Eng Comput, 2007 [3]Abdoli-Eramaki et al, J Electromyogr Kinesiol, 2012 [4]Daley et a. , J Electromyogr Kinesiol, 2012 [5]O'Mahony et al, Sens. Act., A Phys, 2012

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P2-I-59 Evaluation of shoulder rotation axis during three different tasks

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The term shoulder instability refers to a clinical condition in which soft-tissue or bony impairments and rotator cuff imbalances may lead the humeral head to a sublux or dislocate from the glenoid fossa. The rotator cuff and shoulder ligaments stabilizes the glenohumeral joint and limits the humeral head translations They play an important role in maintaining the normal/correct humeral head position in the glenoid fossa especially during abduction and external rotation of the shoulder. The aim of the present study was to investigate the behaviour of finite helical axis (FHA) during shoulder rotations in three different conditions, and to observe how a mechanical constrain affects the shoulder stability. Nineteen healthy subjects (7 males, 12 females, age: 23.2±2.7 years) participated in the experiment. Shoulder kinematics was measured by means of an optoelectric motion capture system (Optitrack) including six infrared cameras. An additional videocamera was positioned behind the subject and used to provide a visual feedback of arm position. The subjects were sitting on a chair with arm abducted 90 degrees laterally and (see figure). The arm was fixed in a light wooden frame with velcro straps in order to keep the elbow angle at 90 degrees flexion. The subjects were asked to perform three series of ten shoulder inward and outward full range rotations. The three series of movements were performed in the following conditions: 1) eyes closed 2) visual feedback of the camera showed on a screen in front of the subjects 3) arm frame locked to a spherical joint on a wooden support. The protocol was repeated for both arms in randomized order. 3D data were sampled at 120 Hz. The shoulder rotations were analysed with the FHA technique, using angles of 10 degrees to compute each FHA. The dispersion of the FHA for each of the four conditions was computed using the minimum convex hull (CH) and mean angle (MA). In addition the range of movement (RoM) of the shoulder was measured for each of the three conditions. The comparison between dominant and non-dominant arm showed slightly although not significant lower CH area and lower mean angles for the dominant arm. The visual feedback condition showed no difference compared to the condition with eyes closed in both arms. A slightly significant higher CH area and significant lower mean angle (1-way ANOVA, $P<0.01$) were observed in the condition with constrain compared to the other conditions for both arms. The FHA technique can be used to quantify the stability of shoulder during internal and external rotations. Further research to explore the association between the helical axis dispersion and the clinical features of shoulder instability is needed. Figure. Subject position during the internal and external rotations of the shoulder. The helical axes are shown for the two conditions: visual feedback and mechanical constrain. As expected the FHA are passing through the mechanical constrain when present.

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P2-I-60 Automatic Image Processing of Ultrasound Elastography for Obtaining Muscle Shear Modulus by Removing Connective Tissue Data

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BACKGROUND AND AIM: Surface electromyography (EMG) has widely been used for estimating muscle force as a non-invasive and inexpensive method. As its limitation, EMG measurements are variable and susceptible to crosstalk from surrounding muscles, particularly on body segments where there are several small, closely packed muscles with overlapping function, such as in the forearm. Muscle shear modulus measured with Ultrasound Shear-Wave Elastography (USSWE) appears to be advantageous in assessing mechanical activity/properties of a specific muscle because it allows for isolated measurement and direct assessment of mechanical properties. The current analysis of USSWE videos for muscle shear modulus is to calculate the spatial average of shear modulus across the manually selected region of interest, including connective tissues. As connective tissues are stiffer than the surrounding muscle tissues, the inclusion of connective tissue areas in an image is expected to skew the average shear modulus toward higher values. The purpose of the study was to develop and assess an automatic image-processing algorithm for analyzing USSWE videos for obtaining shear modulus of contractile muscle tissues without the contamination of non-contractile connective tissues. METHODS: USSWE videos were recorded from 11 male subjects (age: 21.3 ± 0.9 years (mean ± SD); range: 20-23 years). Subjects grasped the handle of a robotic manipulator with the right hand. Subjects were asked to hold a specified arm posture by co-contracting arm muscles while the robot applied multiaxial forces and torques to their hand. Three 10 second trials of thirteen loading conditions were performed. USSWE videos were captured from triceps longus (TRI) and extensor carpi ulnaris (ECU) at 1 frame/second during these trials. An automatic image-processing algorithm was developed to identify connective tissues in each frame of the USSWE videos in order to isolate and take spatially averaged shear modulus data from the contractile muscle tissues. The algorithm used a set of six optimized parameters to identify bands of connective tissues in a manner that is robust to image quality issues (e.g. poor or uneven image contrast). RESULTS: The skewing of the data, quantified as the standard deviation of the included area of the USSWE data, was by 8% in TRI ($p<0.01$) and by 17% in ECU ($p<0.01$), on average. For both muscles, reductions of more than 50% were seen. CONCLUSION: The study shows that automatic image processing of USSWE in a contracting muscle is possible, and the automatic removal of connective tissues in the analysis can substantially reduce the skewness of muscle shear modulus. Supported by the National

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P2-I-61 Is foot mobility related to age in people with anterior knee pain?

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BACKGROUND AND AIM: Across the lifespan, foot orthoses, or shoe inserts, are commonly used to treat anterior knee pain. Those with greater foot mobility may have a greater likelihood of successful outcome with foot orthoses intervention, compared to those with less mobile feet. However, in healthy cohorts, increasing age is associated with higher soft tissue stiffness and reduced ankle and subtalar joint range of motion. Furthermore, 3D motion analysis has demonstrated that older feet have less midfoot and forefoot mobility during walking. These age-related decreases in foot mobility may reduce success with foot orthoses for older people with anterior knee pain. This study investigated whether older people with anterior knee pain demonstrate lower foot mobility than younger adults with anterior knee pain. METHODS: 194 participants (113 females; mean±SD age 31.9±7.2 years [range 18-50]; height 1.7±0.1 m, weight 74±17 kg) with anterior knee pain (>6 weeks duration) were included. Foot mobility was measured using reliable and valid methods. Arch height and midfoot width were measured at 50% of foot length, in weight bearing (WB) and non-weight bearing (NWB). Arch height mobility was the difference between arch height in NWB and WB, and midfoot width mobility the difference between midfoot width in WB and NWB. Foot mobility magnitude (composite value of vertical and mediolateral midfoot mobility), was calculated as the square root of (arch height mobility %2B midfoot width mobility). K-means cluster analysis classified participants into three homogenous age groups. Univariate analysis of variance (covariates: sex, weight) compared arch height mobility, midfoot width mobility, and foot mobility magnitude between age groups ($p<0.05$). RESULTS: Cluster analysis identified three age groups: 18-29 years (n=70); 30-39 years (n=101); and 40-50 years (n=23). There was a significant main effect of age on arch height mobility ($p<0.001$) and foot mobility magnitude ($p=0.006$). Post-hoc tests revealed that arch height mobility was significantly lower for the 40-50 year group compared to those aged 18-29 years (mean difference 3.3 mm, 95% CI 1.9 to 4.8 mm) and 30-39 years (2.1 mm, 0.7 to 3.5). The 40-50 year group also had significantly lower foot mobility magnitude than those aged 18-29 (2.7 mm, 1 to 4.4) and aged 30-39 (1.6 mm, 0.03 to 3.2). There were no significant main effects for age on midfoot width mobility ($p>0.05$). CONCLUSIONS: People aged 40-50 years with anterior knee pain have lower foot mobility than younger adults. Notably, the difference in arch height mobility exceeds the error associated with the measure. Findings are consistent with kinematic studies showing reduced sagittal plane

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mobility with increasing age, provide a simple clinically applicable method of evaluating foot mobility, and have implications for the evaluation and treatment of older people with anterior knee pain.

P2-I-62 Posture of the head and trunk in sitting: quantification of alignment

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BACKGROUND AND AIM: Posture can be assessed either subjectively or objectively. In the literature there are detailed subjective descriptions of 'ideal alignment' in standing but no agreement of an 'ideal seated postural alignment'. The use of radiographs [1, 2], rastersterography , and three-dimensional (3D) motion capture systems have addressed many of the limitations of subjective postural assessments, but are rarely practical in a clinical setting. Video recordings are easily used clinically but also have potential for quantitative analysis of movement. This study used a video based method to generate a numerical definition of postural alignment of the head and trunk in sitting. METHODS: A definition of aligned static sitting posture was agreed in a focus group. Participants (4 male, 4 female, age 27.2±3.25 years) sat upright on a bench. Static and Dynamic trials were recorded simultaneously with a 3D motion capture system and a video camera recording sagittal plane movements. The agreed definition was used to visually identify video frames where posture was aligned. Angles of Head, Neck, Upper, Mid and Lower-Thoracic, Upper and Lower-Lumbar and Pelvis segments were calculated in relation to the absolute coordinate system and used to construct a model of alignment from aligned frames. This clinically based video method has been previously validated against segmental angles calculated from the 3D motion system using the RMSE (ms. under review). RESULTS: For each participant, a segmental model of quantified aligned sitting posture was defined as the set of mean ± SD values from videos. A combined model for the group is shown. RMSE for the Static trials was below 3° and for the Dynamic trials was below 4° in most cases. CONCLUSION: Our study presents a multisegmental numerical model of aligned posture in sitting using a video based method. However, the small sample size is insufficient to generate a universal model. Previous studies [1, 2] have measured angles for the complete thoracic region (36°±12 and 40.60°± 10 respectively). The addition of our mean angles for the UT, MT and LT gives a resultant angle of 45.43°, which is comparable to previous results. For the lumbar region our study revealed much smaller values which is consistent with reports in the literature describing a decreased lordosis curvature while sitting. This multisegmental method of quantification of sitting posture gives greater detail of the spinal profile than previous methods. It has potential as a complementary tool alongside subjective

assessments for patients with a wide variety of pathologies. REFERENCES: [1] Leroux M. 2000. Spine [2] Vialle R. 2005. The Journal of bone and joint surgery. American volume

P2-I-63 Passive and active stiffness of the neck extensor muscles is depth-dependent

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BACKGROUND AND AIM: Muscle stiffness supports joint stability while allowing for a range of movement. Movement limitations and perceived stiffness are major symptoms in chronic neck pain. Understanding the normal regulation of stiffness in the five neck extensor muscles may open new perspectives on altered passive and active muscle properties with chronic neck pain. The aim of the study was to investigate the shear modulus (stiffness) of the five neck extensor muscles during relaxation and graded headlift in healthy individuals. METHODS: Shear-wave elastography of the right neck extensor muscles (trapezius, splenius capitis, semispinalis capitis, semispinalis cervicis and multifidus) was recorded during relaxation and graded isometric head lift, sustained over 6 s. Participants were 4 female and 6 male healthy individuals, aged 22 years (SD 3.2) and free of neck symptoms or previous neck trauma. In prone, participants lifted 1/3, 2/3 or full weight of the head while keeping contact of the forehead with a pressure-sensitive air cushion. Each level of effort was repeated three times, all in a randomized order. Shear modulus within a region of interest in each of the five muscles was extracted over the 3 initial seconds of sustained head lift. Relationships with effort and muscle depth were examined with Spearman correlation (rho). Differences in muscle stiffness were examined using ANOVA. Relationships of shear modulus with effort and muscle depth were estimated with Spearman correlation (rho). Muscle-specific contributions were determined as percentage of total stiffness in each level of effort. RESULTS: Stiffness in relaxation was highest in the multifidus muscle, 14.6 kPa (SD 4.7) $P < 0.002$. Stiffness increased with muscle depth, in relaxation $rho = 0.45$ $P = 0.001$, with head lift $rho > 0.62$ $P < 0.001$. Stiffness of each muscle increased with effort, for multifidus, semispinalis cervicis, semispinalis capitis and splenius capitis $rho > 0.54$ $P < 0.001$, for trapezius $rho = 0.35$ $P = 0.028$. During relaxation and head lift more than 50% of total stiffness were contributed by the multifidus and semispinalis cervicis muscles. CONCLUSIONS: Passive and active stiffness of the neck extensor muscles were organized in a depth-dependant manner with highest contributions from the multifidus and semispinalis cervicis muscles and lowest from trapezius. Passive and active muscle stiffness are biomechanical parameters that provide new insights into synergistic activation patterns. Muscle stiffness can be estimated non-invasively by shear-wave elastography and is likely of clinical relevance.

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P2-I-64 A Preliminary Study on Measurement of Surgery Procedures with Multi-Channel Surface EMG signals

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Backgroud and Aim: The purpose of this study is to examine preliminarily the ability to measure surgical techniques with multi-channel EMG signals. Recently, applications of multi-channel surface EMG signals are discussed on the potentialities in some fields. Surgeons are forced to maintain their posture during surgery and then they often have the trouble on muscle fatigue and decreasing skill performance. In actual, many researchers are concerned in evaluation of muscle fatigue and effort in surgical tasks [1, 2]. Although many publications have reported physiological comparisons during surgical procedures, no study examines measurement of surgery technique itself with EMG signal. Methods: To examine skill of surgery, the subjects were classified into two groups; skill and non-skill groups. The subjects in skill group have surgical experience at least over two years. The subjects in non-skill group have completely no experience on it. During fastening two sutures in a surgical training kit, the multi-channel surface EMG signals on both their forearms are recorded with Myo gesture control armbands (Thalmic labs) each of which have eight bipolar EMG sensors, accelerators, gyroscopes and orientation sensors and can transmit the signals on Bluetooth to the PCs. The subjects were instructed to perform knot-typing tasks six times per a trial. Results: The average times per knot-typing task have significant difference between skill and non-skill groups; 18.4+/-14.5(s) in skill group vs 42.0+/-19.8(s) in non-skill group. Therefore, the surgical skills between the groups are definitely doubtless because of their large time difference. As compared with their root mean squared (RMS) distributions of EMG amplitude on their forearms, the EMG amplitudes of the channels near brachioradialis muscle and extensor digitorum communis muscle on both the arms in both the groups became higher than the EMG amplitudes of the other channels. To evaluate surgical skill quantitatively, we define the parameter of Active Rate which indicates the ratio of RMS values over a threshold in a task. The parameter presents sustainability and concentration of RMS distributions of EMG signals between channels in skill group are distinguishable enough as compared with those in non-skill group. Conclusions: Our results show high possibility of measurement of a surgical technique with multi-channel surface EMG signals. The sustainability and the concentration of the RMS distributions of EMG signals in skill group may contribute to maintain the posture of their forearm to easily control needle holders. In conclusion, multi-channel surface EMG distributions enable us not only to measure the level of surgical technique of knot-typing task but also to support medical education to teach endoscopic

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technique. [1] Berguer, R. Et al., Archives of Surgery, 138: 967-970, 2003 [2] Ehlers, Landon et al., Studies in Health Technology and Informatics, 184: 122-8, 2013

P2-I-65 Real-time ultrasound cervical muscle segmentation: with application to monitoring and diagnosis of cervical dystonia

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BACKGROUND AND AIM: Cervical Dystonia (CD) is a prevalent disease affecting thousands of people worldwide; a neurological condition which causes often painful spasticity in one or multiple muscles in the cervical muscle system, currently without a cure, the most effective treatment is to induce muscle paralysis by injecting botulinum toxin into the affected muscle(s). However, clinicians currently have no non-invasive method of targeting and monitoring treatment of deep muscles. Ultrasound has been used to non-invasively image all five bilateral cervical muscle layers, simultaneously. We present a tool, for segmenting those cervical muscles and the spine in real time. METHODS: MRI and ultrasound data were collected from 10 participants (age: 25.0 ± 6.7, male: 5, female: 5). Due to the difficulty obtaining true and accurate muscle boundary labels in our ultrasound images, we have developed a registration approach, in which an expert annotates MRI images (where image-plane markers are present) and then manually registers those annotations to matched ultrasound images. Then, we used shape analysis to create a mean texture, which was then combined with a principal component model of muscle boundaries to create a texture database in principal components shape space. We then compared images in a test set to all database images, resulting in an initial approximate segmentation, followed by refined fitting, to improve the segmentation of the muscle boundaries in real-time. RESULTS: Our technique can currently segment a single image in ≈0.5'' on reasonably cheap computer hardware (i7-4720HQ) and demonstrates an accuracy of over 90%. Fig 1. Muscle feature segmentation visualisation. The graphic shows how the proposed tool provides visualisation of identified cervical muscle features, and also how those features can be represented quantitatively using the component model. a shows the raw ultrasound and b shows the final segmentation. c and d are a vector plot visualisation of the two main components of variance (2 and 9, respectively) - where the blue contours show the shape the component, and the arrows show angle of deviation (i.e. originates at the mean shape, and ends at the component shape - i.e. the major differences of a person's neck from a population). The bar plot (e) shows the absolute magnitude of the components (scaled), where the colour represents the sign (red = negative). CONCLUSIONS: We have shown that it is possible to obtain reliable quantitative descriptions of the anatomical features of a person's muscles in real time. We provide a tool in which clinicians and/or patients can use cervical muscle

visualisations to interpret features, which can be recorded for group and longitudinal investigations.

P2-I-66 Addition of a verbal dual task results in reduced right arm swing while walking and men are more susceptible

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BACKGROUND AND AIM: Arm swing asymmetry during walking increases when a cognitive dual task is introduced and older individuals are more susceptible to this effect. The characteristics and mechanism of this asymmetry shift under cognitive load are unclear. METHODS: Eighty-three healthy subjects (three age groups; 18-39, 40-59 and 60-80) walked on a treadmill at a comfortable walking speed while performing a congruent (CS) and incongruent Stroop (IS) word/colour discrimination task. Gait parameters, including an index of arm swing asymmetry (ASI) based on 3D kinematic wrist trajectory lengths, were recorded. A positive ASI indicates proportionally larger arm swing amplitudes on the left and vice versa. Participants also completed a lateral preference inventory questionnaire (Coren 1979). Trial means of gait parameters were analysed using a linear mixed model with post-hoc t-tests. RESULTS: Compared to normal walking (NW), ASI values increase significantly during both dual-task conditions in the 40-59 age group (NW: -0.28±2.03, CS: 5.87±3.38, IS: 9.19±3.31; p=≤0.048) and in both tasks in older adults (NW: -0.68±2.07, CS: 8.31±3.70, IS: 15.16±3.80; p≤0.009) compared to NW. In adults over 60, this shift was driven by significantly reduced wrist trajectories (CS: -13.1%, IS: -22.1%; p≤0.049) and maximal shoulder anteversion (mean±SD; NW: 4.35±10.07o, CS: 1.21±10.35o, IS: -0.54±11.62o; p≤0.032) under both dual-task conditions. In this older group, right maximal elbow flexion also reduced significantly between the NW and IS conditions (NW: 53.69±11.49o, IS: 48.34±8.08o; p = 0.012). No changes were seen on the left. A sub-analysis showed that males in all age groups exhibited significant, positive shifts in ASI in the IS task, while a similar effect was only seen in women over 60. There were no correlations between the degree of behavioural lateralisation and change in ASI under cognitive load. CONCLUSIONS: These findings suggest that human arm swing is at least partially generated by cortical inputs which are susceptible to interference from concomitant cognitive tasks. In men and older women, increased cognitive load during the primarily verbal, predominantly left hemisphere Stroop task causes a reduction in arm swing on the right. This paucity of swing amplitude is characterised by decreased flexion at the shoulder and elbow with preserved extension, consistent with previous findings that the upper limb flexors are under more direct supraspinal control. Females appear to be resistant to this effect until old age. Whether this

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is related to dual-task performance strategies or a tendency for females to be less strongly lateralised is unclear, although lateralisation did not predict the degree of arm swing attenuation. Using a similar approach to analyse arm swing under differing cognitive loads in patients with Parkinson's disease, subcortical stroke and spinal cord injury may permit further insights into the control of arm movements in human locomotion.

P2-J -67 Change in the lateral axis of high-heeled shoes on the frontal plane

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BACKGROUND AND AIM: High-heeled shoes are a popular fashion item and are worn by many women and even young girls. Numerous studies have investigated the effects of heel height, but few studies on the lateral movement of the heel axis exist. In this study we investigated and analysed the angle of inversion and eversion of the foot, adduction and abduction of the hip, joint moment inversion and eversion of the foot, joint moment adduction and abduction of the hip and grand reaction force X, in the hope to gaining a better insight into injuries that may be experienced when wearing high-heeled shoes, such as a sprained ankle. METHODS: Eleven healthy female students participated in this study. Their mean (standard deviation) age, height, and weight were 19.8 (1.2) years, 158.1 (4.5) cm, and 50.6 (4.3) kg, respectively. Prior to measurements, the purpose and procedure of this study were explained in detail, and informed written consent was obtained from all subjects. The subjects wore two pairs of shoes with a different lateral axis: lateral 30 mm, 0 mm, medial 30 mm and medial 60 mm . Before the measurements, subjects were allowed to practice walking with each pair of shoes to achieve a comfortable gait. VICON system was used to capture three-dimensional movements. The sampling frequency was 100 Hz. The system was equipped with 6 infrared cameras and 4 force plates, and there were 35 markers (plug-in gait) for each subject. VICON data were recorded while subjects walked, throughout the time of heel contact to the completion of the walking cycle. Data were recorded throughout the right stance phase of the walking cycle. We defined the stance phase of the walking cycle, ankle joint inversion, as the 'reaction phase'. The latter phase, ankle joint eversion, was defined as the 'recovery phase'. Statistical analyses were conducted using one-factor ANOVA and the Williams test. RESULTS AND DISCUSSIONS: No significance was found in relation to inversion and eversion of the foot and adduction and abduction of the hip. No significant values were found in joint moment data of inversion and eversion of the foot and adduction and abduction of the hip. One-factor ANOVA did not reveal a significant increase in grand reaction force X however a significant increase in the lateral axis (lateral 3mm versus 0 mm), (lateral 3mm versus medial 3mm), (lateral 3mm versus medial 6mm) was observed with the Williams test. Therefore, we believe that an increase in the lateral axis of heel

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movement may be related to injuries that occur when wearing high-heeled shoes however further research is necessary to investigate these findings in more detail.

P2-J -68 The effect of Palm Supporter to writing for Patients with Essential Tremor

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Background and aim; Patients with essential tremor have been desired to take tool for writing letters easily due to their shivering of hand. Methods: A tool to control hand was used. The measurement of hand during writing was carried out with use of acceleration sensor. The accelerations of hand during writing lines or letters was measured and these power spectra were evaluated. Results; The tools called palm supporter showed good results that the patients wrote lines and letters easily with use of the tool. The rate to control shivering during writing was obtained to be about 90%. Conclusion: Palm supporter denoted good control for writing lines and letters. Four kinds of writing letters are used: That is, horizontal line, vertical line, circle, and Chinese letter are carried out. The method of writing is as follows: At the first time the subject writes one kind of writing letters without palm supporter and in next time the subject writes it with use of palm supporter. The writing is carried out for four kinds of letters. In order to compared with movement of hand during writing, the movement of hand without writing is measured as the rest state of hand. The data of acceleration measured is calculated by Fourier transform, and the power spectrum is evaluated. The power spectra for respective directions as X, Y, and Z are summed up in the range from 1Hz to 50Hz. The values of X, Y, and Z are evaluated as total power. The total value for three dimensions is evaluated as SQRT(XYZ) where SQRT(XYZ)=(X2+Y2+Z2)(1/2) , the unit being G2, where G is acceleration of gravity. Patients with essential tremor show various levels of shivering. In the rest state without palm supporter, SQRT(XYZ) denote 50 and 7 for the patients with the largest and the lowest shivering, respectively. The patient with largest shivering in writing horizontal line, vertical line, circle, and Chinese letter without palm supporter shows the values of SQRT(XYZ) 3523, 183, 587, and 525, respectively. On the other hand, the patient with use of palm shows the values of SQRT(XYZ) 296, 257, 114, and 470, respectively. These results denote decrease of value of SQRT(XYZ) with use of palm supporter. Especially, the decrease of SQRT(XYZ) for writing horizontal line with use of palm supporter shows from 3523 to 296, as compared with SQRT(XYZ) without palm supporter. The rate of the decrease is 91.6%; That is, the rate is calculated by (3523-296)/3523) x 100. That is, roll of palm supporter for the patient with most shivering shows to controls effectively shivering in writing horizontal line. For other patient with the lowest shivering, the

rate of decrease is 80.1% (i.e., ((168-32)/168) ?? 100). For the letter of circle and Chinese letter, the rates of the decrease are small.

P2-J -69 The effect of Palm Supporter to writing letters for Patients with Essential Tremor

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Background and aim: Patients with essential tremor were difficult to write letters easily, so tool to control hand was desired. New tool to control shivering of hand during writing was made. Methods; The tool called as palm supporter was used during writing. The acceration of hand during writing was measured. The power spectra were calculated. Results; The effect of palm supporter was evaluated by power spectra. The decrease of shivering was evaluated to be large rate in writing letters. Especially, the effect of writing horizontal line was remarkable. Conclusion: The effect of saving shivering of hand during writing was shown with use of palm supporter.

P2-J -70 A study of tissue oxygenation in neck and forearm muscles during mobile phone tasks

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Aims: It is a worldwide trend that smartphones are used by people frequently each day and it has been associated with increased musculoskeletal symptoms both in the neck and forearm regions. Past research has mainly focused on the changes in muscle activity through studying surface electromyography in the neck and forearm muscles during computer use and mobile phone use. This study aimed to investigate the tissue oxygenation and hemodynamic changes in 2 muscles namely right upper trapezius (UT) and extensor carpi radialis (ECR) during a brief mobile phone texting task. Subjects: Twelve male young healthy subjects were recruited for the study. All of them were right-hand-dominant, and either keypad phone or touchscreen phone users without neck pain. Subjects were excluded if they had any traumatic injuries in relevant regions or suffered conditions that may affect the spine or upper limbs.Their mean age (± SD) were 20.75±0.97 yr. Average height and weight were

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175.50±3.99 cm and 61.67±6.95 kg respectively. Methods: Each subject was invited to attend 1 lab session only. It consisted of 1) a 3-min rest period (Resting T0), 2) 1st MVC maneuver, 3) a 3-min recovery period (Resting T1), 4) a 15-min texting task, 5) 2nd MVC maneuver and 6) another 3-min recovery period (Resting T2). In these 5 phases, tissue oxygenation data were measured noninvasively by near infrared spectroscopy. The ISS Imagent functional brain imaging system (ISS Inc., Illinois, USA) was used to capture tissue oxygenation data, with infrared light at a wavelength range of 670 to 850nm, and sampling frequency at 2.5Hz. A flexible probe was firmly attached to the muscle belly of the right UT while a rigid sensor was attached to the right ECR. Results: During the texting task, a significant decrease was found in oxygen saturation (SaO2) and concentration of oxyhaemoglobin [O2Hb] of UT while a significant increase in deoxyhaemoglobin concentration [HHb] was also observed. For ECR, there was no significant change in [O2Hb] while significant increase in total haemoglobin [tHb] and [HHb] were found. Comparing the three resting periods, significant increases in SaO2, [tHb] and [O2Hb] were shown while decrease in [HHb] was observed in UT. For ECR, SaO2, [tHb] and [O2Hb] were also significantly increased while a trend of decreasing [HHb] was observed although it was not significant. Comparing the two MVC maneuvers, there was no significant change in O2 desaturation rate, SaO2 lowest and 1/2 recovery time. Conclusion: The present study showed that oxygen delivery and oxygen consumption in UT and ECR muscles were affected during a 15 minutes sustained texting task on mobile phones. These results suggest that changes in tissue oxygenation may be an important factor to consider in studying the pathomechanics of musculoskeletal disorders associated with prolonged mobile phone use.

P2-J -71 Effects of one-sided loading on trunk muscle activity patterns in healthy subjects and back pain patients

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Background and Aim: Spinal compensation and stabilization during loading in everyday tasks initiated by the limbs is essential for prevention of back pain. Higher loading of the spine is evident in back pain patients. However, alterations in neuromuscular activation patterns of the trunk in different loading situations during one-handed lifting in healthy subjects (H) and back pain patients (BP) are still under debate. Therefore, the aim is to analyze neuromuscular activity patterns of the trunk in H and BP during one-handed lifting with different loads. METHDOS: After assessment of back pain via graded chronic pain scale (Korff questionnaire) all subjects (n=42) performed a short physical warm-up. Next, subjects were instructed to lift 3 times a 20kg weight (water crate) placed in front of them (two-handed lifting) onto a table of 0.75 m height. Subsequently, all subjects lifted one-handed (left-side), 3 times each, a

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weight of 1kg (light), 10 kg (middle) and 20kg (heavy) in random order from the ground up on a table (0.75m height; left side of person). Trunk muscle activity was assessed with a 12-lead-EMG (6 ventral/ 6 dorsal muscles; 4000Hz). EMG-RMS [%] was averaged over the 3 repetitions and analyzed for the whole lifting cycle normalized to RMS of the two-handed lifting. Additionally, the mean (normalized) EMG-RMS of four trunk areas (right and left ventral area (VR, VL); right and left dorsal area (DR, DL)) was calculated. Data were analysed descriptively (mean¡¾SD) followed by student¢¥s t-test to comparing H and BP (¥á=0.05). RESULTS: Seven subjects (3m/4f; 32¡¾7yrs; 171¡¾7cm; 65¡¾11Kg) were assigned into BP (Korff Grade ¡Ã2) and 36 (13m/23f; 28¡¾8yrs; 174¡¾10cm; 71¡¾12Kg) into H (Korff Grade ¡Â1). H and BP did not differ significantly in anthropometrics (p>0.05). All subjects were able to lift light and middle loads. But 57% of BP and 22% of H were not able to lift the heavy load (all of them were women). EMG-RMS ranged from 33¡¾10% (DL, 1Kg) to 356¡¾148% (VR, 20kg) in H and 30¡¾9% (DL, 1Kg) to 283¡¾80% (VR, 20Kg) in BP without being statistically significant between groups regardless of weight (p>0.05). Despite, both groups showed highest EMG-RMS for VR in all lifting tasks increasing with rising load. To account for sample size differences between H and BP, a matched group analysis was applied. Results also reveal no group differences. CONCLUSION: Neuromuscular trunk compensation strategies of expected loading of different weights did not differ between BP and H. Both groups show the same specific muscular activation pattern with highest activity of the contralateral abdominal muscles (VR). Rising load leads to an increase (2- to 3-fold) of trunk muscle activity with comparable patterns between groups. Heavy loading (20kg) leads to task failure, especially in women with back pain.

P2-J -72 Estimating Expert-Based Functional Assessment Scores Using Sensor Data

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Background: EMG-based functional assessments have been used for some time to capture abnormal levels of muscle activity during the performance of predefined series of motor tasks. The work herein presented aims at developing a novel method to automatically generate estimates of expert-based functional assessment scores via analysis of the EMG data. Methods: The data recorded during a functional assessment was inspected by an expert to determine the level of EMG activity associated with muscle spasms, the amplitude of electrocardiographic (ECG) artifacts affecting the EMG signals, and the level of EMG activity at rest. The expert generated scores that captured the severity of abnormal patterns of EMG activity for muscle spasms, ECG artifacts, and EMG activity at rest. To demonstrate the feasibility of automatically generating expert-based functional assessment scores via

analysis of the EMG data, we estimated the correlation between data features derived from the EMG recordings and the scores generated by the expert. In addition, EMG data was recorded during the performance of dynamic tests and data features were correlated with expert-based scores that aimed to capture abnormalities in the magnitude and the shape of the EMG amplitude modulation. In addition, biomechanical measures including the range of motion (ROM) and the functional capacity evaluation (FCE) measure were also gathered by the expert. Associated data features were correlated with the expert-based scores. Results: The correlation between spasm scores and associated features derived from the EMG recordings ranged from 0.64 to 0.89 (mean=0.77, STD=0.11). The correlation between ECG artifact scores and data features derived to characterize them spanned the range from 0.48 to 0.79 (mean=0.71, STD=0.11). Finally, the correlation between scores aimed to characterize the activity observed at rest and associated features derived from the EMG recordings ranged from 0.66 to 0.87 (mean=0.79, STD=0.08). The correlation between data features and expert-based scores that captured the shape of the EMG amplitude modulation ranged from 0.39 to 0.69 (mean=0.55, STD=0.08). The correlation between data features and expert-based scores that captured the magnitude of the EMG amplitude modulation ranged from 0.52 and 0.78 (mean=0.65, STD=0.08). The correlation between the scores associated with the ROM and FCE and their corresponding data features ranged from 0.76 to 0.79, and from 0.90 to 0.94, respectively. Conclusions: The above-summarized correlation analyses show the data features derived from EMG and biomechanical data recorded during predefined tests that are part of the electrodiagnostic functional assessment can be used to estimate the scores generated by field experts via visual inspection.

P2-J -73 A study of neck muscle activity during mobile phone texting and association with flexion relaxation phenomenon

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Objective The purpose of this study was to examine the muscle activation in the cervical spine during mobile phone texting and the effect of muscle fatigue on the Flexion Relaxation Phenomenon (FRP) parameters. Background Static head-neck posture during prolonged mobile phone texting could lead to muscle fatigue in the cervical spine. The FRP was performed to examine the responses of active and passive components of the neuromuscular system. However, no studies investigated the change of FRP after prolonged mobile phone texting. Methods Ten healthy participants (5 males, 5 females) participated in the study. Surface electromyography was used to measure the muscle activity in the postural muscles in the cervical spine. Each participant was required to perform two sessions of 10-minute texting tasks. Neck extensor endurance test was done to induce fatigue on the

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cervical erector spinae (CES) before performing the second texting task. FRP was measured before and after each texting task. Results Repeated measure ANOVA showed that cervical flexion-relaxation ratio (CFR) in left CES had significant difference across four time points ($p=0.038$). The CFR and onset angle were significantly lower after texting task 2 ($p<0.05$). Compared with after texting task 1 and 2, CFR in left CES was significantly lower ($p=0.049$) and bilateral total silence period expansions were significantly longer after texting task 2 ($p<0.05$). The muscle activation of CES during texting task 2 was significantly greater than that of texting task 1 ($p<0.05$). Conclusion Neck muscle fatigue would modulate the FRP and increase muscle activation during mobile phone texting. These results suggest that sustaining a neck flexion posture during prolonged mobile phone texting may affect the interaction between the active and passive connective structures in the cervical spine.

P2-J -74 The effect of a prolonged standing exposure on lower leg volume and muscle fatigue

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Background and aim Prolonged standing at work is associated with several musculoskeletal and venous disorders. Most mentioned disorders are low back pain, musculoskeletal lower extremity pain, chronic venous insufficiency and varicose veins. Increased muscular fatigue and lower leg volume (LLV) in subjects exposed to standing work are considered as surrogate parameters for an increased risk of the above mentioned disorders. The aim of this study was to investigate the time course of muscle fatigue and LLV during 275 min of prolonged standing exposure. Knowledge about changes in the time course would help optimize ergonomic workplace design in standing work. Methods 30 healthy subjects (15♀) spent 275 minutes (including two breaks) standing or walking in randomized order on two separate days. LLV was quantified using waterplethymography (WP) and impedance measurements at the lower leg. WP was determined before exposure and directly after 275 min of exposure. Impedance was recorded before, after 110 and 275 min of exposure time. Muscle fatigue was assessed continuously using bipolar surface electromyography at the gastrocnemius muscle with regard to an increase in electrical activity and a decrease in median frequency. Additionally, subjective ratings of discomfort were assessed by a 10-point numeric Likert-scale. Results In the standing condition LLV measured by WP increased by 109 ±63 ml after 275 min of exposure. During the walking condition changes in LLV were small (9 ±41 ml.). The difference between these two conditions was statistically significant ($p<0.0001$). Impedance decreased statistically significant after 110 and 275 min during the standing condition ($p<0.05$) but not while walking. No signs of muscle fatigue could be found in the gastrocnemius muscle by sEMG measures for both conditions. Subjective

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ratings of discomfort indicated a higher amount of discomfort in the standing condition, especially at the lower back and leg region. Conclusions After 110 min of standing work the risk of venous disorders seems to be already increased. Although muscular fatigue could not be found using sEMG measures, subjective ratings of discomfort indicate increased stress to the musculoskeletal system. Finally walking seems to be a possible intervention during standing work in order to prevent from increased levels of LLV and discomfort.

DAY 3, FRIDAY JULY 8

P3-A-1 An innovative modular wireless system for the acquisition of surface EMG signals

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BACKGROUND AND AIM: The study and analysis of human movement require the acquisition of electrophysiological signals, kinematics and dynamics. Among these, surface electromyographic signal (EMG) plays a fundamental role in order to monitor muscle activity. In the last few years some systems composed of a set of wireless modules, each one allowing to acquire and transmit one bipolar EMG channel, have been developed and are now commercially available. In this work a new system is described, consisting of a set of wireless modules (sensor unit: SU) each one handling up to two EMG channels and interfacing directly to a portable device without the use of an ad hoc receiver. METHODS: The system includes up to seven SU, each one managing two EMG bipolar channels sampled at 2048 Hz with 16 bit resolution. The sampled signals are sent via a Bluetooth 4.0 link to a mobile device (notebook, tablet, or smartphone) which is configured as a Bluetooth server and acts as a receiver. The software for the acquisition and online visualization of the EMG signals has been developed using the cross-platform Qt libraries (supporting Windows, Linux, Mac,

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Android). Two different methods for the synchronization of the SUs have been developed in order to satisfy different requirements. The first one is a hardware solution for use cases requiring a good synchronization (< 1ms): the SUs are synchronized at the beginning of the measure by means of the recharge box. The second one is a software solution for use cases where synchronization is not a must: in this case synchronization is managed by the receiver device and it can be performed also when SUs are still placed on the subject. RESULTS: A prototype with 7 SUs has been realized. The noise is equal to 3.6 µVRMS RTI (Referred To Input). The performed optimization of the data packet size in order to maximize throughput allowed reaching a data rate of 666 kbps for each SU. During the transmission tests no data loss was observed in a range of 30 meters. The energy consumption of each SU is 40 mA allowing a continuous transmission of data for about twelve hours. The software has been tested with Android operating system. The time misalignment between all the seven SUs was one sample (about 500 µs) in the case of hardware synchronization and 55ms (mean) in the case of software synchronization. CONCLUSIONS: The main innovation introduced by the described system is the ability of the SUs to directly interface to a portable device acting as receiver without constraints on transmission distance or acquisition time. The hardware synchronization allows the system to be used in applications where a misalignment error below 1ms is mandatory. Such a system may be used as a tool for movement analysis and biofeedback both in clinical and telemedicine contexts. Figure. On the left the system architecture. Up to 7 sensor units (each one with 2 EMG channels) can be connected to one receiver. On the right the sensor unit is shown.

P3-A-2 Investigation of Force and EMG Measures in Competitive Swimmers

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AIM: ?Swimmers shoulder,? a term attributed to pain in and around the shoulder, is very common amongst competitive swimmers. Many university swimmers train intensively using highly repetitive motions. Overuse of the shoulder musculature is a contributing factor to shoulder pain, injury, and decreased performance in swimmers. Current research on within subject measurements, in university swimmers, during a full season is limited. The purpose of this study was to examine changes in force and muscle activation of the shoulder muscles of university female swimmers over the course of one university season (24 weeks). METHODS: Force and electromyography (EMG) were recorded from the shoulder muscles of 10 female swimmers (mean age 19±1.7 years, mean height= 165.8± 4.4cm, mean weight= 64.9± 3.8kg, right hand dominant, and performed multiple strokes in their sport). Surface electrodes were placed over the anterior and posterior deltoid and EMG data was recorded using a wireless EMG system (Noraxon USA, Telemyo 2400R 2400T). A Cybex (CSMI Inc., USA) isokinetic

dynamometer was used to measure isometric torque. Torque and EMG were sampled at a frequency of 1500Hz for 15s. Measurements were taken during four different phases of the training program: pre-season, taper, overload, and post season. Subjects were asked to produce three maximal voluntary contractions (MVCs) during horizontal arm abduction. Peak torque was measured to compare force output between trials, RMS measured muscle activity and mean frequency of the posterior deltoids was calculated to measure muscular endurance. RESULTS: No significant differences were found in strength or endurance between any of the phases of training or between pre and post-season. The only significant difference in muscular activity was in the left anterior deltoid RMS as it decreased from taper to post-season. The lack of changes in strength and endurance is evidence for the importance of dry-land strength training in elite level swimmers and that cardiorespiratory improvements are likely responsible for performance and endurance improvements after a taper.

P3-A-3 Evaluating Decomposition Methods for Electromyographic Characterization of Neuromuscular Disorders

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AIM: A framework for evaluating decomposition methods for electromyographic (EMG) characterization of neuromuscular disorders (NMDs) is proposed. Identification of motor unit potential trains (MUPTs) for characterization of NMDs can be considered an application tuned, special case of decomposition. Most important is that identified MUPTs include aspects of motor unit potential (MUP) shape and shape stability useful for disease discrimination. Moreover, the methods should be equally capable of identifying MUPTs generated by normal or diseased motor units. There is no need for complete decomposition. The focus instead is on extracting a high yield of clinically relevant information, using computationally efficient algorithms, and producing results that need no or minimal manual editing. METHODS: 1) EMG signals that reflect the neuro-dynamical, anatomical, and electrophysiological characteristics of motor units as well as the characteristics of the conducting medium and acquisition system (and their non-stationarities) are simulated. 2) A simulated motor unit firing is defined using both a firing instance and an observation range. The range identifies the duration over which the firing can be observed. A superposition is assumed to occur, when two or more observation ranges overlap. A superimposed observation range is associated with the MUPT for which the range morphology is influenced more by the MUP of this particular simulated train than by other superimposed MUPs. 3)

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Indices evaluating identified MUPT quality: a) Purity: ratio of correctly assigned MUPs to the total number of assigned MUPs; b) Splitting: the number of identified trains assigned to a simulated train and c) Merging: the ratio of the number of MUPs mistakenly assigned that belong to the second most abundant MUPT in the identified train to the number of MUPs that are correctly assigned, along with indices related to decomposition completeness d) the percentage of detected MUPTs and e) the completeness of each train using precision and recall, along with indices focused on MUPT representativeness including investigating correlations between quantitative EMG feature values calculated using simulated MUPTs and those calculated using extracted MUPTs and finally, indices evaluating computational efficiency were used. CONCLUSION: This framework quantifies issues of particular interest to the use of decomposition results for characterization of NMDs including superposition degree of influence, train representativeness, information yield and potential identification errors including misassignment, train splitting and merging. The reliance on a physiologically sound model allows not only comparison of different proposed methods for MUPT identification, but also identifies the empirical confidence limits of the obtained information. For instance, how close to a muscle fibre should an electrode detection surface be to reliably detect its electrophysiological activity.

P3-A-4 Muscle activation patterns when standing on wedges and being exposed to lateral perturbation

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INTRODUCTION: Instability of posture in the medial-lateral (ML) direction is a significant risk factor for falls in older adults. Standing on wedges changes the angular position in the ankle joints and improves postural stability seen in reduced postural sway in the ML direction. However, it is not known if standing on wedges improves body stability in the presence of external perturbations. AIM: To investigate muscle activation patterns during standing on the wedges while being exposed to lateral external perturbations. METHODS: Ten healthy young participants stood on a plane surface, on two medial wedges or two lateral wedges and were exposed to external perturbations applied to the lateral part of their right shoulder. Bilateral electromyographic (EMG) activity of dorsal and ventral trunk, thigh and shank muscles was recorded. The indexes of reciprocal (R) activation and co-contraction (C) of muscles were calculated (as the difference and sum of the integrals of EMG activity of the dorsal and ventral muscles) and analyzed during the anticipatory (APA) and compensatory (CPA) phases of postural control. RESULTS: Reciprocal activation of muscles was seen in the shank segment on the side of the perturbation while co-contraction of muscles was seen on the contralateral side. Different activation patterns were seen in the thigh and trunk segments as co-contraction of muscles on the right side and reciprocal activation on the left side. Standing

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on wedges significantly affected magnitudes of C and R indexes in both shank segments, however, the activation patterns on the left and right side were similar. CONCLUSION: Standing on two wedges affects patterns of muscle activity when dealing with the lateral perturbation: reciprocal activation seen in the shank segment on the side of perturbation allows some flexibility and co-contraction of muscles on the contralateral side creates better stability needed for maintaining equilibrium.

P3-A-5 Errors in RMS amplitude estimation attributable to the Inter Electrode Distance of the surface EMG electrode grids

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BACKGROUND AND AIM: The distribution of muscle activity over the skin can be obtained by applying a grid of (MxN) electrodes. The estimated spatial amplitude (SRMS) and the image reconstructed from the recorded signals are affected by the size/shape of the electrodes, grid size, and inter-electrode distance (IED). We focus on the effect of IED on the SRMS. Large IED, i.e. low sampling in space, introduces spatial aliasing that prevents reconstruction of the true muscle activity map and results in an error in SRMS and other features. METHODS: To quantify the effect of IED on SRMS estimation, we sampled sEMG signals in space using a grid of pin electrodes (16x8; Ø=1mm, IED = 5mm, 200samp/m) and sampled in time at 2048Hz. We recorded sEMG from: a) short head of biceps brachii (BB) of a subject holding 4Kg in 90° elbow flexion, b) medial head of gastrocnemius (GS) of a subject standing on his tiptoes, and c) medial deltoid (MD) of a subject holding 4Kg in 90° abduction. Skin was rubbed with abrasive paste and rinsed with water before grid attachment. Offset removal in time, bandpass filtering, power line interference attenuation and bad channel removal were performed on sEMG of each electrode. We then Fourier transformed 30720 instantaneous maps (15s) after zero padding in space (64x64 points, 3.13 cycles/m resolution) without removing the offset of each map. To reduce the likelihood of heavy aliasing in our maps (IED=5mm), we excluded the maps in which at least one row or column showed more than 5% of its power above 87.5cycles/m. We found 56%, 61%, and 37% "alias-free" images respectively from BB, MD, and GS. These maps were saved for reconstructing high-resolution maps as reference maps (0.1mm IED) by interpolation with 2D Sinc function. Maps with larger IED were obtained by down sampling the reference maps. We computed: 1) the SRMS of each sEMG map, 2) the mean of the SRMS values over a 1s period for 15s, and 3) the RMS of each channel in 1s period and then the spatial mean over all channels. RESULTS: Larger IEDs cause an error in SRMS estimation (ErrRMS=100(RMS_IED

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- RMS_0.1) / RMS_0.1). We quantified the ErrRMS for IEDs ranging from 0.1mm to 15mm. For IED= 15mm, the ErrRMS was 17.5%, 9.0%, and 17.4% for BB, MD, and GS muscles respectively. In the different approaches to obtain SRMS (see 1), 2), 3) in the METHODS) the ErrRMS was < 3%. CONCLUSIONS: Many images sampled with IED=5mm show aliasing. The ErrRMS due to large IED (15mm) can hit 17.5% for a single map. However, if one considers epoch, an electrode grid with 15mm IED is acceptable to estimate the mean RMS value in 1s since the errors in time average out. Still, in specific applications such as differentiating signals or segmenting regions of activation in a muscle or activities of small muscles, much smaller IED is recommended (IED<5mm).

P3-A-6 The Hand Function of Stroke Patients in the View of Surface Electromyography

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Background: Movement of a healthy organism is characterized by a high degree of variability performance of a movement task. In a situation of a motor control lesion, mainly due to neurological disease, occurs in varying degrees to a fixed musculoskeletal manifestation. There are manifesting in a limiting responsiveness to changing external or internal conditions during the task oriented physical action. Objective: To determine differences in muscle activity and variability between a muscle synergy of acral and proximal muscles during reach and grip in healthy subjects and stroke patients. Methods: The experimental group consisted of 24 probands after ischemic stroke with right-sided hemi-paresis. The control group consisted of 30 healthy subjects. Muscle activity was recorded using surface electromy¬ography during the performation of selected types of grips of cylindric and spheric objects. The differences in the area under the curve record of individual muscles between the experimental and control group were statistically evaluated using the t-test for independent groups. The relationship between the activity of the muscles of the fore¬arm and shoulder girdle muscles was assessed using Spearman?s correlation coefficient for non-parametric values. Results: There were the significant differences in the size and number of statistically significant correlations distal and proximal upper extremity muscles. In stroke group was found significantly lower activity m. pectoralis major and higher activity m. trapezius. At the same time the prevailing high correlation m. pectoralis major and extensors wrist and fingers, unlike the group of healthy subjectss, when the correlation distal and proximal muscle groups appeared at random, in a lesser extent and frequency. Conclusions: The results indicate a reduction in variability of muscle activity during reaching and grasping function of stroke patients. To compensate the lack of activity of acral muscles becomes relatively fixed ?co-activation? with selected proximal muscles.

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P3-A-7 Timing and Balance: The Shoulder a Refined

SystemBackground and Aim: The shoulder is a multi-axial ball and socket synovial joint. The humeral head, owing to its limited bony constraint, translates on the glenoid fossa when the powerful shoulder girdle muscles contract. Precisely modulated muscle activity is required to maintain a stable fulcrum for arm movement. The aim of this study was to comprehensively define, using EMG, normal muscle activation and coordination throughout the globe of shoulder movement.

Methods: The study included twenty healthy participants. The activity of 8 shoulder girdle muscles (anterior, middle and posterior deltoid, upper trapezius, serratus anterior, teres major, latissimus dorsi and pectoralis major) was recorded using bipolar surface electrodes. The activity of the supraspinatus, infraspinatus and subscapularis was measured using fine wire electrodes. Participants completed 10 cycles of shoulder elevation in 4 different planes: flexion, scapular plane elevation, abduction and extension. Mean activity was compared between planes of movement using a paired ANOVA. The onset of peak amplitude was used as a measure of timing. The Pearson correlation coefficient (PCC) was calculated for pairs of muscles to investigate their coordination throughout the movement cycle.

Results: Significant differences in signal amplitude were seen across all movements for the middle posterior deltoid, with activity highest in extension (p=<0.001-0.002). Pectoralis major was significantly more active during flexion as compared to the other movements (p=<001?0.007). The upper trapezius was significant more active during extension than flexion (p=0.029). Peak activity of pectoralis major was significantly earlier in flexion as compared to the other movement planes (p=0.003-0.011). Peak activity of posterior deltoid was significantly earlier in extension (p=<0.001-0.001). Coordination between the deltoid and rotator cuff muscle groups across all movement planes was significant higher during the initial (PCC=0.79) and final (PCC=0.74) stage of shoulder elevation as compared to the mid-range (PCC=0.34) (p=0.020-0.035)(Fig. 1).

Conclusion: The study comprehensively defines normal shoulder girdle muscle activation and coordination through the globe of shoulder movement. Higher activity

of the posterior deltoid during extension was expected given its line of action. Significantly higher activity was seen in the pectoralis major during flexion which was anticipated given its accepted role as a flexor of the shoulder joint. Similar findings are also reflected in the timing analysis. Muscular co-activation is essential for glenohumeral joint stability. A high correlation exists between the deltoid and rotator cuff muscle groups at the start and end range of shoulder elevation. Coordinated rotator cuff activity at these times balances the deltoid and ensures a stable fulcrum. Improved understanding of normality will facilitate a better comprehension of the changes seen in pathology.

P3-A-8 Effects of core muscle pre-activation on the recruitment of the hip muscles during therapeutic hip exercises

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BACKGROUND Therapeutic hip exercises remain as the mainstay of rehabilitation of hip conditions and injuries related to the knee and ankle based on the lower limb biomechanics. Activation of the core muscles prior to the hip muscles recruitment has been reported previously during hip exercises. However, there is a lack of the knowledge on the spatial features of hip muscles with the core pre-activation. This study examined the activity level and recruitment pattern of the prime hip muscles during various hip exercises under two experimental conditions: with and without the pre-activation of the core muscles. Methods 20 healthy females were recruited to perform 6 hip exercises (3 open kinetic chained exercises and 3 close kinetic chained exercises) under core and without core pre-activation condition. Electromyography (EMG) activities of bilateral core muscles and lumbar erector spinae and 3 prime hip muscles: gluteus maximus, gluteus medius and tensor fascia latae were acquired by surface electromyography during the hip exercises. The percentage of maximum isometric voluntary contraction (% MVIC) of the EMG activity was used to examine the effects of the core muscle pre-activation on the recruitment pattern of the prime hip muscles and back extensors. Results Effect of the core pre-activation on recruitment of the back extensors and prime hip muscles is presented in percentage change of %MVIC (in brackets) between the two experimental conditions of the core pre-activation (Figure 1). Significantly greater gluteus maximus activity was found with core pre-activation during pelvic drop exercise (59-72%), hip extension in prone lying (46%) and in 4-point kneeling (22-38%); and single leg sit-to-stand (29%). Significantly higher activities of gluteus medius

was found with core pre-activation during clam exercise (24%), hip extension in prone (16-43%) and in 4-point kneeling (31-56%) and single leg sit to stand (29%). Tensor fascia latae activity was significantly decreased during clam exercise (28%) and increased in single leg sit to stand (43%) with core pre-activation. A 19% and 12% decrease of lumbar erector spinae activities were resulted in hip extension and single leg bridging exercise respectively under core pre-activation trials. Conclusions Core pre-activation enhanced the prime hip muscles recruitment in both open and close kinetic chained exercises of the hip in extension and abduction directions. The findings suggest the potential to improve the efficacy of the therapeutic hip exercises with the core pre-activation. Significantly lower activity of the lumbar erector spinae with the core pre-activation during hip extension exercises implies less stress would be withstood by the lumbar spine when practising hip exercises. The findings demonstrated the potential use of core muscle pre-activation in promoting the efficacy of therapeutic exercises of hip and reducing stress to the lumbar spine during hip exercises.

P3-A-9 Impaired hand function is related to increased alpha band coherence between intermediate deltoid and wrist/finger flexors after stroke: preliminary findings

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Background: Loss of hand function is very common among individuals with stroke. Especially the ability to open and close the hand is often affected by abnormal involuntary wrist and finger flexion while abducting the shoulder, due to the flexion synergy. The expression of flexion synergy is believed to result from an increased dependence on corticoreticulospinal projections following the loss of corticospinal projections from the lesioned hemisphere. Such speculation is primarily supported by anatomic evidence showing that neural pathways originating from subcortical structures (e.g., brainstem) are usually characterized by divergent projections, including those shared neural drive projecting to shoulder abductor and wrist/finger flexors. Currently, evidence from functional data is still missing. EMG/EMG coherence allows for the exploration of a shared neural drive to flexor synergy muscles thus elucidating pathological neural changes underlying the loss of hand function. Prior evidence has demonstrated that EMG-EMG coherence between 8~13Hz (alpha band) is preserved among stroke individuals and may reflect the shift in the neural drive from the direct corticospinal (16~30Hz, beta band) to indirect corticoreticulospinal projections (<15Hz). Therefore, the goal of this study is to determine whether the alpha band coherence is related to impaired hand function after stroke. Methods: A total of 11 individuals (stroke: 8, control: 3) were recruited for this study. Each subject was instructed to perform maximal hand opening and hand closing while the arm lifted with a weight that equals 50% of the

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maximum SABD torque. Hand pentagon area, defined as the area formed by the tips of thumb and fingers, was measured to quantify hand opening. Maximum grip force was recorded during hand closing. EMGs were collected from intermediate deltoid (mDEL), flexor carpi radialis (FCR), and flexor digitorum superficialis (FDS) at a sampling rate of 1000Hz. A DC to 450Hz low-pass filter was applied to the EMG signals. Wavelet coherence was calculated. Results: The stroke group showed significantly greater alpha band coherence than the control group during hand opening ($p<0.05$) and hand closing ($p<0.01$). To explore whether the flexors-mDEL coherence had an functional impact on the hand, a Pearson's product-moment correlation was performed across the 10 stroke participants. The shoulder abduction induced grip force was noted as synergy-induced grip force. A significant positive correlation was found between the 8-13Hz flexors-mDEL coherence and synergy-induced grip force ($r=0.5$, $p=0.034$). Among 7 out of 8 stroke subjects who were able to open the hand, significant negative correlation was found between the 8-13Hz flexors-mDEL coherence and hand pentagon area ($r=0.76$, $p=0.019$). Conclusion: After stroke, 8-13Hz EMG-EMG coherence emerges between mDEL and wrist/finger flexors and is related to the reduced ability to volitionally open and close the hand.

P3-A-10 Exploring sex differences in cervical spine muscle activity during sudden head perturbations in hockey players

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BACKGROUND AND AIM: Sex differences are apparent in the prevalence of concussions in sport. The ability of the neck muscles to dampen sudden head accelerations may be one mechanism that contributes to these differences. Our aim was to examine sex differences in head acceleration and cervical muscle activity during sudden head perturbations. METHODS: 16 competitive ice hockey players (8 female) participated. Three muscles were monitored bilaterally using surface EMG: sternocleidomastoid (SCM), scalene (SC) and splenius capitis (SPC) (Delsys, Boston, MA). Head kinematics were measured using a motion capture system (NDI, Waterloo, ON) with rigid bodies placed on the head and thorax. Cervical perturbations were induced by the release of a 1.5kg magnetized weight (dropped 15cm), attached to a wire wrapped around a height adjustable pulley secured to the participant's head. A load cell, in series with the cable determined perturbation onset. Perturbations were delivered in 4 directions (flexion, extension, right and left lateral bend) 6 times each in randomized order. EMG was sampled at 1926 Hz, low pass Butterworth filtered at 3 Hz and normalized to muscle specific maximal voluntary excitation (%MVE). Kinematics were sampled at 128 Hz and low pass Butterworth filtered at 6 Hz; angular velocity and acceleration were calculated. Three time periods were examined: baseline (-150 to -100ms pre-perturbation), anticipatory

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(-15 to 0ms) and reflex (25 to 150ms post-perturbation). RESULTS: Females had significantly greater head acceleration during left lateral bend (18.6%) and flexion (23.4%) perturbations, with no difference in extension. Averaged across perturbation time periods, during flexion females had greater activity in left SPC (5.5 ± 1.8% MVE vs 3.6 ± 1.6% MVE), right SPC (3.6 ± 3.4% MVE vs 3.0 ± 2.5% MVE) and right SC (2.7 ± 1.9% MVE vs 1.6 ± 1.3% MVE), while males had greater left SCM (2.1 ± 3.1% MVE vs 1.4 ± 1.0% MVE), right SCM (1.9 ± 2.2% MVE vs 1.3 ± 0.7% MVE) and left SC (2.7 ± 3.2% MVE vs 1.9 ± 0.8% MVE). Females had greater left and right SCM and SC activity in extension, with no difference in head acceleration. There was a significant time period x sex interaction during extension, with females displaying 4.1% more overall muscle activity in the reflex period (7.2 ± 2.8% MVE vs 3.1 ± 0.9% MVE). CONCLUSIONS: There were sex differences across most variables, dependent on perturbation direction and timing knowledge, with no consistent neuromuscular strategy that could explain all directional effects. During extension perturbations, females had greater muscle activity in the reflex period, which may explain the lack of head acceleration differences between sexes. The increase in activity during reflex periods suggests a neuromuscular response to counter sudden acceleration. Further investigation of muscle onset times and co-contraction could reveal unique muscular strategies that place female athletes at a greater risk of concussions.

P3-A-11 Accurate identification of motor unit activity during dynamic tasks of the forearm muscles: perspectives for prosthetic control

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BACKGROUND AND AIM: Decomposing the surface EMG signal into its constituent motor unit action potentials allows us to investigate the behavior of motor neuron populations from muscle recordings. However, most methods assume that the performed contractions are isometric, limiting their applicability [1]. In this study we investigate whether it is possible to use EMG decomposition methods developed for isometric contractions for dynamic voluntary contractions. The target application is the control of upper limb prostheses using motor neuron activity. METHODS: EMG signals were recorded using high density surface electrode grids wrapped around the full circumference of the forearm of seven healthy subjects. Motion capture pods were used to track wrist kinematics and to provide visual feedback. The subjects were instructed to activate all degrees of freedom (DoFs) of the wrist, from the neural position to the maximal range of motion in 2.5 s three times. The recorded EMG signals were decomposed using convolutive blind source separation [1,2]. Spike trains with a sensitivity below 90% according to the pulse-to-noise ratio were disregarded [1]. The signal-to-interference ratio (SIR) was also calculated as a measure of the EMG variance

explained by the decomposed potential trains [1]. Discharge characteristics were calculated based on the instantaneous discharge rate smoothed with a 100 ms Hanning window. Means and standard deviations are reported. RESULTS: The average number of decomposed motor units per subject was 12.8 ± 5.3 for flexion, 13.5 ± 6.1 for extension, 9.8 ± 1.2 for radial deviation, 14.7 ± 5.5 for ulnar deviation, 13.5 ± 4.5 for pronation, and 9.5 ± 5.3 for supination. The SIR value was 16% ± 15%. The minimal discharge rate was 7.2 ± 3.6 pps, whereas the maximal was 19.9 ± 9.3 pps. The coefficient of variation of the inter-spike intervals was 0.35 ± 0.25. 27% of the spike trains were present in all repetitions of a given movement. CONCLUSIONS: The results showed that is possible to decompose EMG signals of voluntary dynamic contractions. Discharge rate findings are similar to those of isometric contractions except for the coefficient of variation, as expected. Although some SIR values were similar to the isometric case, the low mean indicates that in some cases not all contributing motor units were decomposed. This is consistent with our finding that only a fraction of the active motor units was detected in all repetitions. However, overall, the number of detected units is sufficient for estimating the neural drive to muscles and can therefore be used to derive robust control signals for prostheses. REFERENCES: [1] A. Holobar et al. Accurate identification of motor unit discharge patterns from high-density surface EMG and validation with a novel signal-based performance metric. J Neural Eng. 2014;11(1):16008 [2] F. Negro et al. Multi-Channel Intramuscular And Surface EMG Decomposition by Convolutive Blind Source Separation. In Press. 2016

P3-A-12 Identification of sEMG-Torque Dynamics May Reveal the Underlying Control Strategy

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Previous studies have revealed the significance of spinal feedback pathways in the neural control of limb locomotion and force generation and the manner they are modulated to satisfy the requirements of a task. We hypothesize that these feedback mechanisms cannot be as useful in fast, ballistic tasks due to the inherent spinal loop time-delays. In this work, we, for the first time, present experimental evidence on how and when the CNS may suppresses these feedbacks to accommodate the speed of the task execution. Our approach is to study this by identifying the dynamic relationship between surface EMG (sEMG) and torque in 6 healthy human ankles in isometric contractions. Subjects were provided with visual feedback of their ankle torque in real-time and instructed to voluntarily modulate it by tracking a Pseudo-Random Binary Sequence (PRBS). The peak-to-peak amplitude of the PRBS was kept small to assure the system remains in its linear range. The switching time of the PRBS was randomly selected from the set {0.1, 0.2, 0.3, 0.5, 2, 4}s. Impulse response

functions (IRF) were first estimated between the rectified sEMG and torque records using an open-loop identification technique. The IRFs had an unphysiological anticipatory component, which disappeared as the tracking speed increased. This non-causal behavior is an indicator that the data were recorded in closed-loop. We excluded vision as a potential source of feedback by repeating the experiments, removing the visual feedback. The resulting IRFs were still non-causal in slow tracking tasks. We repeated the analysis, applying a closed-loop identification algorithm that modeled the EMG-torque relation as a nonparametric IRF, and the noise as an autoregressive-moving-average process. This technique gave causal estimates confirming the closed-loop nature of this system even in the absence of visual feedback. We conclude that the control strategy is feed-forward in fast tracking tasks and switches to a feedback one in slower tasks. The cost is that the error in tracking the visual command significantly increases when the control strategy is feedforward. This technique, while useful in revealing the control strategy, cannot localize the source of the feedback. We speculate that the feedback is due to the spinal and supraspinal reflex loops with muscle proprioceptors as the main sensors.

P3-B-13 Electromyographic analysis of the scapular muscles in rehabilitation exercise: a cross-sectional study

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BACKGROUND AND AIM: The decrease in strength and the presence of imbalances in the trapezius and serratus anterior (SA) are considered causes of dysfunction of shoulder. Excessive activation of the upper trapezius (UT), combined with diminished control of lower trapezius (LT), middle trapezius (MT) and serratus anterior (SA) contributes to abnormal movement of the scapula. Moreover, has been observed an increased activation latency of scapular muscles in patients with shoulder pain. Currently, there are no reports on rehabilitation exercises based both on the scapular muscles balance and onset latency. The aim of this study was to determine the exercises that present a minor upper trapezius/middle trapezius (UT/MT), upper trapezius/lower trapezius (UT/LT), and upper trapezius/serratus anterior (UT/SA) ratio and onset latency in five common rehabilitation exercises. METHODS: A prospective cross-sectional study. Thirty young males were recruited from the University of Talca, with ages between 18 and 24, who voluntarily agreed to participant in this study. The amplitude and onset latency of UT, MT, LT and SA muscles was measured with sEMG during common shoulder rehabilitation exercises: wall-slide (WS), push-up plus (PUP), horizontal abduction with external rotation in a prone position (HAEP), external rotation in a lateral position (ERL) and low-row (LR). The exercises were classified as moderate from 100% to

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80%, good from 80% to 60% and excellent <60% according to the UT/SA, UT/MT and UT/LT muscle ratios. An ANOVA with repeated measures was performed for compare each muscle latency between exercises. A Bonferroni corrected t-tests were used. A P value ≤ 0.05 was considered statistically significant. RESULTS: The exercises ERL (39.3%) and LR (53.6%) obtained and excellent UT/SA ratio. The exercises LR (52.5%), HAEP (57.1%) and ERL (59.1%) presented and excellent UT/MT ratio, while the exercise ERL (22.2%) and HAEP (36%) showed an excellent UT/LT ratio. The exercise PUP (69.3%) presented a good UT/LT ratio. The exercise WS (91.3%) showed a moderate UT/SA ratio. Repeated measure ANOVA revealed an exercise main effect for SA ($F = 20.17$; $p < 0.0001$), MT ($F = 49.20$; $p < 0.0001$), LT ($F = 30.51$; $p < 0.0001$) and UT ($F = 46.82$; $p < 0.0001$). The exercises WS and LR presented the least latency of SA ($P < 0.05$), while the HAEP and ERL exercises showed less latency of MT and LT ($P < 0.05$) (Figure 1). Finally, the PUP exercise presented the least latency of UT ($P < 0.05$). CONCLUSIONS: The HAEP, ERL and LR exercises were considered the most optimum to train the level and onset latency; therefore, it would be appropriate to include them in a shoulder rehabilitation program within initial phases. In change, PUP showed a higher and earlier UT activity at initial stages; therefore, it would not be appropriate to use this exercise within the first phases of shoulder rehabilitation program.

P3-B-14 8-week vibration training of the elbow flexors by force modulation

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AIM: Vibration exercise (VE) has been suggested to have beneficial effects on muscle strength, power performance, bone density, and flexibility. However, most of the previous studies focus on the effect of VE on the lower limbs by using whole body vibration platforms, while studies concerning the upper limbs focus mainly on the acute effect during or immediately after short-time VE. The aim of the present study is to evaluate the effects of VE on the elbow flexor strength after an 8-week training program by using a force-modulated VE system developed and tested as a proof of concept in a previous study. METHODS: Forty subjects underwent a biceps curl exercise twice a week for 8 weeks. Three sets were carried out in each training session, with each set reaching the maximum repetition number until failure. The subjects were randomly assigned to four groups: the vibration group (VG), the no-vibration group (NVG), the dumbbell group (DG), and the control group (CG). The NVG and the VG were trained using the force-modulated VE system. For NVG, the applied load was a ramp-up function applied to the subject's range of motion with the maximum value equal to 80% of the subject's 1 repetition maximum (1RM, Fig.1). For VG, a 30-Hz vibration (sinusoidal force) was superimposed on the rump-up load. The vibration amplitude corresponded to 60% of the baseline force. The DG was trained using dumbbells with a weight equal to 80% of the subject's 1RM, while the CG was not trained. Before and after the 8-week training period, the isometric maximum voluntary contraction (MVC) of the subject's

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dominant arm was assessed using the force-modulated VE system, while the 1 RM of the same arm was measured using dumbbells. RESULTS: After the 8-week training program, the 1RM improvement for the VG is significantly larger than that of the NVG and is comparable to that of the DG. No significant difference in the MVC improvement is found among the intervention groups (Table 1). This may be due to the nature of the adopted exercise, better suited for improving dynamic strength. CONCLUSION: Our results show force-modulated VE to produce larger 1RM improvement as compared to control. In particular, with approximated 50% work load, VE achieves 1RM improvement comparable to dumbbell exercise. This VE system seems, therefore, particular suitable for rehabilitation programs, in which heavy loads are not suitable due to impaired muscle function, weakness, and muscle mass loss of the patients.

P3-B-16 Different sagittal movements of trunk and pelvis dependent on trunk rotation direction at half-hip free sitting posture: Assessment comparable with gait analysis

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BACKGROUND AND AIM: During gait the trunk more or less rotates, flexes or extends. This kind of trunk movements could be mimicked by the trunk movements at the sitting posture with laterally half hip on the chair and other half free from support, since the free half of the hip, hemi-ischium free posture, might correspond to the free half hip at the mid stance with swinging leg not supported by the floor. The half sitting on the chair, hemi-ischium supporting posture, might be akin to the hip on the supportive leg. We here investigate effects of leftward and rightward trunk rotations on the side of hemi-ischium free posture by assessing the movements of upper center of gravity (upper COG) or sitting ground reaction pressure (COP), and applicability of this hemi-ischium free trunk rotation methods as representative of gait analysis specifically at mid stance. METHODS: Subjects were 11 healthy men (25.2±2.9 years old). The measurement was performed with two half sitting conditions, left or right half hip free from sitting with the edge of the seat placed at an intergluteal cleft. Task was the rightward trunk rotation on left side sitting position (right half free) or leftward rotation on right side sitting position. The obtained parameters were compared between left- and rightward rotations at angles of 5°, 10° and 15°. The upper COG and the inclination (°) of pelvis were measured using three-dimensional motion analysis system (ViconMX). The amount of anteroposterior movement of COP on the half sitting position side was measured using a force platforms (AMTI). Statistical analysis was made by paired t-test or Wilcoxon

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signed-rank test. RESULTS: When trunk was rotated, upper COG moved forward by the rightward rotation (e.g., 3.7 mm ahead at 15°), but relatively backward by the leftward rotation (5.3 mm back at 15°) ($p<0.001$). COP also moved forward by the rightward rotation (2.4 mm ahead at 15°) and backward by the leftward rotation (5.0 mm back at 15°) ($p<0.01$). Pelvis tilted backward significantly by the leftward rotation as compared with the rightward rotation (0.86° of the left-right difference in inclination, $p<0.01$). CONCLUSIONS: Because upper COG and COP moved forward and pelvis tilted forward during the rightward rotation at the hemi-ischium free posture, trunk may move to the extension direction. On the other hand, the leftward rotation induced the opposite movements to the rightward rotation. These results are well comparable for gait movements, as we consider the right leg as the functional leg possessed by 70-90% of people, and may correspond to the right leg as the leading leg for gait or the left leg as the supporting leg. The trunk rotation at hemi-ischium free posture may be beneficial for assessment of trunk movements akin to those during gait, since this assessment could be performed at a narrow space, compared with the gait analysis requiring the long distance, more than 10 m.

P3-B-17 Contribution of bilateral asymmetry in hip joint movements and trunk motion to the smooth propulsion in gait of normal adults

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BACKGROUND: Most people have a bilaterally different posture. Postural asymmetry is suggested to help the body weight shift on one limb, then allowing another limb to take a quick step to respond to the postural disturbance (Blaszczyk 2000). Gait is usually performed by the alternative movements of left and right legs with the stance and swing phases. Presumably, the postural asymmetry influences the rhythm of gait to achieve the smooth and coordinate leg movements through the kinematic coupling between trunk and lower extremities. We aim to focus motion couplings among trunk, pelvis and hip joint during the left or right single limb support phases (SLS) of gait to understand the function of bilateral difference in posture for gait performance. METHODS: Subjects with informed consents were 17 healthy men (26.6?}3.6 years old). Using 3-D motion analyzer (MX, Vicon Motion Systems) with standard markers on femurs, pelvis and trunk, movements of hip joint and trunk were measured, and relevant joint angles were assessed as the maximum, minimum and altered joint angles during SLS of left and right legs. The difference in right and left values were analyzed by paired t-test. The incidence of dominance in right or left lateral movements were analyzed by Pearson?Ls chi-squared test. The relationship among movements of hip joint, pelvis and trunk were analyzed by Pearson correlation coefficient. All analyzes were using

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SPSS with p<0.05. RESULTS: With respect to the hip joint extension during SLS, the amount of altered angle was greater in the right hip joint (13/17 persons) and in the left (4/17), indicating the greater incidence in the right hip joint usage for forward trunk movement (p<0.05, ?´2=4.73). While, the substantial maximum extension angle and altered angle of hip joint during SLS did not show the bilateral different. A correlation was obtained between the laterality of altered hip joint extension angle and the laterality of altered trunk flexion angle (r=0.64, p<0.01). CONCLUSIONS: Results suggest the right hip joint extension movements is more predominant than the left among people. Postural asymmetry was suggested that leftward laterodeviation of thoracis was common even in healthy people (Ishizuka, 2013). Presumably, the postural deviation affects the gait through the function of hip joint as follows: the right hip joint takes a role for propulsion in the stance phase, and the left hip joint takes a role for stabilization in the stance phase. The specific functional asymmetry exits in human body, as the lateral difference in hip joint and trunk movement helps their coordination due to the minimization of left or right disturbance of center of gravity. In the clinical sense, it is better to grasp the functional asymmetry in pelvis junction associated with trunk for treatments of gait disorders.

P3-B-18 Is there an age difference in voluntary activation during maximal dynamic contractions with eblow flexor muscles?

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BACKGROUND AND AIM: Skeletal muscle strength decreases with advanced age for most muscle groups [1]. This age-related reduction in maximal force is primarily due to muscle atrophy [2] but also may involve a reduced capacity to voluntarily activate the muscles [3]. Age-related reductions in voluntary activation during maximal isometric contractions were shown for some muscles but not for others [4;5], and less is known about deficits from the motor cortex during maximal dynamic contractions among old adults. The purpose of this study was to determine whether there are age differences in voluntary activation assessed with stimulation at the muscle and motor cortex during maximal isometric, concentric and eccentric contractions of the elbow flexor muscles. METHODS: Sixteen young (7 women) and 13 old (8 women) adults performed maximal voluntary contractions (MVC) with the elbow flexor muscles during isometric, concentric and eccentric contractions. Isometric contractions were performed at a 90° elbow joint angle and dynamic contractions were performed over a 60° range of motion at a velocity of 60°/s. Voluntary activation was assessed with the interpolated twitch technique using either electrical stimulation (2 trials per contraction type) or transcranial magnetic stimulation (TMS; 2 trials per contraction type), and expressed as a percentage of MVC. RESULTS: MVC torque was greater during eccentric (52.9 ± 3.6 Nm) than

isometric contractions (41.2 ± 5.0 Nm; p<0.001) and both were larger than concentric contractions (30.4 ± 3.9; both, p<0.001). Voluntary activation levels were similar whether assessed at the muscle or motor cortex (1.1 ± 0.2% and 1.3 ± 0.2%, respectively; p=0.24), and similar across the three contraction types (p=0.12). Voluntary activation however, was lower for old than young adults when assessed with electrical stimulation (1.4 ± 0.3% and 0.7 ± 0.1%, respectively; p<0.01) and tended to be higher when assessed with TMS (1.6 ± 0.3% and 1.0 ± 0.1%, respectively; p=0.07). Furthermore, the variability in voluntary activation across MVC trials (standard deviation of voluntary activation) was greater for old (1.3 ± 0.1%) than young adults (0.9 ± 0.1%; p<0.001) for all contraction types. CONCLUSIONS: Old adults had lower voluntary activation of the elbow flexor muscles and were more variable across the trials compared to young adults, although the differences were small. Activation levels however, were similar across all contraction types for both young and old adults. Because activation was similar when measured with electrical stimulation and TMS, age-related limitations in neural drive may occur upstream of the motor cortex. REFERENCES: [1] Doherty, J Appl Physiol, 95:1717-727, 2003 [2] Frontera et al., J Appl Physiol, 71:644-50, 1991 [3] Stevens et al., Muscle Nerve, 27:99-101, 2003 [4] Klass et al., J Appl Physiol, 9: 31-8, 2005 [5] Hunter, J Appl Physiol, 105: 1199-209, 2008

P3-B-19 Influence of an Acute Bout of Self-Myofascial Release on the Expression of Isometric Knee Extension Force and Electromyographic and Mechanomyographic Signals of the Quadriceps Musculature

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BACKGROUND AND AIM: Self-myofascial release (SMR) techniques, such as foam rolling (FR), have demonstrated the ability to increase muscle flexibility without subsequent decrements in maximal force output. However, the potential changes in the electromechanical properties of muscle function as a result of SMR remain largely uncharacterized. Therefore, the purpose of this study was to investigate the influence of an acute bout of SMR on the expression of knee extension force and quadriceps muscle activation during a maximal isometric voluntary contraction (MVIC). METHODS: Twenty participants (10 males, 10 females; age = 24.2 yrs; height = 173.1 cm; weight = 70.7 kg) with prior FR experience completed both the experimental (EXP) and control (CON) intervention protocols on separate days (48 hours apart). Protocol order was counterbalanced across all participants. During the EXP protocol, participants completed three 60 seconds sets of FR over the vastus lateralis (VL) musculature with 60 seconds of rest between each set. During the CON protocol, participants rested for 10 minutes. For both protocols, participants completed five MVICs of knee extension pre- and post-intervention. Force output was

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collected using a handheld dynamometer with the leg fixated at 60 degrees of knee flexion and was normalized to bodyweight (kg/kg). Root mean square (RMS) amplitudes of the electromyographic (EMG) and mechanomyographic (MMG) signals from the VL and rectus femoris (RF) during the greatest MVIC trial were used in all statistical analyses. Electromechanical efficiency (EME) was defined as a ratio of the MMG/EMG amplitudes. Changes in force and muscle activation were quantified as a ratio of post/pre for each variable. RESULTS: Paired t-tests (CON vs. EXP) identified no significant changes ($p > 0.05$) in force output (1.04 vs. 1.03), or EMG (1.02 vs. 0.96; 1.02 vs. 0.98), MMG (0.97 vs. 1.03; 1.07 vs. 1.06), and EME (0.97 vs. 1.15; 1.05 vs. 1.14) responses of the VL and RF, respectively. These results are consistent with previous research reporting an acute bout of SMR does not negatively influence the expression of maximal force output. However, inspection of the force data suggested that participants responded to the SMR intervention differently, with one group increasing and one group decreasing their subsequent force output. Although the post/pre force output during the EXP protocol was significantly different ($p < 0.001$) between these two groups of participants (1.13 vs. 0.90, respectively), independent t-tests identified no significant differences ($p > 0.05$) in muscle activation. CONCLUSIONS: This suggests that SMR may primarily influence the non-contractile muscle properties of some individuals, which may in turn influence their expression of maximal force output. However, it is possible that the influence of SMR on muscle function differs between a MVIC and a submaximal action. Future research should examine the influence of SMR on submaximal actions.

P3-B-20 Laterally selective stimulation of laterodorsal muscles affects the bilateral deviation in trunk alignment

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BACKGROUND: In the frontal plane of many people, the trunk deviates laterally leftwards from the vertical line across the pelvis, indicating the lateral asymmetry in the body trunk (Ishizuka et al., 2013). Patients with respiratory diseases often possess the severe asymmetry in body trunk, as the bilaterally and thoracoabdominally deformed trunk in COPD patients (Priori et al., 2013). This asymmetry or deformation of trunk might be affected by activities of muscles surrounding vertebra and ribs. We here investigate the relationship between electrically stimulated activities of laterodorsal muscles and lateral deviation of trunk position or trunk load at sitting. METHODS: Subjects were 11 healthy men (25.3±2.6 years old) at the sitting square posture, and 9 subjects were subjected further analyses since they apparently

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had the leftward deviation in trunk position. Electrical stimuli (maximum below sensing pain, current ~20 mA) were applied to left and right laterodorsal muscles of latissimus dorsi, lumbar quadrate, inferior posterior serratus and external abdominal oblique muscles, and their activities of contraction were confirmed by palpation. Lateral deviation of the trunk was captured using three-dimensional motion analysis system (ViconMX) with 4 markers each placed on upper thorax and pelvis. The trunk position was determined as the center place estimated from 8 marker positions. Bilateral trunk loads were measured using two compact scales placed under the hip as one scale under hemi-lateral side of the hip. Differences in obtained parameters were compared with mostly paired t-test ($p<0.05$). RESULTS: At rest, analyzed subjects had the deviated trunk position leftwards by average 4.4 mm. When electrically stimuli were applied to the left half of laterodorsal muscles, the trunk moved right wards by 5.3 mm from the rest position($p<0.05$). When stimulated the right laterodorsal muscles, inversely trunk moved leftwards by 2.3 mm ($p<0.05$). Accordingly, the left-right ratio of trunk load altered to be increased toward the direction opposite to the stimulated side ($p<0.01$) CONCLUSIONS: Results apparently indicates that the activation of bilaterally one side of laterodorsal muscles induces the trunk movement towards the other side of stimulated muscles of healthy men. The normal deviation of trunk may be attributed by the bilateral difference in trunk muscles. In contrast, when much deviated like pulmonary obstructed patients, the activation of opposite trunk muscles of laterodorsal muscles may help the severe deviation normalize toward upright of the trunk position. Thus, the laterally selective stimulation of trunk muscles may be a feasible strategy for rehabilitation in trunk-related disorders.

P3-B-21 Spatial EMG signal properties in human biceps femoris muscle during running on the treadmill

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BACKGROUND AND AIM: It is very important to elucidate the mechanism of muscle injury such as a pulled muscle. The aim of this study is to elucidate the difference of spatial muscular activity by surface EMG signal during the running on the treadmill. METHODS: The subjects were 5 healthy male volunteers averaged age 22.4 years and they did not have muscle injury. The subject ran on the treadmill at 6km/h, 9km/h, 12km/h and 15km/h. The surface EMG signals were recorded from the biceps femoris muscle. The wireless EMG sensor with inter-electrode distance of 20 mm (IP 3PAD, Oisaka Electronic Equipment Ltd.) was placed in three location of the proximal, distal and middle point on the muscle. The frequency range and the gain of EMG amplifier were set from 19.6 Hz to 442 Hz and 60 dB, respectively. In order to analyze the running cycle, the 3 axis accelerometer and joint angle

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meter were installed on the knee joint. All recorded signals were stored on a personal computer through an A/D converter with a 16-bit resolution and with a sampling frequency of 1,000 Hz. The EMG activity (RMS) of each electrode location was normalized by the highest EMG activity (100%RMS) during an isometric maximum voluntary contraction. RESULTS: The %RMS increased on the last half of swing phase in all running speed. At the running speed over 9km/h, the %RMS increased on the first half of stance phase. The spatial difference and crosswise difference of %RMS was not recognized in four subjects. But in one subject, the %RMS of proximal point on right foot was significantly increased on the first half of stance phase at 9km/h, 12 km/h and 15 km/h. CONCLUSIONS: The relationship between the exercise intensity and the mechanism of muscle injury such as a pulled muscle might be clarified by the spatial muscular activity by surface EMG.

P3-B-22 Relationship between dynamic postural control ability with voluntary sway and passive sway and lower limb muscle activity

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BACKGROUND AND AIM:Fracture or fall accounts for 10% of the cause of the care in Japan.Dynamic postural control ability is necessary for fall prevention in our daily lives.Dynamic postural control ability is categorized voluntary sway and passive sway. Decline of dynamic postural control ability as well as decrease the muscle amount of the lower limb with aging.In this study, we consider the relationship between dynamic postural control ability and lower limb muscle activity by comparison of the young and older adults. METHODS:We performed two tests in measurement of dynamic postural control ability. 1. voluntary sway on the stabilometer 2. passive sway on the unstable tiltboard In addition, we measure lower limb muscle activity of Vastus lateralis（VL）, Biceps femoris（BF）,Tibialis anterior（TA）and Gastrocnemius（GAS）. RESULTS:The results showed that older adults declined dynamic postural control ability and increased lower limb muscle activity more young.In particular, there was increased lower limb muscle activity of the antagonist by voluntary sway, and there was increased lower limb muscle activity of the femoral region by passive sway. CONCLUSIONS:Older adults increased lower limb muscle activity by co-contraction, and it was suggested that they stabilized dynamic postural control ability using hip strategy.

P3-B-24 Running related gluteus medius muscle function in health and injury: A systematic review with meta-analysis

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BACKGROUND AND AIM: Despite the benefits of running for a number of body systems, musculoskeletal injuries in runners are common. The inability to control pelvic equilibrium in the coronal plane is thought to contribute to running related injuries. This lack of pelvic control in the frontal plane can stem from dysfunction of the gluteus medius. The aim of this systematic review was therefore to: (i) compile evidence of the activity profile of gluteus medius when running; (ii) identify how gluteus medius activity (electromyography, EMG) varies with speed, cadence and gender when running; (iii) compare gluteus medius activity in injured runners to matched controls. This information may assist with the development of targeted rehabilitation strategies. METHODS: Seven electronic databases were searched for terms under three main concepts; gluteals, running and EMG. The title and abstracts of studies were screened independently by two authors according to a pre-determined eligibility criteria. Studies were eligible if they recorded gluteus medius muscle activity with EMG in healthy runners; or compared healthy runners to an injured sample. Effect sizes and 95% confidence intervals were calculated from included studies to determine the effect of running speed, running step rate, gender and injury on gluteus medius activity. Data were pooled in a meta-analysis where two or more comparative studies (e.g. injury vs control) were available. The quality of the body of evidence for each meta-analysis was rated according to the GRADE criteria of the Cochrane collaboration. RESULTS: 13 studies were included in this review; mean participant age 21 to 39 years; running experience varied from recreational runners to varsity track athletes. The burst activity profile across a running stride was illustrated in four studies. Gluteus medius activity was monophasic, with peak activity occurring in the initial loading phase of running. Gluteus medius amplitude and duration increased with running speed, although the response was greater in females (4 studies). There was greater EMG amplitude in late swing when running at a higher cadence (1 study). Five studies assessed the impact of injury (Achilles tendinopathy; patellofemoral pain syndrome (PFPS)) on gluteus medius running activity. The most consistent finding across both injuries was a reduction in gluteus medius EMG duration in injured runners compared with controls. Results could be pooled for PFPS (Fig 1), with moderate quality evidence from two studies indicating a moderate and significant reduction in duration of activity (ES=-0.52[-0.97, -0.08]). CONCLUSION: Gluteus medius is most active in the initial phase of stance, however, duration of activity appears to be the outcome that is impaired in injured runners. Strategies such as increasing running step rate (cadence) can potentially facilitate gluteus medius recruitment and may prove beneficial to runners with suspected dysfunction of coronal plane control.

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P3-B-25 Biomechanical Strategies of Drop Jump Depending on Human Knee Extensor Eccentric Strength

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BACKGROUND AND AIM: The eccentric contraction during the landing or breaking phase of a drop jump plays an important role. Although it has been known from frog muscle experiments by Hill (1938) that eccentric force increases beyond the maximum isometric force up to the some point, that's generally not the case for in vivo human muscles during voluntary contractions, typically for untrained people. In recently studies, untrained humans may be unable to activate their eccentric muscles optimally (Enoka, 1997; Sale, 1988). The purpose of the present study was to investigate how the eccentric strength of human knee extensor muscles influenced the biomechanical strategies of drop jump performance. METHODS: Based on the eccentric knee extension torque, sixteen subjects were categorized into the low eccentric (LowECC; n = 10) and high eccentric (HighECC; n = 6) strength group. Lower limb kinematics and kinetics during the drop jump performance were analyzed using a 3D motion capture system (VICON, Oxford Metric LTd. US) with a force plate (AMTI OR6-7, Watertown, MA). In addition, fascicle behavior of the vastus lateralis (VL) was assessed using an ultrasonography (LogicScan 128 EXT-12 kit, Lithuania) and muscle activation was monitored using a surface EMG system (8 channel DELSYS, Boston, MA). Joint stiffness was calculated as the ratio of peak joint moment to joint angular displacement at the braking phase. RESULTS: During the drop jumping, HighECC group showed short contact time compared to LowECC group. In absolute jump height, no significantly different was observed, but the jump height normalized to their height showed that the HighECC group jumped higher compared to LowECC group. HighECC group showed less peak flexion angle in the lower extremities during drop landing and they created higher ankle and knee joint power during both braking and propulsion phase than LowECC group. The knee and ankle joint stiffness were shown that HighECC group significantly was greater than LowECC group. Fascicle length change of the VL during the braking phase was significantly higher in LowECC groups than HighECC group but, during propulsion phase no significantly different between two groups. CONCLUSIONS: To see whether knee extensor eccentric strength capacity might be a crucial factor for the landing strategy, this study examined whether landing dynamics from drop jumps differed among HighECC and LowECC groups. It has been observed that the HighECC group, comparing with the LowECC group, used stiffer landing strategy for a drop jump, indicating that higher eccentric strength might enhance the breaking capacity during braking phase and result in higher energy return during the following propulsive phase. In conclusion, the results of this study concluded that drop jumping strategies could be adjusted based on subject's eccentric strength capacity.

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P3-B-26 Effect of bilateral fatigue in the knee extensor muscles on crank power during sprint cycling

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BACKGROUND AND AIM: The ability to produce maximal crank power during sprint cycling is influenced by the force-generating capacity and activation level of the lower-limb muscles. It is often assumed that a reduction in the force-generating capacity of the knee extensor muscles is largely responsible for decreases in crank power during maximal cycling [1], even if the direct contribution of the work produced by the knee extensors to crank power is limited [2]. The aim of this study was to investigate the effect of repeated maximal bilateral knee extensions on crank power and activation level of the lower-limb muscles during sprint cycling. METHODS: 10 subjects performed a maximal 30-s cycling sprint immediately after 120 maximal bilateral knee extensions and in a control condition. Maximal voluntary force (MVF), twitch force (Qtw) and voluntary activation (VA) of the knee extensors were measured prior to maximal knee extensions as well as prior to and after the cycling sprints. Average crank power, cadence and EMG amplitude for vastus lateralis (VL), rectus femoris (RF), biceps femoris (HAM), gastrocnemius (GAS) and gluteus maximus (GMAX) were calculated during the 30-s cycling sprints. Mean ± SD values are reported. RESULTS: MVF (218 ± 109 N vs. 507 ± 193 N), Qtw (77 ± 26 N vs. 137 ± 41 N) and VA (59 ± 19% vs. 90 ± 6%) were all lower following maximal knee extensions compared to control ($P < 0.05$). Crank power (541 ± 132 W vs. 654 ± 160 W), cadence (88 ± 5 rpm vs. 95 ± 4 rpm), knee extensor EMG (RF: -16 ± 12%, VL: -9 ± 10%) and EMG of HAM (-21 ± 8%), GMAX (-14 ± 13%) and GAS (-12 ± 13%) were lower during the cycling sprint performed after maximal knee extensions compared to the control sprint ($P < 0.05$). MVF (283 ± 86 N vs. 460 ± 157 N), Qtw (60 ± 20 N vs. 89 ± 27 N) and VA (75 ± 11% vs. 94 ± 3%) remained lower after the sprint performed following maximal knee extensions compared to the control sprint ($P < 0.05$). CONCLUSION: Completion of maximal bilateral knee extensions resulted in substantial levels of peripheral and central fatigue in the knee extensor muscles which decreased crank power during the subsequent sprint. However, reductions in the activity levels of GMAX, HAM and GAS during the sprint are also likely to have contributed to decreased crank power. Therefore, large reductions in the force-generating capacity of the knee extensor muscles (-52 ± 22%) may have a relatively small contribution to decreases in crank power (-17 ± 8%) during sprint cycling. REFERENCES: [1] Fernandez del Olmo, et al.,Scand J Med Sci Sports, 2013. 23(1): p. 57-65; [2] Zajac, et al.,Gait Posture, 2002. 16(3): p. 215-32.

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P3-B-28 Changes in postural control and dual task performance following an ultramarathon

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BACKGROUND AND AIM: Postural control following endurance events has not been well studied. The aim was to investigate the effect of a single bout of prolonged aerobic exercise on traditional measures of postural control and dual task performance following a 27-km or 50-km trail race. METHODS: Twelve 50-km and two 27-km runners (age = 40.1 (11.8) years, race time = 6.5 (1.9) hours) completed postural and dual task measures on a VSR sport forceplate (Natus Medical Inc) the day before and immediately following the race. Postural conditions included standing eyes open or closed, on either the flat plate or foam, for 40 seconds. Dual task performance involved completing a two-choice reaction time test while standing on the flat plate or foam for 80 seconds. Postural variables included anterior-posterior (AP) and mediolateral (ML) path length, velocity, root mean square (RMS) and median frequency based upon center of pressure (COP). Statistical analysis was performed using a 3 factor ANOVA with repeated measures (pre-post, eyes open-closed, flat-foam surface). Dual task analysis was also conducted with a 3 factor ANOVA with repeated measures (pre-post, dual-non dual task, flat-foam surface). RESULTS: Significant ($p<.05$) differences in postural control were observed before versus after the ultramarathon. AP path length ($p=0.017$), AP velocity ($p=0.017$), and AP RMS ($p=0.022$) all increased after running. ML RMS ($p=0.010$) and ML median frequency ($p=0.004$) both reduced after running. Dual task analysis showed a pre-post by task interaction for ML RMS ($p=0.026$) demonstrating that performing a two-choice reaction task increased ML RMS compared to a reduction in RMS under non-dual task conditions. Reaction times were not significantly altered between pre-post or surface conditions. CONCLUSIONS: These data demonstrate that following an endurance run, postural sway in the AP direction is magnified. Additionally, ML sway reduced in both frequency and magnitude following the run, but a two choice reaction task produced an opposing impact on the control of ML RMS. Further studies are required to determine the duration of the effect.

P3-B-29 Kinematics Comparison between Dominant and Non-Dominant Lower Limbs in Thai Boxing

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Title: Kinematics Comparison between Dominant and Non-Dominant Lower Limbs in Thai Boxing Abstract: BACKGROUND AND AIM: Muay Thai, also known as Thai Boxing, is

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Thailand's national sport, and it involves athletes using different stand-up striking and clinching techniques. There are a limited number of research studies that have examined Thai Boxing skills and specifically none have examined the kinematics of the dominant and non-dominant legs while in a double collar or double underhook clinching position. The purpose of the study was to investigate the kinematics of the dominant (right) and non-dominant leg (left) between the double collar and double underhook Thai Boxing clinching positions. METHODS: Participants executed six continuous knee strikes with the dominant leg and non-dominant leg in each of the two clinching positions for twelve knee strikes. A standard two-dimensional video motion analysis was conducted. RESULTS: The results revealed statistical significant difference at the hip joint angle between both clinching positions (p = .013) but not at the knee and ankle joints. There were no statistical significant differences in the joint angular velocity and acceleration for the hip, knee, and ankle joint between both clinching positions. However, there was a statistical significant difference found in the joint angular velocity for the knee joint (p = 0.00) between the dominant and non- dominant leg. Lastly, there was a significant correlation of the joint angle (r = 0.65 and 0.63; double collar and double underhook) and the angular velocity (r = 0.76 and 0.67; double collar and double underhook) for the left and right knee between both clinching positions. In addition, there was a significant correlation of the joint angle between the left and right hip (r = 0.66) for the double collar position but not for the double underhook position. CONCLUSION: This study demonstrates the importance of hip joint flexibility and the angular velocity of the knee between the dominant and non-dominant leg. Future research studies investigating the impact of the knee at the point of contact in the Thai Boxing clinch positions among group of elite mixed martial arts athletes are warranted.

P3-B-30 Forearm muscle function investigated by EMG in tennis players suffering from tennis elbow

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BACKGROUND There is no consensus about the main aetiology of Lateral Epicondylitis (LE) or Tennis Elbow. While electromyographic assessment of alterations in neuromuscular control and activation patterns of forearm muscles has received increasing interest as potential intrinsic factors in non-tennis players, there has been insufficient attention in tennis players. The purpose of present review was to search the literature for the electromyographic studies of forearm muscles in tennis players in order to (1) identify related implications for LE, (2) highlight key technical and methodological shortcomings, and (3) suggest potential

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pathways for future research. METHODS An electronic search of PubMed, Scopus, Web of Science, and Google Scholars (1980 to October 2014) was conducted. Titles, abstracts, and full-text articles were screened to identify "peer-reviewed" studies specifically looking into "electromyographic assessment of forearm muscles" in "tennis players". RESULTS After screening 104 articles, 13 original articles were considered in the main review involving a total of 216 participants (78% male, 22% female). There were indications of increased wrist extensor activity in all tennis strokes and less experienced single-handed players, however with insufficient evidence to support their relationship with the development of LE. Studies varied widely in study population, sample size, gender, level of tennis skills, electrode type, forearm muscles studied, EMG recording protocol, EMG normalisation method, and reported parameters. As a result, it was not possible to present combined results of existing studies and draw concrete conclusions in terms of clinical implications of findings. CONCLUSION There is a need for establishment of specific guidelines and recommendations for EMG assessment of forearm musculature particularly in terms of electrode and muscle selection. Further studies of both healthy controls and tennis players suffering from LE with adequate sample sizes and well-defined demographics are warranted.

P3-B-31 Neuromuscular efficiency of trunk muscles is decreased during an acute pain episode in low back pain patients

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AIM: Accepted pain models suggest a centrally controlled strategy of trunk stiffening in LBP, however, supporting evidence is limited mainly to isometric measurements. Based on indications of an impaired neuromuscular efficiency (NME, amount of muscular activation needed to generate force) in LBP, a dynamic protocol comparing relative trunk muscle activity during submaximal voluntary contractions (SMVC) may be a promising alternative. This study investigated the influence of acute LBP on neuromuscular efficiency and activation pattern of trunk muscles during dynamic trunk extensions. METHODS: Eight LBP patients (3 males: 38±16 yrs, 89±8 kg, 1.90±0.11 m; 5 females: 44±12 yrs, 57±12 kg, 1.62±0.06 m) were measured in test-retest design (38±30 d in between) during acute pain (AP, pain level 36±17/100 VAS, Korff>1) and after remission of pain (NP, 7±6/100 VAS, Korff<1) (mean±SD). Participants were equipped with a 12-lead bilateral SEMG (myon m320, myon AG, Switzerland) on trunk extensors (M. erector spinae L3/Th9 (ESL/EST), M. latissimus dorsi (LD)) and flexors (M. rectus abdominis, Mm. obliquus externus/internus). The protocol consisted of isokinetic concentric trunk strength tests (Con-Trex MJ, TP 1000 module, Physiomed AG, Germany) in standing position (ROM: 45° flexion to 10° extension, velocity: 45°/s): warm-up, 5 MVC, each 5 SMVC with bio feedback at 20, 40, 60 and 80% MVC peak torque [Nm], and another 5 MVC for fatigue control. EMG amplitudes (isokinetic phase, RMS [V]) of extensors

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during rest and SMVC trials were normalized to MVC activity [%]. Then, all back muscles averaged (ALLext) were compared by paired t-test (AP, NP) and two-way repeated measures 2 (AP, NP) x 5 (rest, SMVC20-80) ANOVA for an effect of pain status over SMVC loads (α=.05). Similarly, co-activation of abdominal muscles (ALLflx, % agonistic peak activity) and of synergistic back muscles (% overall trunk extension activity) was analysed. RESULTS: Peak torque of MVC was 200±66 Nm (AP) and 211±58 (NP). Normalized EMG values of ALLext showed on average 10±6% higher activity values during AP compared to NP, resulting in a statistical significant difference at SMVC80 (17±12%, p<.01) and an aggregated pain*load interaction effect of F(1,4)=4.377, p<.01. Co-activation of ALLflx was always higher during AP (23±11%) compared to NP, however, differences stayed below level of significance. Individual synergistic contribution was higher for EST (p<.05 at rest and SMVC40-80), lower for ESL (p<.05 at SMVC80) and at lower intensities for LD (p<.05 at rest and SMVC20), resulting in a statistical significant pain*load interaction effect for LD only (F(1,5)=4.415, p<.05). CONCLUSION: NME of trunk extensors has been found to be decreased during acute LBP. This was accompanied by hyperactivity of extensors and flexors, and a redistribution of synergistic extensors towards increased thoracic activity. The results support LBP intervention strategies focusing on neuromuscular trunk control.

P3-B-32 Drop jump kinematic curves differ for ACL-deficient and ACL-reconstructed individuals ~20 years post-injury compared to controls

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Purpose: Unilateral anterior cruciate ligament (ACL) ruptures can influence not only one-legged tasks, but also two-legged dynamic movements decades after rehabilitation. Our aim was to examine and compare drop-jump kinematic curves between and within ACL-reconstructed, ACL-deficient, and non-injured controls. Methods: Subjects with ACL ruptures treated on average 23 (16-29) years ago conservatively with physiotherapy only (ACLPT, n = 26) or in combination with reconstructive surgery (ACLR, n=28) and age- and sex matched controls (n=25) performed a drop jump from a height of 40 cm. 3D knee-, hip-, and trunk-kinematics and jump height were captured (8 Oqus cameras, 240 Hz, Qualisys AB) and the time from the box landing to the lowest position of the pelvis upon landing from the rebound jump was analyzed with a 6 degrees of freedom model. Knee separation curves were also calculated as the distance between the two knee-joint centers divided by the distance between the two hip-joint centers to reflect a measure of the dynamic valgus. Kinematic curves were subsequently compared using functional data analysis (ANOVA) methods within-groups (i.e., comparing between legs) and between-groups (i.e., comparing

the injured [and non-injured] legs of ACL subjects to the non-dominant [and dominant] legs of controls). Level of statistical significance was set to $p < 0.05$. Results: The ACL-treated groups landed from the box with lesser knee and hip flexion in both legs than controls. In addition, ACL groups had greater external rotation at the knee for their injured leg compared to the non-dominant leg of controls during the initial phases of both landings. The ACL groups also exhibited greater dynamic valgus during the flight phase and while landing from the rebound jump. Furthermore, ACLR landed from the box with lesser trunk flexion than controls. Between-leg differences were not detected, except for in ACLR where the injured leg exhibited greater hip internal rotation than the non-injured leg during most of the drop jump. Compared to controls, the deviations in movement curves were more pronounced in ACLPT at the knee, while they were more evident in ACLR at the hip. Controls (37 cm) had a higher mean jump height than ACLPT (31 cm), but not when compared to ACLR (34 cm). Conclusions: Specific functional deviations from controls during the drop-jump task were detected ~20 years post-ACL rupture independent of treatment, while no marked differences were observed between ACLR and ACLPT. However, the different patterns exhibited in hip and knee kinematics compared to controls for ACLR and ACLPT possibly reflected distinct compensatory mechanisms in these two groups. Analyzing the entire drop-jump kinematic curves, rather than just when landing from the box, provided additional insight into potential coping mechanisms and compensatory strategies that might have otherwise been missed using traditional statistical approaches.

P3-C-33 Modulations of correlated neural oscillations for improving muscle coactivation control due to repetition and practice

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BACKGROUND AND AIM: Voluntary muscle contraction often involves correlated neural oscillations including "common drive" (<5 Hz). The purpose of this study was to clarify the modulations of correlated neural oscillations that may accompany the improvement of coactivation control of antagonist muscles due to a repetition or a bout of practice. METHODS: Sixty healthy young adults (22.5 ± 3.0 years old) were divided into 3 groups: Co-activation, Contraction, and Control. All participants completed a target-reaching test before and after a bout of practice using the amplitude of surface EMG (AEMG) of biceps brachii (BB) and triceps brachii (TB). EMG was also collected from brachioradialis (BR). In the test,

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target was divided into a varying-level coactivation, followed by a constant-level coactivation. BB and TB had opposite target levels (4% and 12% of maximum AEMG). During the practice period, Coactivation group practiced repetitive varying-level activation for both muscles at a time; Contraction group practiced with agonist contractions at a time; Control group rested without voluntary contractions. RESULTS: In varying-level coactivation comparing before and after the practice period, mean squared error of AEMG decreased by 21% ($P < 0.01$) and latency of reaching target decreased by 230 ms (by 17%, $P < 0.01$) across groups, with no significant change for variability. Negative peak in cross-correlation function (CCF) was observed in rectified EMG at low frequency (0.5-5 Hz) between the antagonist pairs in varying-level coactivation with opposing orientation. After the practice period, the negative peak became more negative by ~47% ($P < 0. 01$) for both BB-TB and BR-TB pairs. In constant-level coactivation, mean squared error and variance of AEMG decreased by 20% ($P < 0.01$) and 17% ($P < 0.01$), respectively, across groups after the practice period. Positive peak in CCF (rectified EMG, 0.5-5 Hz) was observed between the involved muscle pairs, and it decreased by 18% ($P < 0.01$) for BB-BR pair, 19% ($P < 0.01$) for BR-TR pair, and 10% ($P = 0.067$) for BR-TR pair after the practice period. Improvements of AEMG adjustment specifically in Coactivation group were evident only for varying-level coactivation, but they did not accompany a unique change in CCF between EMGs. CONCLUSION: All three groups improved coactivation control of antagonist muscles just due to a repetition. Presence and associated increase in the negative coupling between antagonist muscles suggests the potential involvement of low-frequency reciprocal coupling for reaching opposing targets faster and more accurately. Associated reduction in the positive coupling across muscles during constant-level coactivation suggests the reduced common drive for maintaining distinct activation levels between muscles. Modulations of these intermuscular coupling are achieved by a simple repetition and not to be further enhanced with a bout of Coactivation practice. Supported by NSF IIS 1317718

P3-C-34 Neural control of human precision and power grips

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Current evidence supports the view that distinct descending motor pathways contribute to the control of hand motoneurons during different grip configurations. For example, studies in non-human primates demonstrated that cortico-motoneuronal cells preferentially discharge during fine precision grip but to a much lesser extent during a power grip. Here, we examined the contribution of the corticospinal pathway, and cortical and subcortical mechanisms to the control of precision and power grip in intact humans. Using motor cortical and cervicomedullary stimulation, we measured motor evoked potentials (MEPs), cervicomedullary MEPs (CMEPs), and the activity in intracortical circuits (suppression of voluntary electromyography, svEMG) in the first dorsal interosseous (FDI) muscle during

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index finger abduction (control task), precision grip of a small cylinder between the index finger and thumb, and power grip at matched levels of background EMG activity in the FDI muscle. We found that MEP size decreased during precision (by 26.5 ± 19.9%) and power (by 48.1 ± 19.3%) grip compared with index finger abduction. MEP suppression was larger during power compared to precision grip ($p < 0.001$). Notably, MEP latency was delayed during power grip (by 0.6 ± 0.4 ms) compared to the other tasks. CMEPs were suppressed during precision (by 33.4 ± 21.7%) and power (by 36.4 ± 16.6%) grip to a similar extent compared to index finger abduction. Whereas the svEMG decreased to a larger extent during power (by 49.1 ± 18.0%) than precision (by 28.1 ± 23.7%) grip compared with index finger abduction and these changes correlated with changes in MEP size. Altogether our results support the view that different descending motor pathways contribute to the control of precision and power grip in intact humans.

P3-C-35 Test-retest reliability of a novel supine knee joint position sense test.

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BACKGROUND AND AIM: Knee joint proprioception is believed to be a key factor regarding knee injury prevention and knee function outcome following rehabilitation from, e.g. anterior cruciate ligament (ACL) injury. Joint position sense (JPS), the ability to reproduce a joint angle, is a common way to assess proprioception ability. However, no gold standard to validly and reliably assess knee JPS exists. Our aim was to investigate the test-retest reliability of a new supine knee active-active JPS test. METHODS: Fifteen physically-active young adults (18-27 yrs) have so far been tested on two occasions (7-30 days between). Participants lay supine with legs at approximately 100° knee flexion and feet strapped to a custom-built manual leg extension/flexion device. Using the dominant leg, three full active leg extension/flexion practice trials were performed at an attempted knee angular velocity of 10°/s during extension with real-time feedback. This angular velocity was attempted for all test trials during extension but without visual feedback. Participants then performed ten test trials by extending the leg until receiving a visual stop cue at a knee flexion angle unknown to them (40° or 65° knee flexion). Once static they pressed a hand-held trigger to confirm the knee target angle (TA). After two seconds they flexed the leg back to the start position then extended the leg to the believed TA, stopped and pressed the trigger. This position was denoted the knee reproduction angle (RA). The protocol was repeated with the non-dominant leg. An eight-camera motion capture system (Oqus, Qualisys, 240 Hz) calculated knee angles from six retro-reflective markers. Absolute error (AE), the difference between the TA and RA of a trial, was calculated for all trials. The mean AE of the five trials for both angle conditions for each leg was used for analysis. Relative reliability and absolute reliability were

assessed using intraclass correlation coefficients (ICC) and standard error of measurement (SEM), respectively. Analysis of variable error (VE) and constant error (CE) are underway. RESULTS: Results suggest high reliability for the 65° knee angle condition using the non-dominant leg (ICC = 0.72, SEM = 0.72°). Moderate reliability was seen for 40° (ICC = 0.58, SEM = 0.70°) and 65° (ICC = 0.55, SEM = 0.90°) using the dominant leg. Lower reliability was seen for 40° using the non-dominant leg (ICC = 0.38, SEM = 1.31°). CONCLUSIONS: Preliminary results suggest low to high reliability for this supine knee JPS test. Ongoing data collection will increase the current sample size and further analyses will include variable and constant error and the ability of participants to maintain the desired knee extension angular velocity and its effect on error. If showing sufficient reliability, the test should be validated by also being tested on individuals believed to have knee proprioception deficits, i.e. ACL-injured persons, and be compared to existing knee JPS tests.

P3-C-36 Does the motor cortex contribute to electrically-evoked contractions in humans?

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BACKGROUND AND AIM: Neuromuscular electrical stimulation (NMES) generates contractions by depolarising motor axons beneath the stimulating electrodes. Thus, the signals that produce these contractions traverse a purely "peripheral" pathway. However, we have shown that "central pathways" can also contribute to contractions produced by NMES, when the depolarisation of sensory axons recruits motor neurons via spinal reflex pathways. Presently, we investigate whether the central pathways that contribute to contractions produced by NMES involve "long-loop" transmission through the motor cortex. One way to assess this cortical contribution is by using subthreshold transcranial magnetic stimulation (sTMS), whereby TMS intensity is set below motor threshold (MT). sTMS has been shown to suppress electromyographic activity (EMG) during voluntary contractions (VOL) by reducing the output of the motor cortex. In this way, suppression of EMG by sTMS indicates a cortical contribution to muscle contractions. The purpose the present study was to examine if the motor cortex contributes to contractions elicited by NMES and, if so, to compare the relative amounts of cortical contribution during NMES and VOL. We hypothesized that suppression of EMG by sTMS would be present during both NMES and VOL, however, we expected that a greater amount of suppression would occur during VOL. METHODS: EMG was recorded from the right tibialis anterior (TA) muscle in four healthy volunteers with no known neurological impairment. 100 pulses of sTMS (figure-eight coil; ~73% MT) were delivered over the left motor cortex while subjects received five 60 s trains of NMES (100 Hz, 1 ms pulse duration) over the right common peroneal nerve or while subjects held a VOL contraction of similar

amplitude. NMES and VOL were matched by the level of background EMG in the TA. EMG suppression was considered to be statistically significant when the level of EMG fell below two standard deviations of the mean background EMG. The magnitude of this suppression was quantified as the duration (ms) and amplitude (mV) of EMG below the level of the two standard deviations. RESULTS: A significant suppression of the EMG was present in two subjects during NMES, and in three subjects during VOL. In the two subjects exhibiting suppression during NMES, the amplitude and duration of suppression were 0.02 ± 0.02 mV and 15.10 ± 11.17 ms, respectively. In the three subjects exhibiting suppression during VOL, the the mean amplitude and duration of suppression were 0.14 ± 0.06 mV and 21.73 ± 6.64 ms, respectively. CONCLUSION: These data suggest that transmission along pathways traversing the motor cortex contribute to NMES contractions in some participants. However, these data also suggest a greater cortical contribution occurs during VOL versus contractions of equal amplitude produced by NMES. It is likely that spinal pathways also contribute to NMES contractions, resulting in a lesser reliance on cortical output.

P3-C-37 Is human walking behavior better predicted by energetics or stability: a case-study involving human-structure interactions

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BACKGROUND AND AIM: Large lateral oscillations of bridges and walkways due to pedestrian synchronization have been observed in many cases, the most famous example of such an event occurred on the opening day of the London Millennium Bridge. Data from such events could provide useful ways to test control strategies for bipeds. Here we develop two different strategies and compare their outcomes for simulated pedestrians. METHODS: 1) We determine a steady-state strategy for a biped walking on a laterally-oscillating platform using minimization of metabolic cost of transport. 2) We determine feedback control strategy using data from 'perturbation experiments' and apply this controller to humans walking on an oscillating platform. RESULTS: Minimization of metabolic cost of transport suggest that for a simple point-mass biped with massless legs, a) walking on a shaken platform (similar to a laterally oscillating treadmill) reduces energy costs below that of normal walking, and b) walking while shaking a shakeable platform (similar to a bridge or walkway) only reduces energy costs below normal if a sufficient number of people are walking on the bridge. These results suggest that energy optimality could explain why pedestrians walk in sync on a laterally oscillating platform, but do not accurately predict the critical number of pedestrians required to switch from a non-oscillating to an oscillating solution for bridges. We will present how a simple feedback controller to stabilize walking, when coupled to a shaking platform or a bridge, results in a wide-stepping walking behavior,

as seen in experiments. Through numerical simulations, we seek conditions under which a large number of pedestrians coupled together by a bridge will synchronize sufficiently to shake the bridge. CONCLUSIONS: Energy optimality on its own is sufficient to generate behavior similar to human beings in unusual scenarios such as walking on laterally shaking platforms even for simple point-mass models. A feedback controller based on walking stability might independently provide similar results. This work was supported in part by National Science Foundation grant no. 1254842.

P3-C-38 FES Control for Restoring Complex Functional Hindlimb Movements in the Rat

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Interventions to restore voluntary movement for patients with spinal cord injuries are limited. Functional electric stimulation (FES) of intact nerves or muscles can produce limb movements, but users' ability to control FES is minimal. We are examining the means to restore voluntary movement using cortically-controlled FES, in which a user's intended movements are estimated from cortical activity and then used to drive electrical stimulation of muscles. In previous work we have demonstrated that monkeys can use a cortically-controlled FES system to produce voluntary movements after a transient, nerve-block paralysis. The next step, application to actual spinal cord injury, is difficult in a monkey model. We are therefore developing a rat model of cortically-controlled FES with the ultimate goal of demonstrating the ability of this approach to restore voluntary locomotion after spinal cord injury. Within this larger goal, we are first establishing techniques for producing functional movements in the rat hindlimb. In previous work, we have demonstrated the ability to produce a range of endpoint forces through activation of multiple hindlimb muscles. We extend that work here in order to produce functional hindlimb movements, analogous to those produced during natural behavior. In preliminary experiments in a sedated rat, we stimulated flexors and extensors in isolation to produce simple unilateral locomotor movements. We used trains of stimulation (50Hz, 0.2-0.5ms, 1-4mA), alternately stimulating the flexor and extensor muscles at the hip, knee, and ankle to cycle the hindlimb through a smooth, repetitive stepping motion. We were able to control functional parameters of the evoked movements, such as step height and length, by varying the stimulation strength applied to individual muscles. These results demonstrate that our previous work showing good force control can be extended to the control of functional movements. In addition to controlling kinematic parameters of evoked movements, we will also measure ground-reaction and propulsive forces in order to demonstrate the feasibility of FES in a weight-bearing context. We will evaluate the consequences of increasing the

complexity of the commands applied to muscles, starting with simple alternation between flexors and extensors and then progressing to commands mimicking those observed from EMGs recorded during natural behaviors. We will also evaluate the minimal set of muscles that can be used to produce adequate control, and how muscle fatigue caused by repeated stimulation affects our ability to produce functional movements. These experiments will yield important information about the use of FES for the restoration of voluntary movement following spinal cord injury. This sophisticated degree of open-loop control of hindlimb motion is a necessary and significant step towards closed-loop control by the rat, achieved through cortically-controlled FES.

P3-C-39 Muscular reflex responses of trunk and lower limb muscles following unexpected gait perturbations in people with and without back pain

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BACKGROUND AND AIM: Poor neuromuscular control of the trunk has been identified in people with back pain. Altered muscle recruitment pattern and activation levels at the trunk were found in response to sudden loading situations. However, investigations were mostly restricted to isolated and quasi-static trunk loading experiments. It remains unclear, whether these alterations are limited to the trunk in more functional situations e.g. when sudden loadings are initiated via the extremities. Therefore, this study aimed to investigate muscular reflex responses at the trunk and lower limbs following unexpected gait perturbations in people with and without back pain. METHODS: 25 subjects with back pain (BP; 9 males, 16 females; 31±9 yrs; 73±14 kg; 1.75±0.12 m; characteristic pain intensity scale ≥30 (out of the graded chronic pain scale; von Korff)) and 29 asymptomatic controls (CTRL; 13 males, 16 females; 26±7 yrs; 72±12 kg; 1.75±0.11 m; characteristic pain intensity scale ≤10) were measured in a cross-sectional study design. Following a familiarization to treadmill walking (1 m/s; 5 min; unperturbed gait), all subjects underwent an eight minute perturbation protocol on a split-belt treadmill releasing 15 superimposed right-sided perturbations (deceleration, 40 m/s2, 50 ms duration; 200 ms after initial heel contact). Surface EMG of the trunk was recorded from 12 trunk muscles (right/left): rectus abdominus, obliquus externus/internus, latissimus dorsi, erector spinae at level L3 and Th9. Surface EMG of the lower extremities was recorded from 4 leg muscles (right): vastus medialis, biceps femoris, peroneus longus and tibialis anterior. For data analysis muscles were pooled into four trunk groups: ventral left (VL), ventral right (VR), dorsal left (DL), dorsal right (DR); and 2 leg groups (right side): upper leg (UL) and lower leg (LL). Latencies [ms] of muscular activity in response to perturbations were analyzed descriptively (mean ± SD) and tested by multiple analysis of

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variance (MANOVA, α=.05) between BP and CTRL. RESULTS: EMG latencies reached in mean 93±10 ms at the trunk for BP and 85±7 ms for CTRL, whereas latencies at the leg showed in mean 83±1 ms for BP and 79±4 ms for CTRL. Latencies were longer in BP compared to CTRL in all muscle groups. However, statistically significant differences (MANOVA, $p<.05$) were only found for the trunk at VL ($p<.01$), VR ($p<.01$) and DR ($p<.05$). CONCLUSIONS: People with back pain revealed altered muscular reflex activities in response to sudden loadings during gait. Though perturbations were initiated by lower extremities, delayed muscle activations were exclusively evident at the trunk. These findings may indicate that muscular reflex activities are predominantly altered at the area of pain in people with back pain. Thereby, rehabilitation of back pain should especially target neuromuscular control of the trunk.

P3-C-40 Impact of neck muscle fatigue on scapulohumeral kinematics in subclinical neck pain pain vs asymptomatic controls

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BACKGROUND: The cervical spine and shoulder girdle are linked structurally and functionally. Scapular orientation is highly dependent upon functioning of the axioscapular musculature, and impairments in these muscles can lead to scapular dyskinesia. It is well documented that chronic neck pain (CNP) patients exhibit dysfunction in cervical spine biomechanics and motor patterns. However, to date the effects of CNP on scapulohumeral kinematics has had limited investigation. Previous studies are also limited because they constrained the shoulder movement to single plane, making it hard to determine if there are differences in shoulder kinematics when participants move naturally, without imposed constraints. We hypothesized that pain in the cervical spine could lead to alteration in the kinematics of the shoulder girdle and that fatigue would alter kinematics in the healthy group to a greater degree than in the neck pain group. METHODS: A three-dimensional analysis of scapulohumeral kinematics was performed during three repetitions of an arm elevation task to approximately 120 degrees in the scapular plane (35-40 degrees anterior to the coronal plane) performed at the participant's self-selected pace in 10 CNP participants and 10 healthy controls. Fatigue of the cervical extensor muscles was induced using repetitive, submaximal isometric contractions (6 s repetitions including 1 second ramp up, 3 s hold at 70% of maximal voluntary effort, and a 2 second rest). RESULTS: There were significant baseline differences in humeral elevation angle between healthy and CNP participants. The pre-fatigue kinematics also differed between the two groups. During humeral elevation, control participants start more purely in

abduction in the first phases of the movement and this continues in the middle phases; whereas in the final phases, the humerus moved more into flexion. In contrast, humeral elevation angle for the CNP group stayed constant in the first and middle phases; moving more toward flexion, similar to controls only in the final phase. The CNP group also displayed less lateral scapular rotation, posterior scapular tilt and external scapular rotation relative to control group throughout humeral abduction. Fatigue significantly altered humeral elevation angle for the healthy group, with no significant effects on the CNP group. Fatigue caused the healthy group to start with the humerus in a more abducted position, while the CNP did not change significantly from the pre-fatigue state. DISCUSSION: Mild to moderate neck pain alters shoulder kinematics, due at least in part to altered scapulo-humeral coupling. The scapular kinematics seen in the CNP group are similar to those in patients with sub-acromial impingement, suggesting that CNP may be a risk factor for shoulder conditions. As hypothesized fatigue impacted shoulder kinematics more in healthy participants, possibly because CNP leads to similar neuromuscular compensations as fatigue.

P3-C-41 Joint learning during dyadic haptic interaction

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BACKGROUND AND AIM: In the last decade there has been a growing interest in studying physical coupling between humans or humans and machines. Having a machine capable of understanding the intention of a movement and interactively cooperate with a human is among the frontiers of the research in robotics as well as rehabilitation. Even if physical coupling between two subjects was shown to be an advantageous solution in many cooperative contexts, little is known about how two people mutually exchange information to exploit the coupling. This work investigated the ability of subjects to learn a novel skill and adapt their knowledge to a cooperative context that requires negotiating a common strategy while being physically coupled. The study mainly focuses on how learning develops in a context where training on a novel skill occurs in pairs. METHODS: We asked subjects to learn to jointly manipulate a compliant tool under the action of an unstable force-field, rendered by a haptic bimanual interface. The dynamics of the tool allows the dyads to select multiple control strategies to accomplish the task. In order to characterize the learning process in the dyad, we compared the case of two interacting individuals to one individual alone. To test the priming impact of an existing knowledge of the tool dynamics we considered the following experimental conditions: i) both the interacting subjects in the dyads have individually experienced the tool dynamics before (solo condition), ii) one of the subjects is an expert in the solo condition while the other lacks any previous experience, iii) one of the

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subjects is an expert in the solo condition while the other has experienced the solo condition. The subjects practiced a reaching task for 4 days. On the fifth day we evaluated the ability of each dyad to perform a tracking task and the reaching task in the solo condition. The former task aimed at testing if the acquired skill could be generalized to a novel task. The latter served to evaluate whether the shared internal representation of the task could be sufficiently accurate to allow for a solo execution. The analyses were conducted on the end-effector kinematics and the electromyographic signals from 10 relevant muscles of the arm and trunk. RESULTS:The results show that the initial skill level has a strong impact on the development of a correct representation of the dynamics of the task. In particular the interaction with an expert in the absence of prior experience is detrimental. Conversely, having previously experienced the task dynamics unbiased by the action of the partner leads to the greatest performance benefit among the tested conditions. CONCLUSIONS:Skill learning in a shared context is possible and can be exploited by the individual. However, in contrast with what previously reported, physical interactions are not always beneficial to the performance of the interacting individuals, which appears to be strictly dependent on prior experience.

P3-C-42 Effects of a compression garment on sensory feedback transmission in the upper limb

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BACKGROUND AND AIM: Cutaneous feedback from the skin provides perceptual information about joint position and movement. Integrated with other sensory modalities, cutaneous feedback informs judgements of position and movement around joints. Currently, it remains unknown if a constant tactile input via compression apparel can alter excitability of muscle afferent feedback. Thus, the purpose of the current experiment was to: 1) Examine if sustained input to the skin via compression garment modulates sensory feedback transmission in the upper limb. 2) Examine if altered transmission is task or phase dependent and accompanied by improved task performance. METHODS: On separate days, neurologically intact participants completed two distinct parts of the experiment. Each part was completed under two conditions: CONTROL (no compression), and COMPRESSION (customized compression sleeve applied across the elbow joint). In both parts of the experiment, electromyography (EMG) of the flexor and extensor carpi radialis (FCR and ECR) was assessed. Stimulation was provided to the median nerve (single 1-ms pulse) just proximal to the elbow to elicit H-reflexes in the FCR. In part 1, constant m-wave (motor response) matched h- reflexes and M-H recruitment curves were elicited during separate

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trials at rest, 10% wrist flexion, superficial radial (SR) nerve conditioning during 10% wrist flexion, and distal median nerve (dMED) conditioning during 10% wrist flexion. Conditioning stimulation was provided 37 ms prior to median nerve stimulation above the elbow. Cutaneous reflexes were evoked during 10% wrist flexion via stimulation of the superficial radial (SR) and distal median (dMED) nerves (3xRT for 5x1 ms @ 300 Hz). In part 2, M-H recruitment curves and constant m-wave matched h-reflexes were elicited during 10% wrist flexion, during arm-cycling at 60rpm and during a discrete reaching task. Reflexes were assessed at two specific phases (3 and 6 o'clock) for both arm-cycling and discrete reaching. All responses were normalized to maximally evoked m-waves. RESULTS: Combined results from parts 1 and 2 suggests that constant tactile input to the skin via compression garment reduces the gain of sensory feedback transmission from muscle afferents. These effects appear regardless of conditioning input or movement task. Accuracy of reaching movements and determination of movement endpoint were improved while wearing the compression sleeve. CONCLUSIONS: These results are indicative of segmental changes in spinal reflex excitability independent from muscular changes or descending input. Providing compression around a joint appears to increase the precision and sensitivity of sensorimotor integration where the sleeve is applied.

P3-C-43 Human upright, postural control: Is sagital centre of mass location controlled to a prior?

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BACKGROUND AND AIM: Posture is generally considered a flexible resource to be adapted as required. Furthermore, in symmetrical human standing, biomechanical mechanisms provide no stable sagittal location for the centre of mass relative to the ankle joints (CoMx). CoMx is biomechanically unstable with respect to the ankle and regulation of CoMx requires neural feedback control. Sensorimotor control is increasingly established as using Bayesian processes in which prior expectations stored in the nervous system are combined with online sensory input. We predict that the nervous system stores an expectation of the normal CoMx location and that posture is estimated and controlled in relation to that prior expectation. We define a prior as a pre-existing desired configuration of the body, which muscle activity is regulated to reproduce. With respect to CoMx the prior is defined as a statistical distribution (mean, standard deviation) which exists outside (before, during, after) the task and is reproduced consistently during task performance. METHODS: To test the hypothesis that CoMx is regulated to a stable prior fourteen participants participated in two tasks (free standing, and perturbed standing). Whole body movement was recorded (Vicon). We tested CoMx for significant difference between tasks. Free standing: Participants stood normally for

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18 s after walking onto a force plate. Walking onto the force plate ensured the initial state had variable altered configuration. Two initial and two later repetitions were separated by the second perturbation experiment which, including setting up, occupied about 30 minutes. CoMx was sampled in three intervals (0-0.05 s, 0.6-5.6 s, 5.6-17.6 s). Perturbed standing: Participants stood for two trials of 210 s, each containing 32 gentle, discrete, asymetric, forward sagittal pulls, randomised in size, duration and leg (2-10 N, 0.2-2 s, right/left) that were delivered at the knee. The apparatus allowed unimpeded movement while standing quietly, could generate a sudden gentle force when required and provided no position information 1. CoMx was sampled prior to every perturbation. RESULTS: During free standing, after an initial positioning of the CoMx which was closer to the ankle joint centre, participants adopted a sustained location which differed from the initial locations but did not differ between repetitions or between tasks. By contrast, ankle dorsiflexion differed between tasks and head extension differed between repetitions of free standing. CONCLUSIONS: These results provide behavioural evidence for a prior sagittal location of the CoM stored within the nervous system and reproduced consistently between tasks and between repetitions of the standing tasks despite extended application of mechanical perturbations. 1 Di Giulio, Baltzopoulos, Managanaris & Loram. Human standing: Does the control strategy pre-program a rigid knee? J Appl Physiol, (2013)

P3-D-44 The effects of exercise in combination with other conventional antidepressant therapies in treating individuals suffering with Major Depressive Disorder.

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BACKGROUND AND AIM: Depression is currently the leading cause of disability worldwide and a leading contributor to disease burden globally. Existing antidepressant therapies are far from satisfactory leaving half of the depressed population undertreated. Research has found that exercise is an effective treatment for depression but it is not clear how and why it works. Brain-derived neurotrophic factor (BDNF) is growth factor and a candidate mechanism that has been shown to facilitate the effects of exercise on synaptic plasticity and cognitive function in rodents. The aim of this study is twofold: first, to investigate the additional benefits of an eight week exercise program in combination with other conventional therapies such as antidepressant medication and cognitive behavioural therapy (CBT) in improving

depressive symptoms, anxiety and cognitive function in depressed individuals and second, to investigate the mechanisms associated with the antidepressant effects of exercise. METHODS: Sixteen participants with a clinical diagnosis of Major Depressive Disorder based on the DSM-IV and clinical interview were recruited from the Lakeridge Mental Health Day Treatment (LMHDT) program in Oshawa, Ontario. All participants were taking antidepressant medication for at least six weeks prior to study enrollment. Eight participants were assigned either to an eight week, supervised, moderate intensity exercise program plus CBT group or a CBT only group. Depression scores were determined using the Beck Depression Inventory (BDI), anxiety scores by the Hospital Anxiety Depression Scale (HADS) and recognition memory was determined using the Delayed Matching to Sample task from the Cambridge Neuropsychological Test Automated Battery (CANTAB). BDNF was quantified using participant plasma. All variables were measured at baseline and again at eight weeks. RESULTS: Following the eight weeks of treatment the exercise group showed a greater decrease in depression scores (169% vs 27%, p=.007). There was no significant difference in the decrease in anxiety scores between groups (27% vs 23%, p=.623). The exercise group showed a significant increase in plasma BDNF (p=.003) while the CBT only group showed no change. There were no significant changes in mean recognition memory in either group, however, the exercise group showed a greater decrease in the mean latency to make a correct response (p=.046) suggesting improved cognitive functioning. CONCLUSIONS: This project has the potential to provide a tool to improve exercise prescription, to predict exercise responders and to guide development of combined treatment approaches related to biochemical markers such as BDNF in order to optimize depression outcomes for Canadians.

P3-D-45 Effects of flexion-extension in upper and lower cervical spines on the laterality of upper and lower thoracic shapes

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[Purpose] Typical thoracic shape common to many people is bilaterally asymmetric as reported previously (Hirayama et al., 2013). Thoracic shape varies along with the movements of other parts like upper extremities and cervical region, and vice versa. When an asymmetrical thorax shape is fixed, motion of upper limb or cervical spine is reduced. Restricted cervical movements are often associated with thoracic malfunction, suggesting the presence of kinematic cervicothoracic coupling. We aim to investigate effects of segmental extension or flexion of upper and lower cervical spines on left and right thoracic cross-

sectional areas as representative of thoracic shape. [Methods] Subjects were 12 healthy men, 25.4±3.4 years old. Using 3-D analysis system (QM-3000, Topcon, Japan), the planer horizontal area at upper thorax (3rd limb level) or lower thorax (xiphoid level) were estimated at 5 cervical spine postures of the resting, the upper cervical spine extension and lower cervical spine extension position (UELE), the upper cervical spine flexion and lower cervical spine flexion (UFLF), the upper cervical spine extension position and lower cervical spine flexion (UELF), the upper cervical spine flexion and lower cervical spine extension positions (UFLE). The thorax planar area was divided into left and right by the center of sternum. We estimated lateral cross-sectional areas of the upper and lower thoraxes. Data analysis: paired t-test or two-way ANOVA. [Results] At resting, the cross sectional area at the upper thorax was significantly bigger in the left (7336.8, average in mm2) than the right (6804.8) ($p<0.05$). In contrast, at the lower thorax the right area (13750) was greater than the left (13266) ($p<0.05$), indicating the opposing relationship in asymmetry between upper and lower thoraxes. The bilateral differences in average values of planar areas in each directed posture were estimated: at the upper thorax, 114.4 (mm2) in UELE, 703.5 in UFLF, 704.5 in UELF and 133.1 in UFLE; and at the lower thorax, 129.7 in UELE, 606.2 in UFLF, 836.0 in UELF and 127.2 in UFLE. These changes in difference values suggest that the thoracic asymmetry was diminished upon extension of the lower cervical spine, but augmented upon its flection. Neither extension nor flection in the upper cervical spine affected the thoracic asymmetry. [Conclusion] Results indicate the cervicothoracic coupling with greater contribution of the lower cervical spine than the upper spine, leading to different changes between upper and lower thorax. Extension of lower cervical segment may straighten the thoracic spine and release the back muscle tension to help functional alignment of the rib, thereby diminishing the asymmetry of thoracic shapes to make the respiration easy. Flexion of lower cervical segment may twist the thoracic spine and heighten the back muscle tension to cause a malalignment of the rib, thereby increasing the asymmetry of thoracic shapes to make respiration obstructed.

P3-D-46 Effects of variation in trunk lateral deviation on respiratory function in relation to thicknesses of rectus abdominis and lateral abdominal group muscles

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Introduction/Background: Respiratory function is dependent on thoracic and trunk configurations. Rectus abdominis muscle (RA) and lateral abdominal muscles (LAs) affect the body trunk motion, thereby affecting respiration. Severe asymmetry in body trunk is observed in patients with respiratory dysfunction. Here we investigate the relation of asymmetry of muscle thicknesses (RA and LAs) or body trunk lateral area to respiratory function by deviating the body trunk position at supine to provide a better intervention for breathing problem. Materials and Methods: Subjects were 15 healthy men (27.6 ± 3.1 yo) and laid at supine on adjoining two beds. The border line of two beds perpendicularly crossed the body trunk at 12th rib. Sliding beds across the trunk axis made trunk shape either more bilaterally deviated or neutralized, in comparison with the intrinsically deviated shape of the trunk. Bilateral symmetric property was measured by estimating left and right areas of trunk back surface divided by the trunk axis captured by a digital camera. Using ultrasonography (Preirus, Hitachi), thicknesses of both left and right sides of RA at the center of the 3rd muscle compartment and LAs between the midpoint of the 10th rib lower end and pelvis were measured. Respiratory functions at resting and forced breathing were measured using gas analyzer (TV, MV and RR) and spirometer (VC, FVC, PEFR, %VC, and V25). Data were analyzed by paired t test or multiple comparison using SPSSver18J. Approved by the Ethnic Committee of Bunkyo Gakuin University. Results: At rest without bed sliding, the body trunk was asymmetrically deviated to the left: left area was 3.3% folds greater than right ($P<0.01$). When bed was slid to increase the body asymmetry to the left, muscle thicknesses of both RA and LAs became significantly smaller in the left than the right at the resting (both $P<0.01$) and forced breathing (both $P<0.05$). In contrast, when slid the bed to have bilaterally even trunk posture (neutralized posture), bilateral differences in muscle thicknesses of RA and LAs were abolished. In respiratory function, TV, RR, VC, FVC, PEFR, %VC and V25 were smaller at the increased asymmetric posture than the neutralized posture with bed sliding ($P<0.05$). While, FEV1.0 was smaller at the neutralized posture than the asymmetric posture ($P<0.05$). Conclusion: Results indicate that the increase in the leftward deviation of the trunk reduces RA and LAs thicknesses, being associated with the reduction in expiratory function. While, at the bilaterally even trunk posture, RA and LAs have bilaterally even thicknesses with the better breathing. At normal trunk posture most people have deviation in trunk slightly leftwards. COPD patients often possess severe deformation in trunk configuration both bilaterally and throcoabdominally (Priori et al., 2013). The severe respiratory dysfunction may be associated with the extensive bilateral deviation of the trunk as well as rib cage.

P3-D-47 Difference in the acute effect of kinesthetic illusion induced by visual stimulus and action observation on the upper-limb voluntary movement after stroke: a single-case study

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BACKGROUND AND AIM: Several studies have reported that induction of kinesthetic illusion by visual stimulus (KiNVIS) (Kaneko et al., 2007; Aoyama et al., 2012) and action observation (AO) (Fadiga et al., 1995) activates the motor cortex or corticospinal tract. KiNVIS could induce kinesthetic sensation in the subjects that their own limb is moving, even though the limb is actually in a resting state. We previously demonstrated the acute effect of KiNVIS on the movement function in stroke patients (Inada et al., ISEK, 2014). However, KiNVIS is apparently similar to AO while watching a movie, during which whether the acute effect is due to induction of KiNVIS or AO is unclear. Therefore, the aim of the present study was to clarify the difference in acute effect of KiNVIS and AO on the upper-limb voluntary movement after stroke. METHODS: The present study was approved by the local ethics committee. The subject was a 47-year-old man with a pons hemorrhage developed 19 weeks prior. The right upper-limb (UL) on the involved side could be flexed by the chest. Partial flexion and extension of the fingers was possible. Tactile sensation was slightly impaired on the UL. Cognition was not impaired. We adopted the ABA design. The interventions of visual stimulus were performed in the order of AO (AO-1), KiNVIS, and AO (AO-2) within a day. The intervention was executed after confirming that there was no effect of the latest intervention. The subject was instructed to watch a monitor, which displayed a movie that repeatedly showed an inverted non-paretic finger movement (flexion and extension) for 10 minutes. In AO, the monitor was placed in front of the subject. In KiNVIS, the monitor was placed on the subject's distal forearm to induce KiNVIS. Hand grip force was measured twice before intervention (pre-1, pre-2) and after each intervention. The subject was instructed to engage in 3 trials of maximal flexion of his finger. The greater of the value obtained for the hand grip force was used as the final hand grip force value. In addition, the subject was asked about the vividness of the illusory sensation by the visual stimulation. RESULTS: Hand grip forces were pre-1, 2.95 N; pre-2, 3.03 N; AO-1, 1.55 N; KiNVIS, 6.85 N; and AO-2, 1.97 N. Additionally, the subject reported vivid kinesthetic sensation of finger movement only after KiNVIS. CONCLUSIONS: This study demonstrated that hand grip force clearly increased after KiNVIS. Kaneko et al. (2015) showed that the motor-association areas of the frontoparietal cortex, insula, and striatum are more markedly activated during KiNVIS than during AO. Furthermore, the subject reported a strong feeling of moving his own finger while watching a movie that induced KiNVIS. Hence, we hypothesize that KiNVIS possibly promotes the upper-limb voluntary movement of the paretic finger after stroke.

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P3-D-48 ULNAR - Upper Limb fuNctional Assessment and Rehabilitation: tools and methods

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Upper limb movement characterization and functional analysis has not received the researchers attention, in the past decades, as much as gait analysis. However, in the case of post-stroke patients, the development of devices and methods that allow a more rapid and efficient evaluation of the condition of each patient is extremely important. Such evaluation would enable applying rehabilitation strategies without the presence of a therapist and significantly improve rehabilitation outcomes. In that way, it would be possible to assist in the assessment of the patient's condition, in the diagnosis and in the respective intervention in order to rehabilitate not only the ipsilesional limb but also avoid possibly harmful compensatory movements. The aim of this study is to develop a method based on concurrent motion analysis and EMG signal analysis to describe and compare the movement of participants without pathology with participants in stroke recovery.

P3-D-49 A comparison of three types of neuromuscular electrical stimulation for reducing contraction fatigue of the quadriceps muscles

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BACKGROUND AND AIM: Neuromuscular electrical stimulation (NMES) can produce contractions of paralyzed muscles to increase functionality and prevent or diminish secondary complications for people with spinal cord injury. Unfortunately, the benefits of NMES are limited by rapid contraction fatigue, which is due in large part to the non-physiological way that NMES produces contractions. Recently, we have found that alternating or "interleaving" NMES pulses (iNMES) between over a muscle belly (mNMES) and nerve trunk (nNMES) produces contractions that are more fatigue-resistant than mNMES and nNMES alone, at least for tibialis anterior (TA). In TA, mNMES preferentially recruits superficial motor units and nNMES recruits motor units more evenly throughout the muscle. Thus, iNMES recruits motor units from different portions of the muscle with every other stimulus pulse, reducing the discharge frequency of motor units by half, decreasing the metabolic demand of the recruited motor units and reducing contraction fatigue. Presently we studied contraction fatigability of the quadriceps muscles because they are the most

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commonly stimulated muscles for NMES-based rehabilitation programs. We hypothesized that iNMES will produce quadriceps contractions that fatigue less than during mNMES and nNMES. METHODS: Six healthy human participants (3 Males and 3 females; ages 21 to 39; 24.6±7 years) were recruited. Each participant completed three sessions with the different types of NMES tested on separate days (iNMES, nNMES, and mNMES). Each session incorporated a fatigue protocol consisting of 170 contractions generated by NMES delivered at 40 Hz, with each contraction lasting 0.3 s and separated from the next contraction by 0.7 s. To determine if torque declined during each fatigue protocol the mean torque during the first five contractions was compared to the mean torque during the last five contractions. Contraction fatigue was calculated as the fatigue index (FI), by dividing the mean torque during the last five contractions by the mean torque during the first five contractions and multiplying by 100. Repeated measures analyzes of variance (rmANOVA) were performed to identify significant differences. RESULTS: Torque declined during the fatigue protocols in 6/6 participants during mNMES and iNMES. In contrast, torque declined in 4/6 participants during the nNMES fatigue protocol, however, it increased in the other 2 participants. Torque declined significantly only during the mNMES fatigue protocol ($p=0.02$). The FIs (mean + SD) for mNMES, nNMES, and iNMES were 60 ± 14.4, 117 ± 105.4 and 74 ± 18, respectively. There were no significant differences in FIs between the three types of NMES. CONCLUSION: The lack of a decline in torque during nNMES and iNMES may reflect the fact that transmission along central pathways may contribute to contractions produced by these types of NMES. The inclusion of more subjects to our sample is needed to increase the power of the study.

P3-D-50 Task-specific movements generated by EMG-FES facilitate cortical beta band modulation for hand rehabilitation in individuals with moderate to severe stroke.

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BACKGROUND AND AIM: Nearly 800,000 people experience a new or recurrent stroke each year, with only 20% regaining normal arm function within 3 months. Debilitating impairments, such as the inability to open the paretic hand, prevent this population from participating in activities of daily living. In mild acute cases of chronic stroke, the progressive repetition of task-specific hand/arm movements induces GABA-mediated plasticity and leads to sizable recovery in function. It has been found that such short-term decreases in GABA inhibition reduce beta band (13-30 Hz) power oscillations in sensorimotor areas just prior to movement, and facilitate cortical activity. Unfortunately, individuals with more severe

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impairments cannot participate in task-specific training due to a lack of volitional control of the paretic hand, and thus we do not know its importance in this large population. To address this issue, our lab has developed a novel electromyography-driven functional electrical stimulation (EMG-FES) device (called the ReIn-Hand device) that allows individuals with moderate to severe stroke to produce electrically-assisted hand openings during functional reaching tasks. The current project aims to elucidate in a cross-sectional approach the importance of producing task-specific movements for generating beneficial cortical activity. METHODS: Two individuals with moderate to severe chronic stroke (S1 and S2) performed task-specific movements (i.e. reach to grasp a jar) and non task-specific movements (i.e. reach to open) using our ReIn-Hand system on a table. We recorded 160 channel high-density electroencephalography (EEG) during these movements, and calculated beta event-related desynchronization (ERD) prior to EMG onset. Additionally, we reconstructed the cortical activity just prior to EMG onset by calculating the inverse using Standardized low-resolution brain electromagnetic tomography (sLORETA). RESULTS: Both subjects showed increased beta ERD prior to task-specific movements (i.e. reach to grasp) compared to non task-specific movements (i.e. reach to open) over the contralateral sensorimotor area. Additionally, task-specific movements generated greater cortical activity in the contralateral primary motor cortex (M1). CONCLUSIONS: These preliminary results suggest that task-specific movements using EMG-FES generate greater modulation of contralateral cortical beta band oscillations compared to non task-specific movements in individuals with moderate to severe chronic stroke. In the future, a larger subject sample will be used to confirm this finding. Furthermore, we will investigate whether the generation of cortical activity could translate into long-term neural reorganization following a task-specific based EMG-FES intervention.

P3-D-51 Nintendo Wii decrease spasticity and improves standing balance in cerebral palsy

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BACKGROUND AND AIM: Spastic cerebral palsy (SCP) commonly presents neuromuscular alterations such as co-contraction, hypertonia and spasticity [1]. Spasticity is manifested by increased of stretch reflex, where a lack of modulation of the stretch reflex causes premature and/or exaggerated muscle contraction that may resist the passive stretch. Spasticity in the ankle plantarflexors can directly affecting the postural stability and standing balance [2]. The aim of the current study was to evaluate the effects of a Nintendo Wii exercise program on the ankle spasticity and the quiet standing balance in young people with SCP. METHODS:

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Ten children and adolescents (aged 6-17 years) with SCP (6 hemiplegic, 3 diplegic y 1 monoplegic) participated in a exercise program with Nintendo Wii Balance Board (NWBB). The intervention lasted six weeks, 3 sessions per week, 25 minutes each session. Ankle spasticity was assessed using the Modified Modified Ashworth Scale (MMAS) [3], and quiet standing balance with center of pressure (COP) using a force platform (AMTI OR67) [4]. Baseline and post-intervention data were compared using paired t-test ($p \leq 0.05$). RESULTS: Participants show a significant spasticity decrease in the ankle plantiflexors ($p < 0.001$). Besides, decreased the area of COP sway (COPSway) ($p = 0.042$). CONCLUSIONS: This is the first report demonstrated that a six-weeks NWBB exercise program reduced the spasticity at the ankle plantiflexors and improved the quiet standing balance in young people with SCP. [1] Richards CL, Malouin F. Cerebral palsy: definition, assessment and rehabilitation. Handbook of Clinical Neurology 2012; 111: 183-195. [2] Bar-On et al. Spasticity and its contribution to hypertonia in cerebral palsy. BioMed Resarch International 2015; 2015: 317047. [3] Ghotbi et al. Measurement of lower-limb muscle spasticity: intrarater reliability of Modified Modified Ashworth Scale. Journal of Rehabilation Research & Development 2011; 48(1): 83-88. [4] Leach et al. Validating and calibrating the Nintendo Wii balance board to derive reliable center of pressure measures. Sensors 2014; 14(10): 18244-18267.

P3-D-52 Onset and cessation timing of seven lower limb muscles during walking in patients with diabetes with and without sensory neuropathy and persons without diabetes

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Background and aim. The aim of this study was to investigate the differences in onset and cessation timing of seven lower limb muscles during gait of participants with diabetes, with (PwDM_SNP) or without (PwDM) sensory neuropathy and asymptomatic adults (PwNoDM). Methods. Surface EMG recordings of rectus femoris, vastus lateralis, medial hamstrings, tibialis anterior, peroneus longus, soleus and lateral gastrocnemius of the three experimental groups were taken while walking at a self-selected speed. Each group consisted of thirteen age-, sex- and speed matched subjects. Onset and cessation timing for each participant and each muscle was determined through the application of the automated method described by Staude et al (2001). One-way ANOVA was applied to investigate differences between the three groups. Results. Both diabetes groups showed changes in muscle activation compared to the persons without diabetes, although not always significant. There were no significant differences in onset timing between the three groups. Cessation timing of the rectus femoris was significantly later in PwDM_SNP compared to PwDM and PwNoDM (table 1). Also cessation of the tibialis anterior was delayed in PwDM_SNP group compared to PwDM

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(p=0.02) and PwNoDM (not significant). The peroneus longus on the other hand, showed a significant earlier cessation time in PwDM_SNP and PwDM compared to PwNoDM. Conclusions. Diabetes patients with and without sensory neuropathy demonstrate altered activation pattern of lower limb muscles during walking.

P3-D-53 Influence of using t-cane on variability of stride interval at a self-selected gait speed

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BACKGROUND AND AIM: Though human gait is highly stereotyped, the stride intervals fluctuate from one stride to the next. The variability of stride interval exhibits long-range temporal correlation. The variability of stride interval may be caused by a number of factors related to physical body and nervous system. Especially, the variability of stride interval was influenced by central nervous system based on integrative sensory feedback. It is not clear that whether the changes of dynamics of the stride interval produces or not with using t-cane. The purpose of this study was to examine the influence of using t-cane on the variability of stride interval at a self-selected gait speed. METHODS: Subjects were 20 healthy adult women (mean age = 21.5±1.2 years, height = 159.4±5 .6 cm, weight = 54±4 kg). After giving written informed consent, 20 healthy volunteers participated in this study. The subjects walked in three types of gait pattern on 20m walking path of 8-shaped line on floor for 10 minutes at their self-selected gait speed. The gait patterns were gait without t-cane, 2-point gait with t-cane, and 3-point gait with t-cane. All subjects were right-hand and right-foot dominant. They hold t-cane in their right hands at 2-point and 3-point gait. Time series data of the stride interval derived from four tri-axial accelerometers placed on seventh cervical vertebra, third lumbar vertebra, right heel, and left heel. Scaling exponent á and approximate entropy (ApEn, r = 0.2, m =2) were calculated from the time series data of stride interval (N = 600 strides) derived from each placed tri-axial accelerometer. Scaling exponent á and ApEn can quantify the long-range correlation and regularity of the time series data, respectively. Scaling exponent á and ApEn were compared using repeated measures analysis of variance with Shaffer's post hoc tests (R ver.2-8-1). Significant level was set at $p < .05$. RESULTS: Scaling exponent á of the time series data of stride intervals from the both heels at 2-point gait with t-cane was significantly lower than that at gait without t-cane. Scaling exponent á from the left heel at 3-point gait with t-cane was significantly lower than that at gait without t-cane, but scaling exponent á from the right heel at 3-point gait was not significantly lower. ApEn from both heel at 3-point gait was significantly lower than those of both at gait without t-cane and at 2-point gait. CONCLUSIONS: External cueing of using t-

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cane may alter the temporal correlation structure of gait. Persistent long-range correlations in the stride intervals of self-paced gait may switch to anti-persistent correlations in the case of using t-cane. It was speculated that the decrease of the correlation and the increase of the regularity in the variability of stride interval at gait with t-cane resulted from being aware of the movement of gait with t-cane.

P3-D-54 Reproducibility of the motion generated by a master-slave system developed using neuromuscular electrical stimulation based on kinematic parameters

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<Purpose>We developed a master-slave system (KineStim) using neuromuscular electrical stimulation (NMES) based on kinematic parameters. KineStim consists of three processes: In process 1, we record the master motion and calculate the angles of the wrist joint and index finger using a three-dimensional motion analysis system (Vicon). In process 2, a program that we developed (KeSS) converts the kinematics parameters into NMES signals that are then transmitted to an electrical stimulation device. In process 3, the NMES signal, when applied to the extensor carpi radialis brevis muscle or extensor digitorum muscle, generates the slave motion in the wrist joint and index finger. KeSS consists of four programs. The first calculates the amplification needed to convert a joint angle into a NMES signal. The second extracts the joint angle calculated using Vicon. The third calculates the NMES intensity necessary to generate the slave motion. Finally, the fourth outputs the NMES intensity to the electrical stimulation device. The goal of this study was to examine the reproducibility of the motion generated by KineStim. <Method>Ten adult males participated as the subjects of this experiment. They were instructed to perform extension and flexion exercises with the right wrist and index finger, thus constituting the master motion. Sequences of exercise were constructed from four components: wrist extension from 0° to 30°, index finger extension from 0° to 30°, index finger flexion from 30° to 0°, and wrist flexion from 30° to 0°. Then, KineStim was used to generate the slave motion for the left arm. We recorded wrist and finger joint angles of the master and slave motions. After the completion of the experiment, we analyzed the reproducibility of the slave motion generated by KineStim, considering the cross-correlation coefficient and phase difference between the master and slave motions. <Result>The cross-correlation coefficients were 0.87 ± 0.12 for the wrist joint and 0.84 ± 0.19 for the index finger, with both exhibiting a strong correlation. The phase difference was 2.09 ± 1.05 s at the wrist joint and 1.04 ± 0.75 s at the index finger. <Discussion>The master and slave motions exhibited similar phases for both the wrist and index finger, but the slave motion was delayed relative to the master motion. The slave motion delay may be due to the

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difference between the minimum NMES intensity and the NMES intensity corresponding to the movement threshold when the NMES intensity increases. <Conclusion>KineStim proved capable of reproducing joint motion, but the slave motion was delayed relative to the master motion. However, given that clinical patients perform their exercises at low speeds, it may be possible to successfully apply KineStim to hemiplegia rehabilitation systems.

P3-D-55 Effect of Visual Feedback on Quality and Consistency of Upper Limb Movement in Stroke Patients

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Background and aim: Deficits in upper limb function often persist after stroke despite intensive motor rehabilitation. Feedback on movements has been suggested to improve motor skill reacquisition. A system for delivering visual feedback during upper limb training in sub-acute stroke patients is presented. Methods: Subjects moved the hand at self-paced speed within a rectangular pattern displayed on a 70 cm x 40 cm monitor embedded in a table under a 5 mm glass plate. The length and width of the pattern were set to 75% of the range of motion of the subject. The thickness of the rectangular pattern was preset to 50 mm. Movements were captured by a Kinect sensor mounted on a tripod above the table surface. Hand position was estimated by detecting a white colored LED, placed on the index finger of the more impaired hand, in the images captured by the Kinect sensor. The LED served as a reference point for the position of the hand during movement. A marker (filled circle) displayed 10 mm ahead of the detected position of the LED served as a guiding point on the monitor for the subjects during movement. The exercise was repeated up to 20 times by each subject. Seven stroke subjects (40-80y) participated in the experiment. In the feedback session, if the marker was kept within the pattern more than 90% of the time during one trial, the rectangular pattern thickness decreased in the following trial. If the hit rate dropped below 60%, the thickness increased. The thickness was changed in 10 mm increments/decrements within a range of 10-110 mm. If the centroid of the marker was within the rectangular pattern, the color of the marker stayed green. If the marker appeared outside the rectangular pattern, the marker color was changed: yellow if the distance was less than 15 mm and red when the distance exceeded 15 mm. Upon completion of each trial the marker trajectory was displayed to the subject. In the control session the thickness of the rectangular pattern stayed fixed at 50 mm, the color of the marker was displayed to the subject in blue, and the marker trajectories were not displayed to the subject after trials. Each subject participated in one control and one feedback session (randomized) on different days. Results: The mean performance time ± SD was statistically higher in the feedback session (43.2 ± 20.9 s) compared to the control session (27.0 ± 16.9 s). The mean movement

variability ± SD was statistically lower in the feedback session (4.1 ± 1.4 mm) compared to the control session (6.1 ± 2.1 mm). Conclusions: These preliminary results showed that performance time increased and movement variability decreased when stroke subjects were presented with visual feedback. The first outcome implies that, when given the visual information about the performance, stroke patients were more motivated to fulfill the task, while the second result suggests that immediate motor relearning was initiated.

P3-D-56 Effects of augmented verbal feedback in the ankle electrical activity and torque of typical individuals

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BACKGROUND AND AIM: It is usual in physical therapy treatments and physical activity using verbal stimuli to encourage motor proposed activity. However, it is unclear whether the response to this stimulus may vary when we change the source of it. The aims is to determine the effect of verbal encouragement, as augmented feedback, in ankle maximum isometric torque and muscle activity of the tibialis anterior in typical individuals and verify the reliability of this method (inter and intra examiner). METHODS: Nineteen healthy volunteers (22.7±4.3yrs old) with no history of ankle surgery had their tibialis anterior myoelectric signal acquired by means of circular bipolar adhesive electrodes of Ag/AgCl (diameter=10mm, IED=20mm) while performing maximum voluntary contraction. EMG signals were sampled at 2kHz, then filtered by a 4th-order butterworth filter (10-500Hz) and amplified (gain=1000). The root-mean-square (RMS) of a 500ms window was calculated for each testing session. Ankle maximum flexion torque was assessed with an ankle dynamometer (ergometer OTBioelettronica) instrumented with a strain gage load cell with a capacity up to 1000 N. The subjects performed the test sitting on a chair properly adjustable, with knees flexed (<90 degrees), and with the ankle joint center positioned in alignment with the axis of the dynamometer. Four conditions regarding the use of verbal encouragement (VE) were set: two examiners (E1 and E2), their recorded voices (R1 and R2) and one condition without verbal encouragement (WVE). Each subject performed two attempts of maximum voluntary isometric ankle flexion. The conditions E1, R1 and WVE were repeated after 1 week. ANOVA for repeated measures was used to compare conditions, followed by Tukey HSD test (α=0.05), and Cohen's coefficients (d) were calculated between conditions to express the effect size obtained. Intraclass coefficients type 2,k and 3,k were calculated to verify reliability between examiners and sessions, respectively. RESULTS: No differences were found between all conditions in the first day of evaluation for ankle torque (p=0.787) and for

tibialis anterior EMG (p=0.206). In the second day of evaluation, again no differences were found in ankle torque (p=0.341) and EMG (p=0.269). The reliability of E1 between day 1 and day 2 for EMG was ICC3,k=0.94 and repeatability between E1 and E2 was ICC2,k=0.94. For maximum flexion torque, E1 reliability resulted an ICC3,k=0.87 and between examiners an ICC2,k of 0.98 was obtained (Table 1). Recorded voices or presential verbal encouragement did not influence in the EMG or torque measures. CONCLUSION: The isometric ankle torque was not influenced by any verbal encouragement: neither presential nor recorded voice. These results shows an important aspect from this assessment very used by researchers. Our results also showed a very good reliability of EMG and torque measures using verbal encouragement between session and between examiners.

P3-E-57 Influence of the mandibular tori in the stomatognathic system function

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BACKGROUND AND AIM: The mandibular tori is a convex bony growth, well-defined, with a dense cortical covered by a thin mucosa, poorly irrigated, with multifactorial etiology, attributed to genetic and environmental factors, masticatory hyperfunction, and slowly growing throughout life. This research evaluated the effects of mandibular tori on stomatognathic system through EMG activity of masseter and temporalis muscles. METHODS: Participants 40 individuals, divided into two groups: with mandibular tori (GI, n=20) and without mandibular tori (GII, n=20). The Myosystem-Br1 electromyography was used to analyze electromyographic (EMG) activity. This study was previously approved by the Research Ethics Committee of the State University of Montes Claros/Minas Gerais/Brazil (case number 226/704). The Myosystem-Br1 electromyography was used to analyze electromyographic (EMG) activity. Assessment of muscle activity was performed by EMG recordings of the right masseter (RM), left masseter (LM), right temporal (RT) and left temporal (LT) muscles, during postural rest condition, clenching in maximum voluntary contraction, maximum right and left laterality with dental contact and maximum protrusion with dental contact. The data were tabulated and subjected to statistical analysis using independent t test (SPSS 19.0). RESULTS: The EMG analysis in the condition of the mandibular at rest showed minimal electrical activity in all of the muscles evaluated in both groups. It was also found one electromyographic hyperactivity of the masseter muscles of patients with mandibular tori during postural condition of protrusion, clenching in maximum voluntary contraction and teeth clenching with parafilm ($p < 0.05$). In lateralities there was

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also a greater electromyographic activity in individuals with Toro, and this difference was significant (p <0.05) in the left masseter during the right laterality and in the right masseter during left laterality. For chewing, it was found electromyographic hyperactivity of the masseter and temporal muscles of patients with mandibular tori (p <0.01). CONCLUSION: A Based on the results it can be concluded that mandibular tori is associated with functional changes in the stomatognathic system. ACKNOWLEDGEMENT: FAPESP and CNPq

P3-E-58 Latissimus dorsi, maximus gluteus and biceps femoris activation in people with sacroiliac joint dysfunction

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BACKGROUND AND AIM: It has been established that the sacroiliac joint dysfunction (SIJD) can explain 15% to 30% of the idiopathic cases of low back pain (LBP). This dysfunction may be secondary to muscle weakness which provides stability to the sacroiliac joint (SIJ) through its interaction with the thoracolumbar fascia (TLF), such as the latissimus dorsi (LD), gluteus maximus (GM) and biceps femoris (BF). According to this stabilizing capacity, it is considered that the deficit in its role would be a trigger for SIJD. The pattern of activation and recruitment of those muscles during dynamic activities, such as lifting a load from ground level, has not been evaluated in people with SIJD. Therefore, the aim of this study is to compare the electromyographic (EMG) behavior of LD, GM and BF in people with LBP, and LBP combined with SIJD during lifting a load from ground level. METHODS: descriptive observational study. Each participant performed one trial lifting with each lower limb, starting from the standing position where feet were kept together. EMG was simultaneously recorded for all muscles. A load cell on the ground was used to identify the start and end of the activity. The EMG was normalized by submaximal voluntary contraction (SVC). The signal processing was performed using MATLAB. The variables were: Root Mean Square (RMS) amplitude and latency. The EMG recording was performed in the beginning of the evaluation. Six pain provocation tests were performed in the end in order to establish the presence or absence of SIJD. Obeying the distribution of variables, comparisons between groups were established by student t test. RESULTS: A total of 15 subjects with low back pain, both genders, aging 31.5±12.81 years, height 167.2±11.26 cm and weight 73.2±17.30 kg were included. Nine subjects in LBP group and six in the LBP/SIJD group. Electrical muscle activation did not show significant differences between groups. However, LBP/SIJD group had a delay in activation. Negative latencies were found in all muscles when the task was performed with both right and left lower limbs. In addition, the BF amplitude was higher (5.72±1.06%SVC) while the GM was low (4.00±0.78%SVC) when the LBP/SIJD group performed the activity with the right lower limb. When the LBP group performed the activity

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with the same limb the amplitude was higher in GM (5.23±0.58%SVC) while the BF was low (4.77±0.85%SVC). It suggests a possible compensation to achieve stabilization of the SIJ in the LBP/SIJD group. CONCLUSIONS: The delay in EMG activation of muscles on the supporting side while lifting in subjects with SIJD suggests a change in the stabilizing strategy that might disrupt the charge transfer through the pelvis, and increase the presence of low back pain in these subjects.

P3-E-59 Subject-specific classification of startle elicited by postural perturbation

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SIGNIFICANCE: Postural perturbations elicit many complex motor responses. These rapid motor responses are essential to our ability to safely and appropriately respond to disturbances during many everyday tasks, such as recovering from tripping or being bumped by a passerby. Recent evidence suggests one such rapid motor response, the release of a movement plan, involves activation of startle-related brainstem pathways. The sternocleidomastoid (SCM) muscle is often used as a physiological marker of brainstem activity; however, in the response to postural perturbations its use is confounded by the role of the SCM in neck stabilization. AIM: To develop a methodology that distinguishes SCM activity involved in neck stabilization from that elicited by postural perturbations thought to activate startle-related pathways in the brainstem. METHODS: Data were collected from 12 healthy subjects as part of a separate physiological experiment examining the response to postural perturbations delivered prior to reaching. Subjects were seated with the right arm attached to a rotary motor used to apply perturbations. Each trial began with an auditory WARNING tone, cueing the subject to prepare a ballistic elbow extension movement, followed by the GO cue, a small 10°/s, 100 ms elbow flexion perturbation. The time between WARNING and GO cues was uniformly distributed between 2.5-3.5 s. Perturbations of 100°/s, also lasting for 100 ms, were presented in 20% of the trials either before the WARNING or at various times before the GO to probe the motor system. Rectified EMGs recorded from the left SCM muscle were displayed on a trial-by-trial basis. Onset was marked as the first sustained rise of EMG, filtered using a 25 ms centered moving average, three standard deviations above background activity. Onsets were then manually reviewed and adjusted to the initial rise of unfiltered EMG from background activity. A subject-specific cutoff time to classify startle-related SCM activation was identified as the 5th percentile of SCM onset for neck stabilization during volitional reaching cued by a postural perturbation. A trial with SCM activity prior to the cutoff time was classified as SCM+. A trial without the presence of SCM activity or with activity later than the cutoff was classified as SCM-. Response classification

was compared to a fixed cutoff time of 120 ms which is commonly used to indicate startle-related activity in the literature. RESULTS: The lower limit of SCM onset for neck stabilization determined using the 5th percentile of onset during voluntary reaching was 96.8 ms (range: 78.0-111.4 ms). The use of this subject-specific cutoff time improved the classification of startle-related SCM activity compared to the commonly used cutoff of 120 ms which classified 83.5% (range: 35.7-100%) of volitional trials as startle responses. CONCLUSIONS: Common methods for using the activity of SCM muscles as an indicator of startle can lead to misclassifications in experiments that also require these muscles to be used for neck stabilization. In these cases, subject-specific criteria that considers volitional activation can lead to a more selective classification. ACKNOWLEDGEMENT: Funding provided by NIH R01 NS053813 and T32 EB009406.

P3-E-60 Analysis of electromyographic fatigue of masticatory muscles in osteoporotic individuals

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AIM: Osteoporosis is a skeletal progressive and chronic disease in which there is a loss of bone mass, reducing its strength and predisposing the fractures, especially in regions of the wrist, hip and spine. It also affects facial bones, such as the maxilla and mandible. This research evaluated the electromyographic fatigue threshold of masticatory muscles in osteoporotic individuals. METHODS: 24 individuals aged between 45 and 70 years, of both genders and with osteoporosis. They were submitted to electromyographic evaluation in right masseter (RM), left masseter (LM), right temporalis (RT) and left temporalis (LT) muscles in the clinical conditions of maximum voluntary contraction for 4 seconds and muscle fatigue during a constant force isometric contraction. The EMG analysis was performed using the Myosystem-Br1 apparatus. The analyses of the median frequency EMG signal data were standardized obtaining the values obtained from the select windows of 5 seconds length duration at initial time (IT), medium time (MT) and final time (FT) of total length duration of each analysis. It was performed statistical analysis using ANOVA (SPSS 22.0). The Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo, previously approved this study. RESULTS: During the clinical condition of muscle fatigue in the medium and final times it was found a progressive decrease of median frequency when compared with the 5 seconds initial, for all evaluated muscles. The values of median frequency were significantly lower for temporalis muscles ($P \leq 0.05$). CONCLUSION: According to the results of this research it can be concluded that osteoporotic individuals show

changes in fatigue levels in the evaluated muscles. ACKNOWLEDGEMENT: This study was supported by FAPESP and CNPq.

P3-E-61 EMG analysis of cervical muscles after acupuncture in women with dysfunction temporomandibular

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BACKGROUND AND AIM: The temporomandibular dysfunction (TMD) is a multifactorial myofunctional disorder that affects the stomatognathic system. Among the most common signs and symptoms are both myofascial and neck pain. Acupuncture is a therapeutic resource that relieves and treat these painful symptoms. This research evaluated by EMG activity and pressure pain threshold (PPT) the right sternocleidomastoid (RECOM), left sternocleidomastoid (LECOM), right trapezius (RT) and left trapezius (LT) of women with muscular TMD submitted to acupuncture treatment. METHODS: 25 women (aged 18 to 50 years) were evaluated and diagnosed with muscular TMD (DC/TMD), also complaining of pain in the cervical muscles. Underwent initial evaluation (I), prior to treatment with acupuncture, EMG activity (Myosystem-Br1 v3,5) and pressure pain threshold (digital algometer). The conditions analyzed in the EMG activity were: postural rest (4s), maximal voluntary contraction (4s), neck rotation to the right (4s), neck rotation to the left (4s), elevation of the shoulders (4s) crucifix (4s). Acupuncture treatment was performed in 10 sessions, 02 times a week, lasting 30 minutes each session. The treatment protocol for acupuncture was: local spots (E6, E7, ID18, ID19, VB20, VB14, TA17, HN3, VG26) and points distance (F3, B60, BP6, E36, VB34, IG4). The needles dimensions used were 0.25 diameter x 0.30 (Dong Bang). Final evaluations were performed after 15 days after treatment with acupuncture (II). The EMG values were normalized by teeth clenching in maximal voluntary contraction (4s). The average EMG and the LDP were tabulated and submitted to statistical analysis by the independent t-test (SPSS 21.0). This research was approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. RESULTS: EMG activity was significant ($P < 0.05$) for lifting shoulders: LT = [(I = 5.53 ± 0.61), (II = 24.4 ± 0.46)]; neck rotation to the right: LECOM = [(I = 4.98 ± 0.82), (II = 6.50 ± 0.96)]. The LDP was significant ($P < 0.05$): RECOM = [(I = 1.35 ± 0.14) (II =1.80 ± 0.13)] LECOM = [(I = 1.43 ± 0.07), (II = 1.70 ± 0.10)] RT = [(I = 1.90 ± 0.19), (II =3.00 ± 0.16)] and LT = [(I = 1.99 ± 0.14), (II = 3.13 ± 0.17)]. CONCLUSION: Based on the results of this research, it can be concluded that treatment with acupuncture was able to alter the activity of the cervical

muscles and increase the pain threshold to pressure from women with muscular TMD.
ACKNOWLEDGEMENT: FAPESP, CNPq and CAPES

P3-E-62 Assessing muscular activation of patients with specific low back pain during daily activities

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BACKGROUND: Due to the growing number of people with specific low back pain and the associated costs the question arises whether there is a cost-efficient and effective treatment approach. Conservative treatment measures, especially with supportive orthoses or bandages, are often rejected, because they are suspected of weakening the muscles. Information on the physiological activation of back and abdomen muscles during daily activities is heterogeneous in literature. This might be because activities of daily living are difficult to analyze due to their complexity. sEMG envelope, often used to assess muscular activation during movements, depends on several biomechanical factors like trunk position, movement velocity or contraction type, all of which are hard to control during daily activities. The aim of this paper is to introduce a procedure, which allows a systematical assessment of the muscular activation of back and abdomen muscles during activities of daily living with relevance for patients with specific low back pain. METHOD: 20 patients with specific low back pain were asked about tasks of daily living causing pain. From that survey five movement tasks were identified as hampering the patients during their daily live. An exercise course of different assistive devices has been developed, in which the five movement tasks can be performed freely by the subjects in their individual movement rhythm and velocity. Trunk position, movement speed and direction of movement during these specific exercises were detected by sensors embedded in the devices. sEMG was recorded from m. erector spinae iliocostalis, m. erector spinae longissimus and m. obliqus externus abdominis synchronously to the sensor information. The sEMG signals were normalized and the sEMG envelope was generated for each channel. Based on the sensor data of the devices, sEMG of each muscle was categorized into groups of similar movement velocity, trunk position and movement direction in order to minimize the influence of movement dynamics on the results. 20 healthy subjects and 10 patients with specific low back pain took part in the study. RESULTS: The variation of sEMG envelope during exercises with healthy subjects decreased when subcategorizing the exercises with regards to trunk position, movement speed and movement direction. Additionally, reproducibility was improved. Patients with specific low back pain were able to complete the exercise course and showed differences in muscular activation.CONCLUSION: The overall procedure allows the systematical assessment of muscular activation in movement tasks of daily living, which are of relevance for patients.

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Although the movements are performed by the subjects in their individual movement-rhythm and velocity, comparability was achieved by categorization. This forms the basis for systematic analysis of the differences in muscular activation of patients with specific low back pain in larger groups and in different centers.

P3-E-63 Linear and Rotational Acceleration of the Head on Snowboard Beginner's Falls during Freestyle Snowboarding

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BACKGROUND AND AIM: The mechanism of injury causes in sports is categorized into two major patterns. One is that actions such as failure in jumping, falls or collisions provoke high energy injury derived from massive impact to the head in translational motion. This conceivably causes severe head injury such as cranial bone fracture and cerebral contusion. The other is that massive rotational acceleration to the head driven by a fall generates a shear deformation between the cerebrum and the endocranium that possibly causes acute subdural hematoma. Therefore, the linear and rotational acceleration of the head function as a parameter to meaningfully measure the injury severity. The objective of this study was to examine the linear and rotational acceleration of the head when falling and to analyse and establish precise evaluation and effective prevention upon head injury of snowboarders. METHODS: The male at beginner level in snowboarding was selected as a participant. Various patterns of falls in freestyle snowboarding were filmed in the slope with an angle of 10 degrees. The fall patterns were defined as follows: a fall in which a snowboarder failed to switch his board's edge from the toe side to the heel side causing a forward lean onto the lower side of the slope was named forward fall, whilst the inverse pattern was named backward fall. RESULTS: The reverse-edge phenomenon in snowboarding is well-known to trigger off severe head injury. The results of this study indicate that the peak values in angular acceleration in rotary motion on the frontal-horizontal axis tended to be larger in backward fall. Since the mechanism of a typical backward fall generated increase in angular velocity of the head in reverse-edge snowboarding, head's rotary movement on the frontal-horizontal axis was assumed harmful. As linear and rotational acceleration increase brain pressure and its motion are activated. The peak value in angular acceleration recorded less than 1,000 rad・s-2, hence were it not for organic issues the risk causing severe head injury is disproved under the condition of this research "falls performed by a snowboard beginner on the gentle slope". The value of the force on the head at its lowest position used as an indicator of impact to the head was 236 (101.7) kg・m・s-2 on the frontal-horizontal axis. As compared to the one demonstrated in exemplary throws of judo; 240 (19.95) kg・m・s-2, the value was not considerable. Therefore, the finding indicates that impact to the head was

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not considered remarkable when snowboard beginners fall onto the gentle slope during their practice. CONCLUSIONS: When a snowboard beginner falls during freestyle snowboarding, kinematic displacement of the head was observed dissimilarly depending on fall patterns. Further research should enlarge the number of analyses of fall patterns in freestyle snowboarding or jump motion and investigate the risk threshold of kinematic parameters of each body part, especially the head.

P3-E-64 Relationship between co-contraction ratio and knee adduction moment in knee osteoarthritis subjects

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Background and Aim: Knee osteoarthritis (KOA) is strongly associated with knee load and the KAM has been used as a predictor of medial knee load. In addition, higher co-contraction ratio has been observed in KOA subjects and identified as one of the possible reasons for the increased medial knee load. The aim of this study was to investigate the relationship between co-contraction ratio and knee adduction moment in KOA subjects. Methods: Twenty-five subjects diagnosed with KOA were included in the study. They were underwent a three-dimensional gait analysis at self-selected speed. The co-contraction was measured using Heinden et al. (2009) method for the follow ratios: VM:MG, VL:LG, VL:BF, EXT(VM,VL,RF):FLX(BF,MG,LG), QUA(VM, VL):GAST(MG, LG). In order to process the correlation measurements we used the KAM during the stance phase, first and second peak. Results: A significant correlation was found between the co-contraction ratio VL:BF and knee adduction moment during stance phase ($r = -0.54$, $p=0.01$), first peak ($r = -0.61$, $p=0.01$) and second peak ($r = -0.58$, $p = 0.01$). Conclusions: Considering our findings, the co-contraction ratio VL:BF might be considered in future studies to better understand the behaviour of knee medial load compartment, mainly with treatment approach in KOA subjects.

P3-E-65 Quantification of head movement when testing segmental trunk control

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BACKGROUND AND AIM: Trunk control is fundamental for effective functional activity in neuromotor disability [1]. In contrast to other subjective tests that consider the trunk as a single unit the Segmental Assessment of Trunk Control (SATCo) assesses discrete segmental levels [2]. Furthermore, the SATCo includes Static, Active and Reactive control giving a more complete picture. The SATCo is conducted in sitting with firm horizontal support directly beneath the tested trunk segment. It tests six segmental levels (Head through Lower Lumbar) and free sitting. This study measured Head motion during a SATCo to give an objective quantification of a subjective assessment. METHODS: One healthy adult (27y) and two children with different degrees of neuromuscular disability (4y1m, 4y5m) were tested using the SATCo. Child 1 was learning to control his trunk without external support. Child 2 was learning to control his trunk with external support at waist level. A video camera additionally recorded sagittal plane movements. Markers were placed on the ear tragus and temporal fossa in vertical line with the ear when the head was aligned. These were used to define a Head segment. Head segmental angles were calculated in relation to a real vertical. Cumulative displacement from the vertical normalised by time was calculated for each trial. RESULTS: Head motion during testing of Upper-Thoracic (UT) and Lower-Lumbar (LL) segments are shown in Figure 1. As expected, the Adult showed only small Head displacement throughout. Larger values for the Reactive tests are a clear indication that Child 1 is still acquiring full trunk control. The poor lumbar control of Child 2 is clearly demonstrated and contrasts with Child 1 for the Active and the Reactive tests. CONCLUSION: The results show how increasing task complexity (Static to Reactive) and reducing the level of segmental support (UT to LL), increases Head motion in the presence of a neuromotor disability. This is consistent with the subjective valuation of the SATCo. Previous studies have quantified Head motion of typically developing children in relation to the level of support during quiet sitting [3, 4] showing 2.3°/s for unsupported sitting [3] and 18° for thoracic support and 30° for pelvic support [4]. However, the methods used by Curtis [3](3D motion capture system) and Rachwani [4] (magnetic tracking sensor) are difficult and costly to use in a clinical setting. Our video based method is clinically practical with minimal disrruption to the clinical session. Quantification of an assessment complements the subjective findings and provides validation for any changes observed over time. REFERENCES: [1] Curtis D. 2014. Developmental Medicine and Child Neurology [2] Butler P. 2010. Pediatric Physical Therapy [3] Curtis D. 2015. Journal of Motor Behaviour [4] Rachwani J. 2013. Experimental Brain Research

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P3-E-66 Impact of rheumatoid arthritis in stomatognathic system of the women

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BACKGROUND AND AIM: Rheumatoid arthritis is a serious disease that considered may influence the quality of human life, characterized by signs and symptoms such as fever, malaise, weakness, pain, swelling, warmth, redness in any joint in the body, morning stiffness, fatigue , limitation of movement and destruction of articular cartilage. This research evaluated the effects of rheumatoid arthritis on stomatognathic system through EMG activity of masseter and temporalis muscles and maximum molar bite force. METHODS: 16 women with natural dentition (aged between 40 and 60 years) were divided into two groups: GI: rheumatoid arthritis (n=8, average age 51.50 ± 3.12 years) e GII: healthy control (n=8, average age 50.75 ± 3.18 years). The groups were matched subject to subject by age and body mass index. GI presented discomfort in the preauricular region, normal mandibular mobility, and absence of popping, clicking or grinding sounds in the temporomandibular joint. This study was previously approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. Assessment of muscle activity was performed by EMG recordings of the right masseter (RM), left masseter (LM), right temporal (RT) and left temporal (LT) muscles, during postural rest condition (4s), clenching in maximum voluntary contraction (4s), maximum right and left laterality with dental contact (10s) and maximum protrusion with dental contact (10s). Surface EMG was performed using TrignoTM Wireless EMG System Delsys. Kratos digital dynamometer was used to analyze right and left maximum molar bite force. The values were normalized by of the EMG signal of maximum dental clenching (4s). The EMG and bite force means were tabulated and subjected to statistical analysis using independent t test (SPSS 21.0). RESULTS: EMG activity was significant ($P < 0.05$) for mandibular rest: RM= [(I = 0.24 ± 0.04), (II=0.09 ± 0.02)]; RT= [(I = 0.34 ± 0.04), (II=0.20 ± 0.03)]; protrusion: RT= [(I = 0.34 ± 0.03), (II=0.18 ± 0.03)]. The values maximum molar bite force (N) was significant ($P < 0.05$) for right region= [(I = 147.88 ± 2.44), (II = 220.84 ± 2.58)] and left region = [(I = 125.23 ± 2.68), (II = 215.05 ± 2.92)]. CONCLUSION: Based on the results of this research, it can be concluded that adult women with rheumatoid arthritis showed changes to the stomatognathic system, especially concerning EMG activity and maximum molar bite force. ACKNOWLEDGEMENT: FAPESP and CNPq

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P3-K -67 The effect of carbohydrate supplementation to muscle fatigue trend in training of table tennis

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BACKGROUND: The recovery of muscle fatigue for carbohydrate and nutrient supplement after exercise has been well known that is important. However, actual sports must be a long time practice and maintaining the fitness level. Especially, table tennis must be a lot of practice for technology acquisition because there is a lot of technology. Therefore, maintenance of physical fitness level and performance in practice is important, to suppress the fatigue and recovery during training as well as after the practice. METHODS: This study was carried out in two methods at the same time. The first method was seen change in blood lactate concentration after the trial of muscle fatigue analysis experiment. The Second method was see muscle fatigue trend by the EMG analysis results. The subject belong to table tennis club of Niigata University. They all right-hander and they use pimples-in rubber on face of forehand. The electrodes were put on subject's biceps femoris muscles, vastus medialis muscles, and gastrocnemius muscles. The subjects wore goniometer to pick out a stroke with angle of elbow. Then, they did a stroke for a second and it continued for three minutes on trial. After taking a 15-minutes break, they did a trial again. Then, we did Fourier transform by the program was made with MATLAB R2014a(produced by Math Works) on condition that sampling frequency 1000Hz, section length 500msec, shift length 20sec. We got Average Rectified Value (ARV) to estimate muscle active mass, and Mean Power Frequency (MPF) to know information about frequency of muscle discharges. RESULTS: In the comparison of the blood lactate concentration and average exercise intensity, direction of fatigue suppression group was relatively lower number than the fatigue group. Therefore, the lactic acid concentration and EMG fatigue analysis in the blood had been suggested that relevant. The subject of fatigue suppression group's lactate threshold is higher than fatigue group because they have a high endurance. Also from a change in the blood lactate concentration, muscle fatigue suppression group was got the energy supply from the mainly aerobic system, the other hand muscle fatigue group was got mainly energy from glycolysis. CONCLUSIONS: The effect of carbohydrate supplementation to muscle fatigue is different each by the energy supply system and lactate threshold. If lactate threshold is high and mainly using aerobic system, carbohydrate replenishment is fully effective. It is possible to advice of training and carbohydrate supply by EMG analysis results and blood lactate concentration result.

P3-K -68 Influence of data precision on quantifying skeletal muscle movement in ultrasound images

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BACKGROUND AND AIM: Ultrasound (US) imaging is a well-recognised technique for studying static tissue, due to its portability, low cost and ease of use. The majority of commercially available US devices do not allow access to "raw data". Instead, RF data (radio frequency, unprocessed data collected from the US transducer) is post-processed, compressed and stored, most often to 8 bit precision (256 possible values). Many of the filters and compression algorithms employed are "black box", so the inner workings are not accessible, distorting data in an unknown manner. In an irreversible operation, a portion of RF data is lost during this process (lossy compression). As such, the only data available to many studying neuromuscular function are highly compressed and filtered video files. Some current generation US devices offer important features which make the RF data available to researchers. 10-16 bit data can now be accessed before filtering or compression is applied. This improvement allows access to higher resolution data, and allows users to apply their own post-processing, which may be adapted to their specific requirements. The potential value/advantages of the availability of such data has not however been widely investigated. Comparisons between RF and compressed data currently available have focused on the timing of events or pixel brightness rather than qualitative differences between data. The aim of this work is therefore to evaluate the effect of data compression on tracking muscle movements. METHODS: RF (12-14bit) and compressed (8bit) formats, were acquired from the medial gastrocnemius (MG) during active contractions (20, 50 and 80 % MVC) and joint rotations (4 and 8 degrees/s). Muscle movement in MG was quantified using a Kanade-Lucas-Tomasi feature tracking approach. A description of the joint torque as a first degree polynomial was estimated from the US movement information in a least-squares sense. As a result, Normalised Root Mean Square Error (NRMSE) values were obtained by comparing the polynomial estimations from RF and compressed US of muscle movement information with joint torque, acquired synchronously with US data using an isokinetic dynamometer. RESULTS: RF data provided a more accurate measurement of passive movement and active contraction, and was a greater predictor of net joint torque. The extra precision that the RF data provides was shown to be most reliable during passive length changes, with NRMSE significant (NRMSE > 0) in all cases. CONCLUSIONS: During passive joint rotations, the movements between consecutive US images present smooth and slow changes, conditions that are in many ways analogous to the ones observed in ultra-fast US imaging, which has frame rates greater than 1000 fps. This should be considered an important finding as it leads to believe that, as frame rates of standard US increase over time, the use of full resolution RF data will likely become imperative.

P3-K -69 Muscle material properties of stroke-impaired plantarflexor muscles

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BACKGROUND AND AIM: Impaired mobility is a common challenge for stroke survivors. In addition to decreased voluntary control, muscle properties may also be altered. In particular, muscle stiffness has important function implications as it influences force generation and transmission and range of motion. Our previous work showed that stiffness, measured as shear wave (SW) velocity using SW ultrasound elastography, is up to 59% greater in stroke-impaired biceps brachii muscle compared to the contralateral non-paretic muscle. To gain insight into changes in stiffness of lower extremity muscles, we measured SW velocity at different ankle angles to determine differences in the relationship between SW velocity and ankle positions between the paretic and non-paretic side of ankle plantarflexors (medial gastrocnemius, MG) and dorsiflexors (tibialis anterior, TA). METHODS: Fourteen stroke survivors participated in this study (age:60.15.9yrs; height:1.680.09m; body mass:77.612.5kg; time post-stroke:10.67.3yrs.). Subjects were seated with their knee in maximum extension and their foot secured to a platform of a dynamometer (System3Pro, Biodex). B-mode and SW elastography ultrasound measurements (Aixplorer, SuperSonic Imagine) of MG and TA muscles were captured, as well as joint angle, torque, and electromyography (Delsys) with the ankle at different angles (0 degrees dorsiflexion (DF), 15 degrees plantarflexion (PF), maximum DF, maximum PF, and two other intermediary angles that were torque-matched between the paretic and non-paretic side) while the muscle was passive. Quadratic fits were used to evaluate the relationship between SWS and ankle angle. Analysis of Variance was used to compare the SWV at the ankle angles of the non-paretic and paretic side. RESULTS: Our main findings show that SW velocity of the MG and TA increase non-linearly (quadratic fits of R^2: 0.940±0.05 and 0.820±19) from plantarflexion to dorsiflexion (muscle length). In addition to the SW velocity of the paretic MG muscle being on average 27.7% greater ($p = 0.004$) than the non-paretic side, the SW velocity was also significantly greater, on average 27.0% at 15 deg PF ($p=0.0023$), and 22.8% at the maximum DF (angle matched from paretic side, $p=0.04$). CONCLUSIONS: These results demonstrate that the passive stiffness across the range of motion and muscle lengths is greater in stroke-impaired muscle compared to the muscle of the non-paretic side of the MG, the primary plantarflexor muscle. This has possible implications for the affect of these changes in passive stiffness during gait. In addition to altered motor control and decreased muscle strength, having to overcome the increased stiffness at specific events during gait would certainly exacerbate any deficiencies. Having this information on muscle stiffness on a patient specific basis would allow clinicians to refine rehabilitation interventions and training to specifically address decreasing muscle stiffness.

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P3-K -70 Effects of rheumatoid arthritis in masticatory cycles of the women

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BACKGROUND and AIM: Mastication is one of the most important functions of the stomatognathic system and many factors can influence the masticatory performance, such as the loss of teeth, restorations in posterior teeth, bite force, age, gender, occlusal contacts, motor functional changes, orofacial pain, parafunctional habits and systemic alterations. The aim of this research was to analyze the efficiency of the masticatory cycles of the temporalis and masseter muscles, in women with rheumatoid arthritis, using the evaluation of habitual and non-habitual chewing. METHODS: 16 women with natural dentition (aged between 40 and 60 years) were divided into two groups: GI: rheumatoid arthritis (n=8, average age 51.50 ± 3.12 years) e GII: healthy control (n=8, average age 50.75 ± 3.18 years). The groups were matched subject to subject by age and body mass index. GI presented discomfort in the preauricular region, normal mandibular mobility, and absence of popping, clicking or grinding sounds in the temporomandibular joint. This study was previously approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. The efficiency of the masticatory between individuals was evaluated by the ensemble average of the masticatory cycles (microvolts/second), during the time. The masticatory process was analyzed during habitual chewing of peanuts and raisins, and non-habitual chewing of flavorless gum (Parafilm M®; Pechinery Plastic Packaging, Batavia, IL, USA), for 20 seconds each. The values of ensemble average were normalized by the value of the EMG signal of maximum dental clenching (4s). Surface EMG was performed using TrignoTM Wireless EMG System Delsys. The EMG means were tabulated and subjected to statistical analysis using independent t test (SPSS 21.0). RESULTS: EMG activity was significant ($P < 0.05$) for chewing of Parafilm M® : RM= [(I = 0.66 ± 0, 09), (II=1.09 ± 0.13)] and chewing of peanuts: RM= [(I = 0.95 ± 0.05), (II=1.35 ± 0.13)]. CONCLUSION: The authors concluded that there was a decrease of EMG activity of the habitual and non-habitual chewing cycles of the masseter muscles in women with rheumatoid arthritis. ACKNOWLEDGEMENT: FAPESP and CNP

P3-K -71 Impact of complete implant-supported dentures anchored in the zygomatic bone in stomatognathic system

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AIM: The surgical treatments that use specific and different techniques as the zygomatic implant, which provides support for the dental prosthesis to rehabilitate edentulous arches with substantial amount of bone loss and no need for bone grafts. This research evaluated the electromyographic (EMG) activity of masseter and temporalis muscles in individuals with complete implant-supported dentures anchored in the zygomatic bone. METHODS: 54 volunteers of both genders, between the ages of 35 and 70 years (mean age 52.5 years) were selected for this study and distributed into two groups: ZIG (Zygomatic Implant, n=27) and CG (fully dentate subjects, n=27).The groups were matched subject to subject by age and body mass index. This study was previously approved by the Ethics Committee in Research of the School of Dentistry of Ribeirao Preto, University of São Paulo. Assessment of muscle activity was performed by EMG recordings of the right masseter (RM), left masseter (LM), right temporal (RT) and left temporal (LT) muscles, during protrusion (10s), right laterality (10s), left laterality (10s); dental clenching (4s) and maximal voluntary contraction on twice-folded parafilm sheet (Parafilm M®, Pechinery Plastic Packaging, Batavia, IL, USA) (18x17x4mm, 245 mg) and positioned between the occlusal surfaces of the superior and inferior first molars, bilaterally. Surface EMG was performed using Myosystem BR1 apparatus (Data Hominis Ltda., Uberlandia, MG, Brazil). The values were normalized by of the EMG signal of maximum dental clenching with Parafilm M® (4s). The EMG means were tabulated and subjected to statistical analysis using independent t test (SPSS 21.0). RESULTS: EMG activity was significant ($P \leq 0.05$) for protrusion: RM= [(ZIG = 0.44 ± 0.08), (CG=0.16 ± 0.02)], LM= [(ZIG = 0.49 ± 0.07), (CG=0.17 ± 0.02)], RT= [(ZIG = 0.21 ± 0.04), (CG=0.10 ± 0.01)], LT= [(ZIG = 0.17± 0.03), (CG=0.11 ± 0.01)]; right laterality: RM= [(ZIG = 0.32 ± 0.05), (CG=0.09 ± 0.01)], LM= [(ZIG = 0.39 ± 0.05), (CG=0.14 ± 0.02)], LT= [(ZIG = 0.17± 0.03), (CG=0.09 ± 0.01)]; left laterality: RM= [(ZIG = 0.44 ± 0.08), (CG=0.14 ± 0.03)], LM= [(ZIG = 0.28 ± 0.06), (CG=0.10 ± 0.01)], RT= [(ZIG = 0.16± 0.03), (CG=0.10 ± 0.01)]; dental clenching: LM= [(ZIG = 0.86 ± 0.05), (CG=0.68 ± 0.05)]; LT= [(ZIG = 0.93± 0.17), (CG=0.77 ± 0.04)]. CONCLUSION: Based on the analysis performed in the present research, it can be concluded that the oral rehabilitation with implant-supported prosthesis (anchorage in the zygomatic bone) promoted functional hyperactivity of the masseter and temporalis muscles when compared to the muscles of fully dentate individuals. ACKNOWLEDGEMENT: FAPESP and CNPq

P3-K -72 Fat infiltration of the Paretic Upper Limb in Individuals with Chronic Hemiparetic Stroke: Preliminary Results

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BACKGROUND AND AIM: The long-term effects of motor impairments on upper limb muscle architecture are unknown post stroke. It is hypothesized that motor impairments may cause decreased neural activation and subsequent decreased use of the paretic limb, which over time may cause muscle atrophy and fatty infiltration. The aim of this research is to quantify long-term changes in intramuscular, perimuscular and subcutaneous fat following hemiparetic stroke. METHODS: Magnetic resonance images were acquired from 5 stroke subjects using a 3D gradient echo pulse sequence of the upper limb (TR=7ms, flip angle=12°, matrix size = 256x216, slice thickness = 3mm). The Dixon method was used to estimate percent fat using an echotime (TE) of 2.39ms, when water and fat are in phase and a TE of 4.77ms, when water and fat are out of phase. Percent fat was calculated using a ratio of the intensity of the fat image compared to the intensity of the water image. Using AnalyzeDirect, manual segmentation of the biceps, triceps, brachialis and coracobrachialis was done to measure intramuscular fat and of the upper limb muscle compartment as a whole to measure perimuscular fat. Manual segmentation of the subcutaneous fat compartment from the superior aspect of the axilla to the olecranon process was done to measure the volume of subcutaneous fat. RESULTS: The average percent fat for the upper limb muscle compartment as a whole was 16.30% for the paretic limb and 9.23% for the non-paretic limb. The average percent intramuscular fat was 7.25% for the muscles in the non-paretic limb and 10.77% for the muscles in the paretic limb. The percent intramuscular fat of the paretic biceps was 3.25% greater than the non-paretic biceps, 2.60% for the triceps, 4.3% for the brachialis and 3.93% for the coracobrachialis. The volume of subcutaneous fat was 11.21% greater in the paretic upper limb compared to the non-paretic upper limb. CONCLUSIONS: The percent intramuscular fat was greater in the paretic limb compared to the non-paretic limb for the biceps, brachialis, triceps and coracobrachialis muscles. The percent fat for the muscle compartment as a whole was greater in the paretic upper limb compared to the non-paretic, suggesting an increase in perimuscular fat. The volume of subcutaneous fat was greater in the paretic upper limb compared to the non-paretic upper limb. Deficits post stroke, especially musculoskeletal changes like muscle fat infiltration and atrophy, are not fully understood. Rehabilitation of the upper limb post stroke varies widely and outcomes are variable. Further information about musculoskeletal changes post stroke may help guide rehabilitation towards more efficacious treatments.

P3-K -73 Greater fatigability among type 2 diabetics without neuropathy is not associated with disruption of neuromuscular propagation or corticomotor excitability

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Background and Aim We have demonstrated that people with type 2 diabetes (T2D) exhibit greater reductions in muscle force and power (i.e. greater fatigability) than non-diabetic controls, after a dynamic fatiguing contraction. Furthermore, people with T2D and diabetic polyneuropathy (DPN) have greater fatigability compared with controls and this is associated with impaired neuromuscular propagation (decreased amplitude of compound muscle action potential, M wave) (Allen, MD et al 2015 JAP). However, it is unknown if disruption of neuromuscular propagation contributes to greater fatigability among patients with T2D who have no symptoms of DPN. The purpose of this study, therefore, was to determine if greater fatigability among people with T2D and no DPN was associated with impairments of neuromuscular propagation. A secondary aim was to determine if corticomotor excitability (assessed with motor evoked potentials (MEPs)) is impaired among T2D. Methods 16 people with T2D (9 men, 7 women; 58.6±8 years) and 17 age-, activity-,and BMI-matched controls without diabetes (10 men, 7 women; 58.7±10 years) performed a 6-minute single-limb dynamic protocol through 90° of knee extension while seated at 90° of hip and knee flexion. 120 maximal velocity concentric contractions (MVCC) were performed (1 per 3 s) with a load equivalent to 20% maximal voluntary isometric contraction (MVIC) torque. MVICs were performed before and immediately after the fatigue protocol. EMG from the vastus lateralis, vastus medialis, and rectus femoris were collected using bipolar electrodes, sampling at 2,000 Hz, band-pass filtered (13 - 1,000 Hz) and amplified (100×). Before and after the dynamic fatiguing contraction, M waves were elicited at rest with supramaximal femoral nerve stimulation and MEPs were evoked with transcranial magnetic stimulation over the motor cortex during maximal and submaximal isometric contractions. The properties of these EMG responses were assessed (amplitude, area, and latency of the MEPs and M waves) in order to quantify corticomotor excitability and neuromuscular propagation. Results People with T2D demonstrated greater reductions in MVCC power (38.4±5% vs. 23.5±16%; time × group, $p < 0.05$) and MVIC torque (42.9±19% vs. 32.7±9%; time × group, $p < 0.05$) compared with controls. T2D and controls both demonstrated reductions in the MEP and M wave amplitudes and areas (time, $p < 0.05$); and increased latency of the MEP and M wave (time, $p < 0.05$); and no group differences were evident (time × group, $p > 0.05$). Conclusions People with T2D and no clinical signs or symptoms of DPN demonstrated greater fatigability compared with controls after a dynamic fatiguing contraction, however, the greater fatigability among T2D was not due to disruption of corticomotor excitability or neuromuscular propagation. Among patients with T2D and no DPN, corticomotor excitability and neuromuscular junction propagation likely do not contribute to increased fatigability.

P3-K -74 Intra-rater reliability and agreement in the ankle electromyography activity emg during sit to stand in healthy young adults

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BACKGROUND AND AIM: EMG is a neurophysiologic measurement of the muscle electrical activity, used for assessment of the activation and recruitment pattern. In functional activities, such as Sit to Stand (STS),EMG pattern of the lower limb has been evaluated, specifically activity of the Tibialis Anterior(TA), Soleus(SO),Medial Gastrocnemius(MG) and Lateral Gastrocnemius(LG),since these muscles play important role for foot stability, displacement the center of gravity and anticipatory movements. It has been reported a EMG reliability moderate to excellent (Intraclass Correlation Coefficient ICC:0.57-0.92) during isolated muscle contractions of trunk and knee(isometric, concentric or eccentric), however there is not available information regarding the STS task. The aim is to evaluate the intra-rater reliability and the agreement level of the ankle muscles EMG analysis during STS.METHODS:An evaluation of a diagnostic test, with a non-probability sampling. Participants performed three STS trials and the average was used for statistical analysis. TA, SO, MG and LG were assessed synchronizing EMG surface signal (sEMG) with a load cell to differentiate stages of pre-extension (start of movement to takeoff) and extension (takeoff to stand). The sEMG was normalized by submaximal voluntary contraction (SVC) and signal processing was performed using specific routines in MATLAB. The variables were: Root Mean Square (RMS); amplitude; and Median Frequency (MF). In order to enhance the independence of the measurements, the same rater conducted the two assessments with a period of eight days between them. Reliability was analyzed by the ICC and agreement with the Bland-Altman method.RESULTS:Ten healthy participants of both genders aged 24.3±1.6 years, height 165.6±9.4 cm and weight 63.1±13.1 kg were included in the study. The reliability for the RMS amplitude was good to excellent in the pre-extension:TA(ICC:0.70),LG(ICC:0.92),SO(ICC:0.91), and the extension: TA(ICC:0.84), LG(ICC:0,94) and SO(ICC:0.92). Same results were observed for the FM in pre-extension: TA(ICC:0.88), LG(ICC:0.64) and SO(ICC:0.81). For MG, the reliability was acceptable for the RMS amplitude in pre-extension (ICC:0.32), extension (ICC:0.36); and FM in pre-extension (ICC:0.45), but FM in extension was moderated (ICC:0.60). The Bland-Altman method showed mean differences of the measures close to zero and narrow limits, except the FM of the GM in both phases, pre-extension: 4,92(95% limits of agreement -43.3, 53.1) and extension: 0,54(-39.9, 41.1).CONCLUSIONS:In this population, the measurement is reliable when it is performed with a standardized and synchronized technique during functional task. Therefore, it is recommended in future studies to evaluate the psychometrics properties of these test in people with impaired movement to determine the muscle electrical activity and the effect of therapeutic interventions, without the changes been attributed to error or measurement variability.

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P3-K -75 Ageing and electromyographic fatigue patterns of masticatory muscles

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BACKGROUND AND AIM: Muscle fatigue is induced during a constant force isometric contraction, determining the functional performance and the resistance of the individual. The purpose of this research was to determine electromyographic (EMG) fatigue, by median frequency (MF) of the EMG signals of masseter and temporalis muscles in children, adolescents, adults and elderly to demonstrate the normal parameters of the masticatory muscles based on age. METHODS: 74 volunteers (age 7-80 years), fully dentate (except for I - mixed dentition) were divided into five groups: I (7-12 years), II (13-20 years), III (21-40 years), IV (41-60 years) and V (61-80 years). All groups were divided with respect to gender (08M / 08F), except for Group V (05M / 05F). This research was approved by the Ethics Committee in Research of the School of Dentistry of Ribeirão Preto, University of São Paulo. The EMG analysis was performed using the Myosystem-Br1 apparatus. The analyses of the median frequency data EMG signal were standardized obtaining the values of the select windows of 5 seconds length duration at initial time (IMF), medium time (MMF) and final time (FMF) of total length duration of each analysis. EMG fatigue was obtained during a constant force isometric contraction .The total length (seconds) for EMG fatigue of the groups were: I (29.12 ± 4.88), II (32.16 ± 3.28), III (39.57 ±3.50), IV (41.68 ±4.74) and V (60.97 ± 9.82). Normalized median frequency were tabulated and subjected to statistical analysis (ANOVA; SPSS 21.0). RESULTS: There were no statistically significant differences ($P < 0.05$) between the Groups for the median frequency (Hz) of the EMG signals of masseter and temporalis muscles: Right Masseter: IMF=[(I=1.01 ± 0.03, II=1.03 ± 0.03, III=0,94 ± 0.02, IV=0.95 ± 0.02, V=0.92 ± 0.05)], MMF=[(I=0.93 ± 0.02, II=0.89 ± 0.04, III=0.86 ± 0.04, IV=0.87 ± 0.02, V=0.86 ± 0.05)], FMF=[(I=0.92 ± 0.03, II=0.80 ± 0.05, III=0.83 ± 0.05, IV=0.78 ± 0.04, V=0.80 ± 0.05)]; Left Masseter: IMF=[(I=1.01 ± 0.03, II=1.03 ± 0.05, III=0.93± 0.03, IV=0.98 ± 0.03, V=0.97 ± 0.01)], MMF=[(I=0.90 ± 0.03, II=0.91 ± 0.05, III=0.85 ± 0.04, IV=0.91 ± 0.03, V= 0.92 ± 0.02)], FMF=[(I=0.91 ± 0.03, II=0.84 ± 0.05, III=0.81 ±0.04, IV=0.84 ± 0.03, V=0.90 ±0.04)]; Right Temporal: IMF=[(I=0.98± 0.02, II=1.00 ± 0.03, III = 0.97 ± 0.01, IV = 0.94 ± 0.01, V = 0.99 ±0.01)], MMF=[(I =0.91 ± 0.03, II=0.89 ± 0.04, III=0.89 ± 0.03, IV=0.89 ± 0.01, V=0.93 ± 0.04)], FMF=[(I=0.87 ± 0.04, II=0.83 ± 0.04, III= 0.82 ± 0.04, IV=0.84 ±0.02, V=0.88 ± 0.05)]; Left Temporal: IMF=[(I= 0.97 ± 0.03, II=1.04 ± 0.03, III = 0.96 ± 0.02, IV=0.98 ± 0.02, V=0.98 ± 0.03)], MMF=[(I=0.90 ± 0.03, II=0.92 ± 0.03, III=0.88 ± 0.03, IV=0.91 ± 0.02, V=0.91 ± 0.03)], FMF=[(I=0.88 ± 0.04, II=0.87 ± 0.03, III=0.79 ± 0.04, IV=0.85 ± 0.02, V=0.88 ±0.02)]. CONCLUSION: The results this research showed that age is not

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associated with EMG fatigue of masseter and temporalis muscles. ACKNOWLEDGEMENT: FAPESP