Introduction: The electric field induced by magnetic stimulation (MS) is able to stimulate intramuscular motor axons, which evoke muscle contraction (Machetanz, 1994). The purpose of the present study was to examine the effects of repetitive MS (rMS) of the m. soleus (So) on the Hmax/Mmax-ratio.

Methods: 24 healthy male students took part in a double blind study. Subjects were randomly assigned to a treatment group (G1: n = 13; age 24.08 ± 1.98; weight 77.77 ± 7.34; height 181.31 ± 6.76) and a control group (G2: n = 11; 23.00 ± 1.55; 79.55 ± 11.67; 182.00 ± 8.31). rMS was delivered using a MagProR30 stimulator and a MC-125 circular coil. The stimulation protocol included the application of symmetric biphasic pulses, a frequency of 15 Hz, 20 trains, inter train interval 2sec, 100 bursts per train and 40% stimulator output. rMS took place once and was applied to So of G1. G2 received a placebo rMS. Before and after rMS Hmax/Mmax-ratios and torque (T in Nm), produced by plantar flexion of So after electrical stimulation of the N. tibialis, were evaluated.

Results: After rMS Hmax/Mmax was significantly enhanced in G1 (0.585 ± 0.176 vs. 0.630 ± 0.142; p = 0.015), whereas Hmax/Mmax of G2 remained nearly unmodified (0.516 ± 0.195 vs. 0.519 ± 0.214). The increment of Hmax/Mmax of G1 was not generated by enhancements of Hmax (3.681 ± 1.914 vs. 3.637 ± 1.679), but on account of a significantly decreased Mmax (6.105 ± 2.095 vs. 5.644 ± 1.945; p = 0.027). Furthermore, T of G1 revealed nearly no changes (10.20 ± 2.67 vs. 10.13 ± 2.81).

Discussion: The decline of Mmax was likely induced by muscular fatigue, although T did not indicate on that. Possibly Mmax decreased during the course of the experiment [1]. The predominant mechanisms remain unclear.

Conclusion: The used stimulation protocol led to an enhancement of Hmax/Mmax-ratio, due to the reduction of Mmax.

References


Adaptations in muscle strength and neuromuscular activation on selective muscles of the ankle joint following a combined sensorimotor and strength training

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Introduction: It has been proved that high-intensity strength training (HST) and sensorimotor training (SMT) enhance muscle strength and neuromuscular activation [1]. The present study investigated the effects of a combined SMT and HST on ankle joint muscles.
**Methods:** 17 subjects were divided into two groups. Group 1 (young short track elite athletes, G1: $n=7$; age $17.0 \pm 1.3$; weight $67.7 \pm 7.0$; height $176.4 \pm 8.2$) had to go through a combined SMT and HST, which were performed successively in each training session twice a week for twelve weeks. A control group without training was investigated additionally (students, G2: $n=10$; age $25.90 \pm 4.23$; weight $74.81 \pm 13.79$; height $176.40 \pm 8.44$).

Before and after training period maximum peak torque (PTmax in Nm) during inversion/eversion of the right ankle joint was evaluated. Isokinetic concentric testing occurred at $240^\circ/s$ using the CYBEX NORM®. The activations of mm. peroneus (Pe) and soleus (So) were recorded by surface EMG. Root mean square (RMS in mV) was evaluated.

**Results:** G1: After training PTmax during inversion was significantly enhanced ($17.47 \pm 4.37$ vs. $23.57 \pm 3.58$; $p=0.006$) accompanied by significantly increased RMS in So ($12.42 \pm 6.09$ vs. $24.00 \pm 9.37$; $p=0.008$). PTmax during eversion revealed a moderate improvement ($16.35 \pm 3.05$ vs. $17.82 \pm 2.43$) accompanied by enhanced RMS in Pe ($37.51 \pm 16.60$ vs. $50.79 \pm 36.88$). G2: After training PTmax during inversion was slightly increased ($23.85 \pm 7.84$ vs. $26.93 \pm 7.27$) accompanied by minor enhanced RMS in So ($20.47 \pm 16.91$ vs. $21.85 \pm 10.31$). PTmax during eversion was hardly improved ($20.61 \pm 8.23$ vs. $21.53 \pm 7.59$) associated with nearly unmodified RMS in Pe ($32.86 \pm 14.53$ vs. $32.97 \pm 9.30$).

**Discussion:** In G1 increased PTmax during inversion/eversion was likely induced by enhanced recruitment of So and Pe motor units. G2 revealed a minor enhancement of PTmax and RMS during inversion, probably on account of learning effect.

**Conclusion:** Combined SMT and HST evoked adaptations in muscle strength and neuromuscular activation of selective ankle joint muscles.

**References**


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**Neuromuscular fatigue after an ultra-marathon**

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**Introduction:** Despite an increasing number of people participating in ultra-marathons, the causes and the kinetics of neuromuscular fatigue induced by that type of exercises are poorly known. The aim of this study was to examine the effects of 24 h treadmill running on neuromuscular function.

**Methods:** Twelve experienced ultra-marathon runners performed (i) knee extensors (KE) and plantar flexors (PF) maximal voluntary contractions (MVC; global fatigue), (ii) KE and PF maximal voluntary activation (%AV; central fatigue), (iii) KE and PF low and high frequency stimulations (excitation-contraction coupling), and (iv) KE absolute force of MVC + 0.3 s superimposed tetanus at 100 Hz (intrinsic force) before, every 4h during and after a 24 h treadmill run. Blood samples were taken immediately after each neuromuscular test.

**Results:** KE strength losses were greatest during the first 12 h ($-32\%$), KE MVC decrease reaching $-41 \pm 17\%$ ($P < 0.001$) at Post 24 h. PF MVC decreased linearly to its lowest value $-34 \pm 16\%$ ($P < 0.001$) after 20 h. %AV decreased by $33 \pm 22\%$ ($P < 0.001$) and $15 \pm 19\%$ ($P < 0.01$) for KE and PF, respectively. Low-to-high frequency ratio remained unchanged in both muscle groups. Intrinsic KE force decreased to a low extent ($-10\%$, mostly during the first 16h) and a large variability was found for this factor ($\pm 16\%$). A large variability was also
Table 1

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<th>Activity</th>
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observed for serum creatine kinase concentrations (CK), reaching 13.319 ± 13.493 U/L at Post24h. A significant negative correlation ($R = -0.65; P < 0.05$) was observed between CK at 24 h and the changes in KE intrinsic force.

**Conclusion:** Alteration of excitation-contraction coupling does not play a role in fatigue induced by an ultra-marathon. Peripheral fatigue, likely located at the cross-bridge level, decreased by 10% but a large heterogeneity was found between subjects for this parameter. Fatigue after an ultra-endurance running event is mostly accountable to central mechanisms. The risks associated with muscular damage after an ultra-marathon must be individually determined.

**Polymyographic study of the pelvic floor muscle activation in daily and therapy related activities**

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**Introduction:** The aim of this study is the evaluation of the involvement of the Pelvic Floor Muscles (PFM) in daily and therapy related activities (ADL).

**Methods:** The neuromuscular activity was measured by a NORAXON EMG-System in healthy women (N=37, 23–46 years). Detected were the PFM (probe) and the main muscles of the trunk and the lower extremity. The raw EMG was sampled with 1500 Hz in a band of 10–500 Hz. The EMG data were full wave rectified, smoothed (RMS 100 ms) and mvc normalized. All data were statistically analyzed by a multi-factorial analysis of variance by using the software EASYSTAT.

**Results:** In ADL the PFM was seen as the most active muscle. Under exercise conditions the PFM is the most active muscle group in nearly all analyzed activities. The highest neuromuscular innervation was found in machine exercises.

**Discussion:** The results outline the important role of PFM innervations in ADL. The data revealed that PFM can effectively be trained by dynamic exercise in preventive and therapeutic strategies. It seems reasonable to conclude that with the use of complex exercises the non-voluntary activation of the PFM can be facilitated.
Conclusion: The result of this study emphasizes the involvement of the PFM in ADL and therapeutic treatment modalities. In ADL PFM seems to stabilize and protect the trunk and the viscera in healthy women. The results of the therapeutic activities seem to offer many new and more interesting possibilities of preventive and rehabilitative training the PFM.

References


Vibratory exercise improves the dynamic balance in women with fibromyalgia

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Introduction: It has been recently reported balance deficit in persons with fibromyalgia. This deficit is consistent with the neuromuscular alterations they show. Vibratory exercise has improved balance in postmenopausal women and elderly but there is no study analyzing the effect of whole-body vibration on patients with fibromyalgia.

Objective: The purpose of the current study is to assess the feasibility and effects on dynamic balance of a 3 month whole-body vibration exercise program in women with fibromyalgia.

Material and Method: 36 women with fibromyalgia were randomly assigned in two groups: 18 in the control group and 18 in the exercise group. The training program lasted 12 weeks, three weekly sessions were offered. Each session consisted of 6 repetitions at 12.6 Hertz on a reciprocal platform (Galileo 2000) with an initial duration of 30 seconds that was increased monthly, in 15 seconds. Between each repetition a rest of a minute existed. We assessed the isometric force by isokinetic dynamometer (Biodex System 3) and the dynamic balance with a balance platform (Biodex). Data were analyzed by multiple linear regression including baseline data.

Results: All patients completed the vibratory exercise program. The exercise group compared to the control group improved dynamic balance. Patients had a smaller level of isometric force at baseline and those that had a greater weight improved more because of the relative load of training was greater.

Conclusions: A whole-body vibration exercise program is useful, safe and applicable to improve the dynamic balance in women with FM.

Hemodynamic impact of a “test-training” isokinetic session

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Introduction: Test and training on isokinetic device induces an important hemodynamic response. Unfortunately, there are few studies on the continuous evolution of those parameters during such session. The aim of this study is to evaluate, on healthy subjects, the hemodynamic responses (Bloods pressure (BP), heart rate (HR), cardiac output (CO)) of a typical isokinetic session.

Material and method: 20 healthy subjects realized a isokinetic session consisted in a testing (60 and 180°/sec) and a training (10 sets of 7 contractions at 180°/sec, separated by a 1 minute recovery period). The hemodynamic parameters are non invasively and continuously measured by a Task Force Monitor Device.
Results: The total work during the 60°/sec test is naturally higher than during the test at 180°/sec. The HR, BP and CO are always higher during the 60°/sec test but the differences are not significant.

During the training, the total work remains constant, at more and less 80% of the maximal work realized during the test. We observe a progressive drift of all the parameters (except systolic volume) during the successive sets. Isolated values of BP higher to 200 mmHg have been observed with a mean of about 180 mmHg. The maximal HR represent about 70% of the maximal predicted HR. We observe a week correlation between total work and maximal observed HR or BP.

Conclusions: During the training session, the total work remains stable but the hemodynamic parameters increases during the successive sets. The observed HR pic value are moderated but important considering the BP. CO increase significantly, during the test and the training, but principally by the HR increase, systolic volume is unchanged.

The hemodynamic responses of “real patient” of older people remain to be investigated.

Session 2

Inter- and Intra Observer Reliability of a New Measurement Device for Tibiofemoral Rotation

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Introduction: Evaluation of the inter- and intra-observer reliability of a new developed measurement device for tibiofemoral rotation.

Methods: 30 healthy subjects (15 m, 15 w, mean age of 24 years) were examined with the Rotameter knee laxity measurement device. After fixation of the device on the lower extremity and positioning of the patient in the starting position the device was first externally and then internally rotated at an applied torque of 5, 10 and 15 Nm. To decrease the measurement error the procedure was repeated 5 times. Afterwards 5 measurements were performed by a second examiner in the same way to measure the inter-observer reliability. All 30 patients were measured again by the same examiners at a mean of 4 weeks to test the intra-observer reliability. Statistical analysis was performed using the intra-class correlation coefficient (ICC).

Results: At an applied torque of 5 Nm the ICC for the intra-observer reliability of was 0.87 for the external rotation and 0.81 for the internal rotation; the ICC for the inter-observer reliability was 0.97 for the external and 0.96 for the internal rotation. At 10 Nm of rotation torque an ICC of 0.87 was reached for internal and 0.91 for external rotation, the ICC for the inter-observer reliability was 0.98 for internal and 0.98 for external rotation. At the highest applied torque of 15 Nm an ICC for the intra-observer reliability of 0.95 was observed for the external rotation and 0.89 was found for internal rotation. For the inter-tester reliability the ICC was 0.98 for external and 0.99 for internal rotation.

Conclusion: The Rotameter testing device for the measurement of tibiofemoral rotation showed a high inter-observer and intra-observer reliability. It is easy to perform and might be used in a wide field to examine the rotational stability.
Rehabilitation exercises for patients treated with characterized chondrocyte implantation and microfracture

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\textit{Introduction:} To evaluate the achievement and compliance with a specific standardized rehabilitation protocol, the rehabilitation protocol was applied in the multi-center randomized clinical trial comparing CCI to microfracture in treating symptomatic cartilage defects of the knee.

\textit{Methods and Materials:} The proposed protocol describes the rehabilitation process by goals and restrictions. Duration, frequency and intensity of exercises to be performed were not preset. The reporting rate and the physiotherapy were followed-up over a post-operative period of 12 months. Ninety-five physiotherapists received instructions for applying and reporting the standardized rehabilitation protocol. Reporting variables included clinical examination, physical exercise routines, mobilization modalities, electrotherapy and thermotherapy.

\textit{Results:} Reporting rate during the first three months was 100%, with a response frequency of at least 85% once month. The following 3 months, the frequency dropped to 50%, from which 41% occurred once a month. In the last 6 months; a total of only 27% reported of which 15% monthly. Due to the low report rate after 3 months, the physiotherapy data was not analyzed. The first 3 months the physiotherapists reported 4 modalities per session on an average of 3.3 sessions per week. The preference and timing of the modalities were highly consistent with the protocol in both groups. Moreover, the modalities used for both treatment groups were not significantly different over 12 weeks. However within specific weeks, minor differences for time spent on gait re-education (week 7) and active mobilization exercises (week 2 and 5) were observed.

\textit{Conclusion:} Overall, rehabilitation was implemented in the same way in both treatment arms. The physiotherapists followed and reported the protocol with an excellent compliance during the first three months. Unfortunately, follow up to 12 months showed a progressive decline in reporting.

Evaluating knee function in patients treated with characterized chondrocyte implantation and microfracture, following an identical, standardized rehab protocol

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\textit{Introduction:} Compared to microfracture, a two-step open surgery with characterized chondrocyte implantation (CCI) is expected to be unfavorable for the recovery of knee function. The objective was to assess index knee function in patients following an identical, standardized rehab protocol as part of a multi-center randomized clinical trial comparing CCI to microfracture in treating symptomatic cartilage defects of the knee.

\textit{Methods and Materials:} Fifty-one CCI and 61 microfracture patients were assessed prior to, and six, nine, and 12 months after surgery. Mobility (AROM), Anterior Laxity (with KT1000), Isokinetic Strength (at 60 \degree/sec) and Functionality (as expressed by the single hop, crossover triple hop and timed hop test) were evaluated. Eighty-nine percent (N = 100/112) of the patients completed the mobility tests, 75.8% (N = 85/112) the functional tests, 66.9% (N = 75/112) the strength tests and 58% (N = 65/112) the anterior laxity tests. Completion rate was equally divided amongst both groups. Differences were assessed using the Wilcoxon and Fisher’s exact test for respectively the continuous and categorical variables. A value of \( P < 0.05 \) was considered significant.
Results: No significant differences in baseline knee function between both treatment groups were observed. In general, knee function recovered at 12 months for both groups. This trend continues up to 12 months for all four tests. At 9 months the difference for quadriceps strength was significantly higher ($p = 0.046$) in the microfracture group (median = 186) compared to the CCI group (median = 144).

Conclusion: The results show that the physical impact of an arthroscopic MF procedure compared to a two-step open-knee CCI procedure has no significant influence on target knee function at 12 months after surgery.

Long-term outcome of fasciotomy for chronic exertional compartment syndrome of the forearm in competitive motor cyclists

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Introduction: Chronic exertional compartment syndrome of the forearm is probably an underdiagnosed cause of forearm pain in the motor cyclists. The clinical diagnosis is confirmed by measurements of intracompartmental pressures. The treatment is an open fasciotomy. Although data suggest that this technique may be effective, no researchers have evaluated the patient satisfaction neither post-surgical muscular strength.

Methods: We are reviewing 24 forearm fasciotomy in 12 patients who had chronic exertional compartment syndrome of the forearm. They are all professional motorcycle racer at national or international level. The follow-up is from 36 to 66 month. The indications for surgery were resting pressures in excess of 15 mmHg and elevated post-exercise pressure measurements with delayed normalization. A written questionnaire about satisfaction or the evolution was already made and a clinical and isokinetic strength evaluation is now performed.

Results: Eleven patients reported success with complete resolution of symptoms or significant reduction of pain during exercise. Four patients noted the return of pain during strong effort. After fasciotomy, the return to training was made in a delay of 5.4 weeks (4–10) and return to competition after 9.8 weeks (6–24). Nine patients don’t report any muscle weakness, two patients described subjectively an increase of their strength and two a strength decrease of the forearm. Isokinetic strength test show a decrease of flexor muscle groups about 10–15% on dominant side. Nevertheless, most of patients have been treated on both sides and dominant side was always the most symptomatic. Isokinetic tests are going to be performed to a second group of healthy motorcycle racers with the same competition level and identical characteristics, in order to be able to compare results.

Discussion: This study has demonstrated that fasciotomy of forearm, when done with the correct indications and with the appropriate technique, gives excellent relief of chronic forearm pain by competitive motor cyclists. It allows for the large majority of patients to return to sports, to a pre-operative competitive level. A decrease in forearm strength is possible but without functional impact.

References
Free Communications

Intensity control in swim training by means of the individual anaerobic threshold

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Introduction: In competitive swimming, training intensities are usually expressed either as percentages of personal best time or maximum heart rate. However, there is evidence that this procedure may result in heterogeneous metabolic strain in different subjects. The present study aimed at evaluating the homogeneity of metabolic strain during swim training bouts when intensities were prescribed with reference to the individual anaerobic threshold (IAT, Stegmann et al. 1981).

Methods: 16 competitive front crawl swimmers (4♀/12♂, age: 17.1 ± 2.1 years, training history: 7.3 ± 2.8 years) performed an incremental swimming test to determine the IAT. Within a maximum of 3 weeks, 4 typical training programs were conducted: 20x100m low-intensity endurance training (LET, 97% IAT), 5x400m high-intensity endurance training (HET, 101% IAT), 5x200m intensive interval training (IT, 105% IAT), and 10x100m IT (108% IAT). Blood lactate concentrations [bLa] were determined during each training session. Results are given as median (lower/upper quartiles).

Results: During LET and HET [bLa] were 1.8 mmol*L-1 (1.2/3.0 mmol*L-1) and 4.4 mmol*L-1 (4.2/6.5 mmol*L-1), respectively. Average [bLa] were higher during both IT programs, rising to 6.4 mmol*L-1 (5.6/7.2 mmol*L-1, 5 × 200 m) and 6.8 mmol*L-1 (5.0/6.5 mmol*L-1, 10 × 100 m). The [bLa] of most individuals were found closely around the median values. However, in each training program, there was one subject with [bLa] situated clearly above the median (~3 to 7 mmol*L-1 higher). Although not statistically significant due to the low number of subjects, [bLa] seemed to be higher for short-distance swimmers (50 and 100 m) compared to long-distance swimmers (>400 m) during all tested programs.

Conclusion: Intensity prescriptions by means of the IAT seem to elicit a homogeneous metabolic strain in most individuals. The observed averages [bLa] are similar to those recommended in the current scientific literature for such programs.

Sports injury surveillance in young athletes in Luxembourg

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Introduction: Sports injuries could have a considerable impact on the young athlete’s career and quality of life in adulthood. Effective preventive countermeasures must rely on permanent sports injury surveillance.

Methods: Seventy-two athletes, 20 girls and 52 boys, enrolled in the Luxemburgish sport academy were followed for one school year (from September 2007 to July 2008). Training and competition volume were recorded daily in a personal diary. Every sports injury was recorded via a standardized form. A sports injury was defined as an incident occurring during training or competition that prevented the athlete to participate in at least one training session or game.

Results: Of the 72 athletes aged 11.9 to 17.8 years, 41 (56.9%) had at least one sports injury. In total 97 injuries were recorded, corresponding to an injury rate of 1.35 injuries per athlete per period of interest. On average the athletes had 9.1 hours practice per week. The global incidence reached 3.43 injuries per 1000 hours of sport practice. The risk of injury in competition (incidence of 13.66) was 10.7 times greater than the injury risk in training (incidence
Most injuries implicated the lower extremity (66%). Considering the injury severity, 17.5% were classified as major, preventing the athlete from normal sport practice for more than 4 weeks. Almost half of the injuries were declared as recurrent. Thirty-one percent of the sports injuries were progressive, 69% were acute injuries of which approximately half were due to an internal cause.

**Discussion:** A high proportion of progressive and noncontact injuries was found. They could have been induced by modifiable risk factors which should be targeted by preventive strategies.

**Conclusion:** The present results could have implications for the organisation of the Luxembourgish sport academy. A long term follow-up is required to evaluate the effectiveness of preventive measures.

Session 3

**Relation between maximal power output during isokinetic workout on a cycling ergometer and maximal strength**

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**Introduction:** Common cycling literature recommends disclaiming unspecific strength training during season but to prefer on a bike strength endurance training [1]. Only few studies show benefits of strength training for endurance sports [2]. The purpose of this study was to proof correlation between power output at different cadence and maximum strength.

**Methods:** Power output of junior cyclists (male; n = 8; weight: 63.2 kg ± 5.7 kg) was measured during isokinetic test on a SRM Ergometer with fixed cadence as well as maximum strength on a static measurement system (BAG).

**Results:** Neither at 60 RPM \( (r = 0.03) \) nor at 140 RPM \( (r = 0.03) \) a relation between maximum strength and power output could be found. But at 80 RPM a correlation could be found \( (r = 0.65; p < 0.05) \) while at race specific cadence a high correlation could be located. 100 RPM \( (r = 0.83; p < 0.01) \) and 120 RPM \( (r = 0.77; p < 0.05) \) are race specific and seem to show a good correlation.

**Discussion:** The measured data show a high correlation between maximum power output during fixed race specific cadence and maximum strength. At higher cadence force development is not fast enough to produce maximum force until movement is finished [3]. Especially in decisive situations during races the ability of a high power output and fast force development seem to be reasons to recommend unspecific maximum strength training to enhance neuromuscular influencing variables of maximum force like recruitment, synchronisation and firing rate.

**Conclusion:** The current result only shows a cross section of young athletes. Further studies with a higher sample should give more information. In addition studies with a treatment “training maximum strength” should be established.

**References**


Relevance of inertial fatigue test in sport applications

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Introduction: Inertial tests are interesting because they involve common resistance training exercises. However, they usually focus on maximal strength, power and velocity. Recently, a sustained dynamic exercise was proposed in order to assess muscular fatigue. The present study investigates the relevance of such inertial fatigue test in sport applications.

Methods: The inertial fatigue test consisted in 30 maximal bench press repetitions with a resistive charge corresponding to 40% of the one repetition maximum (1RM). Three studies were performed in order to explore its reproducibility and sensibility. In the reproducibility study, 10 subjects performed the fatigue test twice, one week apart. The second study appreciated sport influence in comparing sedentary (n = 10), physical education students (n = 10), power lifters (n = 10) and throwers (n = 6). The third study investigated the ability of the test in monitoring specific training effects (n = 20).

Results: Reproducibility of the fatigue parameters (fatigue index and mean power during the 30 repetitions) was good (coefficients of variation ranging from 3 to 6%). The test was discriminative: differences were observed in mean power between sedentary and sportsmen, and in fatigue index between power lifters and throwers. In the third study, the fatigue test indicated significant improvement after 5 weeks of muscular endurance training.

Discussion: The present study demonstrated the reliability and sensibility of bench press inertial fatigue test. Such testing method indicated the level of muscular performance (with mean power) and how it can be maintained during prolonged exercise (with fatigue index). In several sport contexts inertial fatigue test should be used in order to compare athletes and to monitor resistance training effects. The test duration and the relative load to be used may be adapted to the sport specificity.

Conclusion: Inertial fatigue test is an original and functional method which deserves more attention in sport applications.

Strength imbalances and prevention of hamstring injury in professional soccer players: A prospective study

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Introduction: Hamstring strains are very common and prone to recurrence in soccer players. Strength imbalances are suggested to play a key-role in muscle injury, yet relationship between hamstring strain and strength disorders remains matter of controversy in the literature. The aim of our study was to determine whether (a) strength variables could be predictors of subsequent hamstring strain and (b) normalization of strength imbalances could reduce the incidence of hamstring injury.

Methods: 687 professional soccer players performed a standardized preseason isokinetic testing. The concentric and eccentric measurements permitted to identify soccer players with strength imbalances. Subjects were classified among four subsets according to the imbalance management content. Recording subsequent hamstring injuries allowed defining injury frequencies and relative risks (RR) between groups.

Results: Of 687 players isokinetically tested in preseason, a complete follow-up was obtained in 462 players, for whom 35 hamstring injuries were recorded. The rate of muscle injury was significantly increased incases with
untreated strength imbalances in comparison with players showing no imbalance in preseason (RR 4.66). The risk of injury remained significantly higher in players with strength imbalances and subsequent compensating training but no final isokinetic control test than in players without imbalances (RR 2.89). Conversely, normalizing the isokinetic parameters reduced the risk factor for injury to that observed in players without imbalances (RR 1.43).

Discussion-Conclusion: The outcomes in this prospective study allow to conclude that (1) the isokinetic intervention, as a preseason screening tool in professional soccer players, gives rise to the early detection of strength imbalances; (2) untreated strength imbalances increases the rate of subsequent hamstring injury; (3) restoring normal strength performances and agonist/antagonist ratios in players with preseason imbalances significantly reduces the risk of hamstring injury.

Award Session

Neural and muscular adaptations to resistance training in young men supplemented by essential amino acid

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Introduction: This investigation evaluates the increase in skeletal muscle mass (SMM) and muscle strength following essential amino acids (EAA) supplementation, as well as the neural adaptations to a resistance training program.

Methods: 23 young active males were divided into placebo (PL) and EAA groups performing resistance training during three months. Maximal strength during squat and bench press exercises were tested on an isokinetic ergometer. SMM was assessed by anthropometric measurements [1]. The maximal isometric torque of the triceps surae and the electromyographic (EMG) activities of the soleus were studied in response to voluntary and electrical stimulations. Gastrocnemius medialis muscle architecture was examined in vivo using ultrasonography.

Results: The mean concentric strength for the two exercises and the SMM increased significantly in both groups. When comparing the normalised strength (initial strength/SMM) and the gain in strength, the EAA supplementation tended to be more effective in a “weaker” population. Maximal isometric torque increased by 4%. Muscle activation increased by 0.5% and voluntary EMG to M-wave ratio was enhanced by 15.6%; pennation angle was increased by 6.8%.

Discussion: Our study pointed out an increase in SMM in both PL and EAA groups, with no statistical difference between the groups. However, the increase in SMM under EAA supplementation appears to be more effective in subjects who had a lower initial muscle torque. The increased ratio of the maximal voluntary EMG, recorded without any change in the amplitude of the M-wave, indicates an increase in the neural activation of the agonist muscles. Our study is in accordance with the study of Aagaard (2) which indicates a positive correlation between pennation angle and muscle volume.

Conclusion: The torque gain may not be fully explained by muscle hypertrophy, but also by changes in agonist neural command.

References

Characteristic of agonist muscles activation during a ballistic contraction preceded by rapid antagonist muscles activation

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Introduction: The rate of isometric torque development is usually greater when a rapid (ballistic) contraction is preceded by the activation of the antagonist muscles than when performed from a resting state.

Methods: To analyse the underlying mechanisms, subjects performed a task that consisted successively: (1) to sustain a submaximal force (20% MVC) with the dorsiflexor (DF) muscles (agonists), (2) to perform a rapid contraction at ∼50% of the maximal force with the plantarflexor (PF) muscles (antagonists) and (3) to produce, without transition, a ballistic contraction with the DF. The motor evoked potential (MEP) induced by transcranial magnetic stimulation (TMS) and the Hoffmann reflex (H-reflex) were recorded at different times of the task.

Results: The results showed a silent period (SP) of 35 ± 5 ms in the EMG activity between the end of the antagonists’ activation and onset of agonists’ activation. The changes in MEP and H-reflex amplitudes followed the same time course throughout the task. They never overpassed 50% of the control values during the antagonist activation, increased progressively during the SP period and reached 120% and 150% during the ballistic action for the MEP and H-reflex, respectively.

Discussion and conclusion: The study indicates that in addition to the recoil of the elastic energy stored in the DF muscles during the preceding activation of the antagonists, the SP seems also to play a role in the increased rate of torque development during the ballistic contraction. Presumably, the functional contribution of the SP period is to bring motoneurones into a non-refractory state and thereby enable them to discharge at a higher rate during the subsequent ballistic contraction. The similar time course of change for the MEP and H-reflex suggests the contribution of post-synaptic inhibitory mechanisms.

References

How the brain acts: Imagination of proprioceptive modalities after ACL-reconstruction

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Imagination is thought to be a useful tool in rehabilitation even though there still is a lot of scepticism in practitioners. Spectral EEG frontal Theta and parietal Alpha-2 spectral power values were consistently described in cognitive and sensorimotor tasks in conjunction with the load of the working memory. The purpose of the study is to look if EEG spectral power is influenced by an ACL reconstruction even during imagination of two different sensorimotor tasks.

Eight patients after ACL-reconstruction and eight controls performed an imagination of repeated knee angle reproduction (4 min; JPS) and of a repeated reproduction of a standardized force (4 min, FS) each with a resting period (4min) afterwards. The EEG was measured from frontal, parietal and occipital scalp locations and analyzed in a 2 (group) × 2 (modality) × 2 (condition) design. Average power spectra in Theta and Alpha-2 frequency were log-transformed and computed across all modalities and conditions in each participant. Brain activity results in increased Alpha-2 power (O2, F1, 14 = 7.869; p = 0.020; part.&#951; 2 = 0.349) in the ACL-group compared...
to the controls. Theta (Fz, F3, F4: F1, 14 = 14.405; \( p < 0.002; \text{part. } \eta_{\text{p}}^2 = 0.579 \)) and Alpha-2 power (Pz, P3, P4: F1, 14 = 8.829; \( p < 0.011; \text{part. } \eta_{\text{p}}^2 = 0.404 \)) demonstrated differences between conditions imagination and rest. There were no differences between modalities. Occipital Alpha-2 power is influenced by an ACL reconstruction. This may be due to information processing in the visual cortex. Differences between conditions are discussed in terms of changes in focused attention with involvement of the anterior cingulate cortex (frontal Theta) and sensory processing in the somatosensory cortex (Alpha-2). The increased Alpha-2 power during imagination compared to rest seemed to be an inhibition process in the somatosensory cortex.

In conclusion the EEG is able to measure the load of the working memory related to focused attention and sensory information processing and can probably be used in evaluation mental training.

**Functional and therapeutic effects of 8 weeks sensorimotor training in Achilles and Patellar tendinopathy**

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**Introduction:** Sensorimotor training (ST) is frequently used to optimize neuromuscular performance, especially to improve joint stability in athletes. Possible effects on maximum strength performance capacity in athletes with chronic injuries are unclear. The purpose of this study was to analyse the effects of an 8 week ST on maximum strength and possible pain reduction in athletes with unilateral tendinopathy at the lower limb.

**Methods:** 26 athletes with unilateral tendinopathy (Achilles or Patellar tendon) randomized to either control group (C; \( n = 14 \)) or ST group (S; \( n = 12 \)) and 33 healthy athletes (H) were examined. During the 8 week intervention, training habits were not influenced accept an additional ST for group S. Concentric and eccentric strength performance capacity of knee extensors/flexors, ankle dorsi-/plantarflexors as well as the extensors of the total lower limb was assessed with dynamometers (Con-trex MJ/LP®) pre and post intervention. Subjective pain ratings were additionally assessed with validated pain scores. Measures were analysed descriptively followed by univariate ANOVA for repeated measures \( (\alpha = 0.05) \)

**Results:** Results showed higher strength values after ST (S) for eccentric knee extension (+14.1%) and eccentric extension of the total lower limb (+24.0%) compared to controls (H; C) \( (p < 0.05) \). No differences were found in all other conditions. Subjective pain ratings were reduced up to 24% of initial values in S, whereas in C pain ratings increased during the intervention.

**Discussion:** 8 Weeks of ST obviously improves maximum strength performance capacity in athletes suffering from Achilles and Patellar tendinopathy. Additionally, pain reduction is observed due to training. The combination of functional and therapeutic benefits, support the thesis of optimized neuromuscular performance to reduce negative stress on the passive (tendon) structures.

**Conclusion:** ST is an appropriate tool to optimize neuromuscular performance (eccentric strength) and reduce subjective pain ratings in patients suffering from lower limb tendinopathies while regular training is maintained.