SESSION IX

Title: STRETCHING AND EXERCISE: BENEFITS AND DOWNSIDES FOR SKELETAL MUSCLE.

A MULTI-ELECTRODE ARRAY APPROACH TO MUSCLE FIBERS CONDUCTION VELOCITY ESTIMATION DURING DYNAMIC EXERCISES

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The possibility of investigating motor control strategy from myoelectric signal has been variously addressed using needle or surface EMG (sEMG) with controversial results. Nevertheless, sEMG time-domain or frequency domain parameters provided some reliable informations about the physical phenomena underlying sEMG signal generation. In general, it has been accepted that:

• Amplitude content of sEMG reflects the level of muscle activation;
• Spectral content of the myoelectric signal provides indirect information related to the quality of active MU. However, sEMG spectral parameters are strongly influenced by a number of factors thus their reliability is largely questioned.

On the other hand, muscle fibre conduction velocity (CV) is an important physiological parameter because it allows the non invasive assessment of motor units recruitment-derecruitment (1) and thus the modification of the peripheral properties of the neuromuscular system as a consequence of exercise. Estimation of CV from sEMG recording is a complex task and asks for a complex experimental set-up which uses multi-electrode array configurations.

In this paper, we present CV estimation methods used in our laboratory and a set of the different results we obtained.


KNEE FLEXORS-EXTENSORS COACTIVATION DURING VERTICAL JUMPS IS REDUCED IN VOLLEYBALL PLAYERS

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Aim: The aim of the present work was to verify the hypothesis that in skilled volleyball players the neuromuscular control around the knee joint during vertical jumps (CMJ) is more efficient than in non athletic subjects. Neuromuscular control was assessed in terms of agonist-antagonist coactivation, resistance to fatigue, mechanical power.

Methods: 5 male volleyball players and 5 male young healthy subjects matched for age, weight, height, BMI, were recruited for this study. The following tests were performed in random order: 5 single CMJ, 5 single squat jumps (SJ). At the end of single jumps test, subjects performed 30
repetitive CMJ (CMJ30). Surface EMG signals were recorded from Vastus Lateralis (VL) and Biceps Femoris (BF) muscles on both sides. Ground reaction forces and moments were measured with a force plate (Bertec, USA). Right knee angle was measured with an electrogoniometer (Satem, Roma).

Results: CMJ data provided better results than SJ in both groups and, as it was expected, volleyball athletes performed better than sedentary subjects in all tests. The CMJ30 test showed that athletes are much more resistant to fatigue than sedentary. Contrary to controls, athletes’ sEMG shows a reduced coactivation of antagonist muscles (knee flexors) irrespective of the jump style. Present results seem to stand for a neural adaptations of the motor control scheme to training.

Conclusions: Previous studies have suggested that muscle coactivation could be reduced by specific long-lasting training. This seems to be the case also for vertical jump training that seems to induce specific neural adaptations.

ACUTE EFFECTS OF PASSIVE STRETCHING ON A PREVIOUSLY FATIGUED SKELETAL MUSCLE

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Passive stretching (PS) has been shown to depress maximum muscle performance. However, few studies focused on the effects of PS on maximum force in a fatigued muscle. Thus, the aim of the present study was to evaluate the stretching-induced changes in the electrical and mechanical characteristics of a previously fatigued muscle during electrically evoked contractions. Eleven subjects (age: 21±2 yrs; body mass: 71±3 kg; stature: 176±3 cm; mean±s.e.m.) were tested twice. In both occasions, the calf muscles were fatigued with continuous electrical stimulation. During the first test, after fatigue the subjects underwent 3 tetanic electrical stimulations, before and after a bout of PS. On a different day, after fatigue the subjects were tested again before and after a resting period of the same duration as the PS protocol. During contractions, surface EMG, mechanomyogram (MMG) and force were recorded from the medial gastrocnemius muscle. From the 3 signals, the electro-mechanical delays were calculated (EMG-MMG, EMG-force and MMG-force, respectively). Fatigue induced a reduction in peak force in both testing sessions (-17.5±3.7 N and -18.0±3.4 N, respectively). Without PS, EMG, MMG and force parameters, together with electro-mechanical delays returned to their values before fatigue. With PS, however, EMG parameters returned to their values before fatigue, but MMG parameters remained depressed whilst peak force further decreased (-22±9%, p<0.05). Moreover, EMG-force and MMG-force delays were significantly lengthened by +10±3% and +12±4%, respectively. In conclusion, a bout of PS further decreases muscle maximum force generating capacity, affecting in particular the viscoelastic properties of the muscle–tendon unit. Thus, PS does not seem to be advisable as a method to recover maximum force after fatigue, especially when a following task is required.

EFFECT OF ORAL CREATINE SUPPLEMENTATION ON NEUROMUSCULAR FUNCTION

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Despite oral creatine supplementation has been proven to be effective in enhancing exercise performance, its effect on neuromuscular function is still uncertain.

**Aim:** The present study aimed at verifying whether short-term creatine (Cr) supplementation would improve muscle contractile properties (as assessed by evoked and voluntary contractions), the force-velocity relationship and muscle fatigue during repeated bouts of exercise.

**Methods:** 16 moderately active men (25±3 years) were assigned to a creatine (CRE) or placebo (P) group using a double-blind random design. Subjects assumed either 5g Cr + 15g maltodextrin (CRE) or 20g maltodextrin (P) 4 times a day for 5 days. Before and after supplementation, isometric maximal voluntary contraction (MVC), maximal twitch, force-velocity relationship and repeated dynamic fatiguing contractions were assessed in the elbow flexor were evaluated and mechanical and electromyographic (EMG) parameters recorded and analysed. Mean fibres conduction velocity (CV) was estimated from adjacent EMG signals and used as a parameter of interest.

**Results:** Peak torque of maximal twitch was 33.46% higher and time to reach the peak torque was 61.29% lower in CRE than P (P<0.05). Torque-angular velocity curve was improved after Cr supplementation. Mean fibres CV was on average 8.9% higher in CRE at all angular velocities after supplementation (P<0.05). Creatine supplementation did not affect EMG and mechanical parameters during the repeated exercise fatiguing protocol.

**Conclusions:** Oral creatine supplementation enhances intrinsic and voluntary contractile capacity of skeletal muscle of young men. This could be related to an increased Ca$^{2+}$ sensitivity and maximum Ca$^{2+}$-activated force, which are associated to an increase in cellular water content needed to maintain osmolality.

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**KNEE EXTENSOR MUSCLE BEHAVIOUR AFTER FATIGUE IN KATA AND KUMITE ELITE ATHLETES**

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Karate athletes are divided in two main disciplines: Kata and Kumite. The former includes a choreographed patterns of isometric and explosive movements whereas the latter is a 3-min combat against an opponent. The 2 arts imply different training programs in order to enhance athletes’ performance. This could have induced differences in skeletal muscle resistance to fatigue. Thus, aim of the study was to evaluate the knee-extensor muscle response to fatigue in a group of elite karate athletes. Fifteen athletes (8 Kumite and 7 Kata), with similar anthropometric characteristics and muscle-plus-bone area of the knee-extensors, performed a maximal voluntary contraction (MVC) before and after a fatiguing protocol. During MVC, the electromyogram (EMG), the force signals and the blood lactate concentration ([La]) were acquired. From EMG signal, the root mean square (RMS) and fibres conduction velocity (CV) were calculated. MVC was similar in the 2 groups. The fatiguing protocol lasted significantly longer in Kata than in Kumite (44±8 SD cycles and 31±11 cycles respectively). After fatigue, the MVC and EMG RMS significantly decreased in both groups to similar values, but no changes were found in CV. [La] was significantly higher after fatigue in Kata than in Kumite (4.9±0.73 mM and 3.9±1.3 mM, respectively). However, after normalisation by the number of fatiguing cycles, the difference in [La] disappeared. In spite of a similar MVC, Kata showed a higher resistance to fatigue compared to Kumite. The continuous isometric contractions typical of Kata may have induced changes in muscles compatible with a more resistant behaviour. On the contrary, Kumite, involving rapid dynamic contractions, could have lead muscles to faster but less resistant characteristics.