**Poster Abstracts**

**Intra-rater variability of sonographic measurements of the Achilles tendon**

M. Cassel, A. Carlsohn, S. Müller, H. Baur, J. Scharhag and F. Mayer  
*University Outpatient Clinic, Sports Medicine and Sports Orthopaedics, University of Potsdam, Germany*  
E-mail: mcassel@uni-potsdam.de

**Introduction:** To evaluate adaptation to strength training in clinical diagnostics and follow-up of Achilles Tendinopathy repeated sonographic measurements of the tendon diameter are regularly performed [1]. However, limited data on validity criteria, especially intra-rater variability of anteroposterior (a.p.) diameter of the Achilles tendon (AT) are available. It is unclear whether longitudinal and transversal transducer placements represent reliable methods to measure AT a.p. diameter. Therefore, the purpose of the study was 1. to assess validity of transversal scan of AT a.p. diameter compared to longitudinal transducer placement (standard [2]) and 2. to evaluate the intra-rater variability of both measurements.

**Methods:** The AT a.p. diameter of 14 healthy recreationally active subjects (28.1 ± 4 years; 170.4 ± 9 cm; 68.3 ± 12 kg) was measured at baseline and after 3 days of follow-up (8-MHz transducer, Xario, Toshiba) by the same experienced examiner. Diameter was measured in two different conditions (longitudinal versus transversal) 2 cm proximal the insertion [2]. Differences were tested by one-way ANOVA (α = 0.05). To evaluate reliability of measurements test-retest-variability (TRV), ICC and 95% limits of agreement (LOA [3]) were calculated.

**Results:** AT a.p. diameter measured with transversal scans was not different from results of longitudinal transducer placement (p > 0.05; Table 1). Intra-rater-TRV ranged from 3.3–5.8%, ICC from 0.74 to 0.89. LOA were narrow between measurement days, transducer position and sides (Table 1).

**Discussion:** Results suggest that measurement condition (i.e. transducer placement) does not influence values of AT a.p. diameter in healthy subjects. High reliability was observed in both tendon sides independently of transducer placement.

**Conclusion:** Longitudinal and transversal measurements of AT a.p. diameter are valid and reliable.

**References**


---

**Footwear comfort perception evolution with running exercise duration**

J. Cavagna, F. Hintz, J. Issart, and J.-L. Chaverot  
*Laboratoire de Physiologie de l’Exercice, EA 4338 Université de Savoie, Le Bourget du Lac, France*

**Table 1**  
Means ± SD, TRV, ICC and LOA in different positions at both measurement days (M1, M2)

<table>
<thead>
<tr>
<th>Transducer placement</th>
<th>Side</th>
<th>M1 ± SD[mm]</th>
<th>M2 ± SD[mm]</th>
<th>TRV[%]</th>
<th>ICC</th>
<th>LOA[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal (n = 14)</td>
<td>Left</td>
<td>5.2 ± 0.5</td>
<td>5.3 ± 0.7</td>
<td>5.8 ± 4.3</td>
<td>0.74</td>
<td>−0.90–0.75</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>5.1 ± 0.4</td>
<td>5.1 ± 0.6</td>
<td>5.3 ± 4.0</td>
<td>0.77</td>
<td>−0.65–0.71</td>
</tr>
<tr>
<td>Transversal (n = 11)</td>
<td>Left</td>
<td>4.9 ± 0.5</td>
<td>5.0 ± 0.5</td>
<td>5.5 ± 4.0</td>
<td>0.78</td>
<td>−0.76–0.52</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>4.9 ± 0.5</td>
<td>5.0 ± 0.4</td>
<td>3.3 ± 3.3</td>
<td>0.89</td>
<td>−0.47–0.31</td>
</tr>
</tbody>
</table>

**Discussion:** Results suggest that measurement condition (i.e. transducer placement) does not influence values of AT a.p. diameter in healthy subjects. High reliability was observed in both tendon sides independently of transducer placement.

**Conclusion:** Longitudinal and transversal measurements of AT a.p. diameter are valid and reliable.

---

**Footwear comfort perception evolution with running exercise duration**

J. Cavagna, F. Hintz, J. Issart, and J.-L. Chaverot  
*Laboratoire de Physiologie de l’Exercice, EA 4338 Université de Savoie, Le Bourget du Lac, France*

**Table 1**  
Means ± SD, TRV, ICC and LOA in different positions at both measurement days (M1, M2)

<table>
<thead>
<tr>
<th>Transducer placement</th>
<th>Side</th>
<th>M1 ± SD[mm]</th>
<th>M2 ± SD[mm]</th>
<th>TRV[%]</th>
<th>ICC</th>
<th>LOA[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal (n = 14)</td>
<td>Left</td>
<td>5.2 ± 0.5</td>
<td>5.3 ± 0.7</td>
<td>5.8 ± 4.3</td>
<td>0.74</td>
<td>−0.90–0.75</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>5.1 ± 0.4</td>
<td>5.1 ± 0.6</td>
<td>5.3 ± 4.0</td>
<td>0.77</td>
<td>−0.65–0.71</td>
</tr>
<tr>
<td>Transversal (n = 11)</td>
<td>Left</td>
<td>4.9 ± 0.5</td>
<td>5.0 ± 0.5</td>
<td>5.5 ± 4.0</td>
<td>0.78</td>
<td>−0.76–0.52</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>4.9 ± 0.5</td>
<td>5.0 ± 0.4</td>
<td>3.3 ± 3.3</td>
<td>0.89</td>
<td>−0.47–0.31</td>
</tr>
</tbody>
</table>

**Discussion:** Results suggest that measurement condition (i.e. transducer placement) does not influence values of AT a.p. diameter in healthy subjects. High reliability was observed in both tendon sides independently of transducer placement.

**Conclusion:** Longitudinal and transversal measurements of AT a.p. diameter are valid and reliable.

**References**


Introduction: Shoe comfort is one of the most important aspects for shoe manufacturers, as a consequence it is an important element for the design of shoes [1]. Comfort encompasses different characteristics and has varied definitions related to the concept of positive sensation [2], feelings of relaxation and well-being [3] or pleasant state [4]. Footwear comfort perception is not well studied and, to our knowledge, no author focuses on the evolution of the footwear comfort perception with the duration of the exercise. Thus, the purpose of the present study was to investigate overall subjective footwear comfort perception (OFC) with running exercise duration.

Methods: Ten males (age: 21.1 ± 1 years, height: 177.1 ± 6.6 cm, weight: 70.7 ± 7.4 kg) physically active and free of lower limb injury were recruited. Each participant selected the running footwear (Salomon shoe) that fit the best his feet. The OFC evaluation was realised with a 150 mm Visual Analogic Scale (VAS) [5]. Subjects have to answer the question ‘What is the degree of comfort perceived in your footwear?’ by ticking the VAS with the left end labelled ‘very negative’ and the right end ‘very positive’. The subjects realised two identical sessions (i.e. test/retest protocol) with one week interval. Each session was a running trial on a 2.6 km lap, similar to a trail race, until exhaustion. The freely chosen speed corresponded to each individual speed race. OFC was evaluated at the end of each lap during a fifteen seconds walking period and at the end of the test. OFC ratings were compared with Student or Wilcoxon tests.

Results: The subjects ran during 95.5 ± 3.0 minutes, i.e. 5.5 laps. Lap durations were not different between sessions but increased significantly with the running time. OFC results are reported in the Table 1. OFC (1) decreased significantly with running time whatever the session and (2) were not different between sessions.

Table 1
Mean ± SD of OFC for each lap of the two sessions

<table>
<thead>
<tr>
<th>Lap</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>session 1</td>
<td>108.4 ± 18.8</td>
<td>105.5 ± 20.2</td>
<td>92.4 ± 24.5</td>
<td>85.8 ± 19.5</td>
<td>73.4 ± 20.3</td>
</tr>
<tr>
<td>session 2</td>
<td>111.0 ± 19.1</td>
<td>102.8 ± 16.5</td>
<td>95.8 ± 18.1</td>
<td>88.0 ± 19.3</td>
<td>86.9 ± 26.5</td>
</tr>
</tbody>
</table>

Difference with the first lap: Δp < 0.05; ΔΔp < 0.01; ΔΔΔp < 0.001; Difference with the second lap: ♦p < 0.05; ♦♦p < 0.01; ♦♦♦p < 0.001. Difference with the third lap: ×p < 0.05; ××p < 0.01; ×××p < 0.001 Difference with the fourth lap: □p < 0.05; □□p < 0.01; □□□p < 0.001.

Discussion: OFC were significantly different between the beginning and the end of the running test, i.e. the footwear comfort decreased significantly with exercise duration. Moreover, the lap duration increased with running time, what can be considered as a fatigue consequence. OFC deteriorations were reported between the 1st and the 2nd lap but OFC decrease were observed between lap 2 and 3 (P = 0.002 for session 2; P = 0.059 for session 1). Similarly, no differences were observed between 3rd and 4th lap (all sessions), 3rd-4th and 5th lap (session 2). Then fatigue and/or duration exercise influenced the subjective footwear comfort during running. Two explanations could be proposed. First, the footwear became ‘really’ uncomfortable at the end of the test and this discomfort was evaluated by the subject. Second, the subject getting tired during the test, their feet sensors could be more sensitive so that the subject felt the footwear uncomfortable whereas it doesn’t be. But these explanations could not be verified with this study. According to the test/retest protocol, the reliability of the OFC measurements would seem to be acceptable for evaluation of comfort.

Conclusion: This repeatable methodology point up that OFC perception decreases with exercise duration for all subjects. This deterioration of general footwear comfort is not time proportional and one should expect at least 30 min running exercise at speed race to notice comfort rating differences.

References

Estimation of the stratum corneum Diclofenac reservoir by chromametry

R. Clijsen\textsuperscript{a,b}, P. Clarys\textsuperscript{b}, J.-P. Baeyens\textsuperscript{b} and A.O. Barel\textsuperscript{b}
\textsuperscript{a}University College Physiotherapy “Thim van der Laan”, Landquart, Switzerland
\textsuperscript{b}Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Belgium
E-mail: r.clijsen@physioschule.ch

Introduction: The stratum corneum (SC) is known to form a reservoir for topically applied substances. Investigations on the reservoir function of SC are important in order to understand the pharmacokinetics of topically applied substances, and to elaborate the optimal treatment procedure. The aim of our study was to estimate the reservoir properties of Diclofenac (DF) after a single topical application with and without occlusion.

Methods: A group of 14 healthy volunteers (females and males, aged 20–25) free of local or systemic treatment with any drugs participated in this study. During the duration of the experiments the volunteers were asked to maintain their daily activities but to abstain swimming and extensive showering. A 1% DF (Voltaren Emulgel\textsuperscript{®}, Novartis) formulation (12 mg) was applied on the volar forearms on randomized defined circular skin areas of 7 cm\textsuperscript{2}. The product was applied for 20 minutes under two different conditions at the same time; passive diffusion under a semi occlusive sponge and an application without occlusion. Bioavailability of DF in the SC under the two conditions was assessed by quantification of a methyl nicotinate (MN) induced erythema at respectively 48 and 72 hours post DF application. When DF is present in the stratum corneum the nicotinate response is depressed in a concentration dependent way. The response of the MN induced erythema was quantified with the Minolta Chromameter operating in the L*\textsuperscript{a} \textsuperscript{b} mode. Measurements were carried out before DF application; prior to MN application and at every 5 minutes until 1 hours post MN application. Kinetics were compared using the MANOVA procedure.

Results: \textsuperscript{a*} in function of time at respectively 48 hours post DF application is represented in graph 1. At both measurement times (48 and 72 hours post DF application) the MN response was weaker at the DF treated skin sites compared to the MN response at the untreated control site. There was no difference between open or semi-occlusive application, neither at 48 hours nor at 72 hours post DF application. When comparing the application modalities at the different time intervals (48 hours versus 72 hours post DF application) no significant differences were found.

Conclusion: Up to 72 hours post an initial open or semi occlusive DF application we found an inhibition of the MN response. This can be used as an indication for the presence of active DF in the stratum corneum. The
reservoir formation seems to be independent of the application modality. Evaluation of the MN response at longer time intervals post DF seems necessary to estimate the duration of the DF reservoir.

Risk for the Female Athlete Triad in adolescent synchronized swimmers

R. Clijsen\textsuperscript{a,b}, M. Kersting\textsuperscript{a} and J. Taeymans\textsuperscript{a,b}
\textsuperscript{a} University College Physiotherapy Thim van der Laan, Landquart, Switzerland
\textsuperscript{b} Department Human Biometry and Biomechanics, Vrije Universiteit Brussel, Belgium
E-mail: r.clijsen@physioschule.ch

Introduction: The aim of the study was to examine adolescent synchronized swimmers for risk factors of the Female Athlete Triad and to investigate correlations between menstrual disorders (MD) and energy balance (EB) on the one hand, and anthropometric parameters on the other hand.

Relevance: Until now only two surveys in connection with the risk for the Female Athlete Triad in synchronized swimmers have been carried out, although prevalence has increased in aesthetic sports [1–3]. Early recognition is of high importance.

Methods: 20 juniors of the Swiss Synchronized Swimming National Team (SY) (Mean age \(\pm\) SD = 16.4 \(\pm\) 1.2 years) were tested. Examination included anamnesis of menstrual cycles by questionnaires, determination of EB during a practice camp, measurements of 8 skin folds (SKF) and calculations of body fat percentage (\%BF) and somatotype (S). MD were defined as polymenorrhea (cycle length (CL) < 25 days), oligomenorrhea (CL > 35 < 90 days) and amenorrhea (no menstruation > 3–6 months). Subjects were divided into athletes with eumenorrhea (ATHL\textsubscript{Eu}; \(n=9\)) and athletes with MD (ATHL\textsubscript{MD}; \(n=11\)). For statistics \(p>0.05\) was fixed.

Results: Athletes were 164.3 \(\pm\) 5.3 (M \(\pm\) SD) cm tall, weighed 51.8 \(\pm\) 6.3 (M \(\pm\) SD) kg and had 22.1 \(\pm\) 3.7 (M \(\pm\) SD) \% body fat. Altogether 55\% of SY showed MD distributed over 10\% polymenorrhea, 30\% oligomenorrhea and 15\% amenorrhea. Mean EB was \(-1132 \pm 607.9\) (M \(\pm\) SD) kcal/day, mean EB of ATHL\textsubscript{MD} (\(-1259.5 \pm 663.5\) (M \(\pm\) SD) kcal/day) was lower than mean EB of ATHL\textsubscript{Eu} (\(-976.1 \pm 527\) (M \(\pm\) SD) kcal/day). There was no correlation between MD and EB (\(r_{pbis} = 0.232\)). Significant correlations were found between MD and SKF\textsubscript{Biceps} (\(r_{pbis} = 0.524\)), MD and SKF\textsubscript{Pectoral} (\(r_{pbis} = 0.452\)), and MD and S (\(r_{pbis} = 0.454\)), but not between MD and \%BF (\(r_{pbis} = 0.415\)).

Conclusion: The prevalence of MD found in SY is higher than that found in the literature [3]. The conclusion may be drawn that adolescent synchronized swimmers show an elevated risk for MD and the Female Athlete Triad.

References


Physiological response to 6 minute walk test in healthy subjects

G. Deboeck, F. Dessables, A. Moreau and R. Naeije
Hôpital Erasme, ULB, Belgium
E-mail: gael.deboeck@ulb.ac.be

Introduction: Maximal aerobic capacity is defined by maximal oxygen consumption (VO\textsubscript{2max}) that is determined during a maximal cardiopulmonary exercise testing (CPET). In clinic, the 6-minute walk test (6MWT) is usually
used to determine submaximal aerobic capacity. It is derived from the running Cooper test, based on the linear relationship between VO$_2$ and mean running or walking speed, maximal walking speed being good correlated with VO$_2$max. Although 6MWT is considered as a submaximal test, several studies already shown in patients that VO$_2$ observed during 6MWT was equal to VO$_2$max or peak with even thought a respiratory exchange ratio (RER) < 1 [1, 2]. Physiological response to 6MWT in healthy subjects had never been reported.

**Methods:** 52 healthy subjects (26 women) (age: 20 to 59 y, height:172 ± 9 cm (mean ± SE), weight: 68 ± 11 Kg) performed a 6MWT and CPET with telemetric measurements of ventilation (VE), VO$_2$, CO$_2$ production and heart rate (HR). RER, respiratory equivalent for CO$_2$ and oxygen pulse (O$_2$pulse) were derived.

**Results:** Cardiac and ventilatory variables observed during 6MWT and CPET are given in Table 1. Eleven subjects (∼20%) attained a VO$_2$ and VE/VCO$_2$ equivalent to maximal exercise measurements with however HR and RER similar to those observed at anaerobic threshold (AT).

**Conclusion:** 6MWT elicits ∼ 80% of maximal aerobic capacity with a metabolic stress (RER) corresponding to AT, 20% of the healthy subjects reaching VO$_2$max during walking with a RER still below 1.

**References**


**A new device to understand the biomechanics of whiplash injuries: A pilot study**

H. Felder$^a$ and L.A. Gäng$^b$

$^a$University of Applied Sciences Fresenius, Idstein, Germany
$^b$University of Applied Sciences Kaiserslautern, Department of Microsystems Technology, Zweibrücken, Germany

**Introduction:** Motor vehicle collisions are a common case of musculoskeletal trauma, with soft-tissue injury of the spine, namely whiplash injury, accounting for as many as 90% of all collision-related injuries. The neck is very prone to sudden force injuries, where a sudden force is applied and the unstable head and neck hyperextend or hyperflex. To understand the biomechanics of this trauma several models are used: in vitro (including postmortem human subjects), in vivo (including animals or human volunteers), computational (including kinematics and stress analysis-based finite element research) and physical models (crash test dummies) [1]. Our device is suitable to understand the intrinsic biomechanics of several load or acceleration levels. It combines mechanical (kinematics, kinetics) measurements depending on biological properties of the neck.

**Methods:** Former empirical studies were undertaken with the objective of finding out how high the actual myoelectric and mechanical strain of the muscles of the neck and shoulder is during an ‘in-vivo’ drive in an automobile in relation to their maximum power [2]. Previous studies using a virtual setting has shown significant differences between shoulder and neck muscles activity as well as differences right to left side muscle activities. For ethical reasons, researchers will always be constrained from producing injury in subjects, and the exact pathological basis for the whiplash injury remains elusive.
**Results:** Findings from [2] are used (input) for the physically and biological modelling (tension calibration of the neck muscles) of an vivo-equivalent test dummy to understand the morphological and biomechanical behavior of the muscles during a whiplash injury. In vitro studies provide data for the design, development, and validation of biofidelic physical models (see Fig. 1). Biomechanical effects such as initial cervical posture and occupant awareness on the head-neck behavior could be delineated. It has been possible to describe the temporal overall, segmental, and local component biomechanics of the head-neck complex. Results have shown that kinematic and kinetic responses are greater in the impact domain than during normal biomechanics loading.

![Fig. 1. Vivo-equivalent test dummy.](image)

**Discussion:** The kinematics and kinetics of the neck during a simulated rear-end impact are very complicated; the neck experienced compression, tension, shear forces, flexion, and extension at different stages. Biomechanical investigations of the artificial neck supports the hypothesis that injuries are caused in a combined axial and shear force acting [3].

**Conclusion:** The findings with the physical dummy are relevant for prevention in the field of conditions using technical assistance as well as in the field of behavior prevention (f.e. safety engineering of head rests). Occupational health professional – therapists – must therefore become increasingly familiar with the research concerning whiplash injury mechanisms to optimize therapy.

**References**


**Effects of a new training method on dynamic balance performance**

M. Fröhlich\(^a\), A. Pieter\(^b\), S. Junker\(^a\), H. Felder\(^b,^d\) and C.T. Haas\(^b,^c\)

\(^a\)Saarland University, Institute for Sport Science, Germany
\(^b\)Institute for Health Promotion, DHfPG-University of Applied Sciences, Germany
\(^c\)Institute for Sport Sciences, J.W. Goethe-University Frankfurt, Germany
\(^d\)Olympic Training Centre Rhineland-Palatinate/Saarland, Germany

E-mail: m.froehlich@uni-saarland.de

**Introduction:** While swissball training has been applied in therapy for years [1] – e.g. regarding strengthening trunk muscles – its effects have not been proved in competitive sports very well. With respect to the modus of
some swissball exercises one can speculate about improvements in coordinative parameters, too. This could be of crucial importance e.g. for wrestlers as various coordinative components – e.g. dynamic stand stability – play an important role in the competition. Similarly reaching coordinative improvements in elite wrestlers is challenging as their performance is already developed very well.

Methods: The effects of wrestling-specific coordination training using the swissball was examined in 9 young elite wrestlers from the Olympic training centre Rhineland-Palatinate/Saarland (EG: age: 15.5 ± 1.4, height: 169.9 ± 7.6 cm, weight: 63.7 ± 19.0 kg) and 9 sport students (CG: age: 26.6 ± 0.6, height: 177.6 ± 9.5 cm, weight: 78.4 ± 7.6 kg). The training in the experimental group took place twice a week for 10-weeks overall. In each training session the wrestlers performed 5–6 different swissball exercises (i.e., kneeling with closed eyes, diagonal hand-knee stand, swissball course, 10 m swissball pushcart forward) in 2–3 sets. Coordination performance was analyzed on the one hand via a specific swissball parcour (measuring time to complete and heart rate). One the other hand dynamic stand stability was analyzed using different tests on a Posturomed device (30sec single-leg stance, provocation test). Before testing two familiarization appointments took place.

Results: The time to complete the swissball course was reduced significantly (p < 0.05) between the pre- and post-test in the wrestlers group, while there was no difference in the control group. The heart rate amplitude (post-stress heart rate minus resting heart rate) did not change significantly in any group (all p > 0.05). However, in the wrestlers a tendency for reduced heart rate in the post-test became evident. Regarding balance, wrestlers show in the post tests significantly improved performance in the Posturomed provocation test (p < 0.05) and in the single-leg stance (p < 0.05). In the control group changes in the Posturomed balance tests did not reach significantly (p > 0.05).

<table>
<thead>
<tr>
<th></th>
<th>Swissball parcour</th>
<th>Posturomed Balance Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time to complete</td>
<td>Heart rate amplitude</td>
</tr>
<tr>
<td></td>
<td>[s]</td>
<td>[min⁻¹]</td>
</tr>
<tr>
<td>Group</td>
<td>EG</td>
<td>CG</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>37.8 ± 12.5</td>
<td>89.6 ± 20.9</td>
</tr>
<tr>
<td>Post-Test</td>
<td>33.1 ± 10.6</td>
<td>89.9 ± 21.5</td>
</tr>
</tbody>
</table>

Discussion: The results show that specific swissball training leads to improvements in various coordination components in young elite wrestlers. This is of crucial importance on the one hand as coordinative performance is already developed very well in these subjects and on the other hand it is likely that improved coordination enhance overall performance in competition. The trend of the reduced heart rate in the wrestler athletes combined with higher coordinative performance represents improved economy of movement. With respect to the competition this adaptation might help to avoid metabolic situation with borderline values [2].

Conclusion: Swissball training can be used effectively not only in therapy but also in high performance sports as an alternative intervention. In the end, the probability of success can be increased through optimized movement coordination by the use of a swissball training by wrestlers.

References

The sense of coherence in patients with neuromuscular diseases – a comparative study
M. Fröhlicha, A. Pieterb, E. Emricha, H. Felderb,d, M. Klein and C.T. Haasa,c
aSaarland University, Institute for Sport Science, Germany
bInstitute for Health Promotion, DHfPG-University of Applied Sciences, Germany
Introduction: The construct “sense of coherence” (SOC) describes a global orientation that expresses the extent to which one has a pervasive, enduring but still dynamic feeling of confidence. This relates to the stimuli received from one’s internal and external environments being structured, predictable and explicable. Also, it is assumed that available resources meet the demands posed by these stimuli, and finally, we need to consider that demands are challenges, worthy of investment and engagement [1]. The subscales of the SOC measured the three categories comprehensibility, meaningfulness, and life’s manageability. The aim of the study was to analyze the SOC in patients with neuromuscular diseases.

Methods: The sense of coherence questionnaire has 29 items. 11 items are related to comprehensibility, 10 to meaningfulness, and 8 to manageability (answered in a 7 point semantic differential). Scores are calculated for each subscale and all items are added to obtain the SOC score (SOC scores range from 29 to 203). Examples of the phrases used in the response line for the SOC are completely fascinating vs. deadly boring, full of interest vs completely routine, and a source of deep pleasure and satisfaction vs a source of pain and boredom [1]. The effect of the SOC was examined in 96 patients with neuromuscular diseases – e.g. muscular dystrophy, atrophy, motor neuron disease etc. (EG: age: 50.02 ± 13.22; 59 female, 37 male) and 82 subjects without any chronic disorders as a control group (CG: age: 38.67 ± 11.05; 45 female, 37 male). The age was different in the two groups (F = 37.84; df = 177; p < 0.05; η² = 0.18). An analysis of covariance (age as covariate) was used to determine differences between the two groups. Pearson product moment correlations were used to analyze the interrelationship between the subscales and the SOC. The statistical significance was set at p < 0.05.

Results: The comprehensibility scale shows a significant difference between the two groups (F = 9.27; df = 169; p < 0.05; η² = 0.05). The meaningfulness subscale was significantly different (F = 5.03; df = 170; p < 0.05; η² = 0.03). In the manageability subscale there was no significant difference between the subjects with neuromuscular diseases and the subjects without any diseases (F = 2.60; df = 169; p = 0.11; η² = 0.02). The sense of coherence (total; sum of the 29 items) shows a significant difference between the two groups (F = 6.94; df = 167; p < 0.05; η² = 0.04). The interrelationship between the three subscales in the EG was: comprehensibility vs manageability (r = 0.77, p < 0.05), comprehensibility vs. meaningfulness (r = 0.72, p < 0.05), and manageability vs meaningfulness (r = 0.79, p < 0.05). The correlation in the CG was: comprehensibility vs manageability (r = 0.68, p < 0.05), comprehensibility vs meaningfulness (r = 0.44, p < 0.05), and manageability vs meaningfulness (r = 0.66, p < 0.05).

Discussion: The results show that there was a global difference in the SOC between patients with neuromuscular disorder and a comparable group without any chronic impairment. The results are in disagreement with the findings from Hawley et al. [2] who found no differences in SOC by patients with rheumatic diseases.

Conclusion: In this study, subjects with neuromuscular diseases show different values in the sense of coherence in comparison with subjects without any chronic diseases. The results suggested that through the SOC, available health resources in patients with neuromuscular diseases could be activated and support therapy [3].

References

Chronological order and perceived exertion in rehabilitation training of spinal cord injury patients

C. T. Haas\textsuperscript{a},\textsuperscript{b}, M. Fröhlich\textsuperscript{a}, A. Klein\textsuperscript{a}, A. Schießer\textsuperscript{a}, U. Eisenkrämer\textsuperscript{b}, O. Marcus\textsuperscript{c} and R. Thietje\textsuperscript{d}

\textsuperscript{a}Sport Science Institute Saarland University, 3 BG Trauma Hospital Frankfurt, 4 BG Trauma Hospital Hamburg, Germany
\textsuperscript{b}Institute of Sport Sciences Goethe-University Frankfurt, 3 BG Trauma Hospital Frankfurt, 4 BG Trauma Hospital Hamburg, Germany
\textsuperscript{c}E-mail: c.haas@mx.uni-saarland.de

\textit{Introduction:} Effective rehabilitation of spinal cord injury is fundamentally based on exercise training. Voluminous and intensive training programs – like the constraint induced movement therapy – are commonly used to counteract non-use effects like muscular atrophy and deficits in strength, endurance, or coordination. A further goal of the training is a reorganisation of motor patterns and acquisition of compensatory techniques which assures day to day functions despite neurological deficits. In order to enable maximum learning progress all training actions should be organised systematic and goal-oriented. As it is well known from basic research \textsuperscript{[1,for review]} that success in motor learning depends – amongst others – on the intensity of the exercise, the duration of rest intervals, and the order of training exercises, we analyzed the status quo in two clinical rehabilitation units.

\textit{Methods:} Chronological order of training exercises was documented in 12 incomplete spinal cord injury patients. After each training exercise subjects were asked for their individually perceived exertion using a modified Borg scale. Furthermore, it was analyzed which relative part of the overall exertion results from demands in coordination, strength, and endurance. Documentation was accomplished in each subject over a period of minimum four days.

\textit{Results:} All subjects underwent a voluminous and variable training program each day. An example is given in Fig. 1. On average 45\% of the exercises had coordinative character, 40\% consisted of strength-, and 10\% of endurance-exercises. 5\% of the exercises had mixed goals. After 31\% of all exercises the perceived exertion was $\geq$ 15 points on the Borg scale. Coordination training led in 47\% to 15 or more points on the Borg scale. Rest periods were short on average. Only in 11\% the rest took more than 2 hours between different training exercises whereas in 26\% no rest periods occurred.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Chronological order of rehabilitative training exercises during the course of the day and perceived exertion. The different colours of the bars represent the relative parts of overall exertion: black represents the coordinative part, white represents the strength part, and grey represents the endurance part.}
\end{figure}
Discussion: Patients underwent a voluminous, intensive, and variable training. The risk of developing non use deficits seems therefore low. However, intensity in the coordination training was frequently too high and rest periods too short which might counteract effective motor learning [1,2]. Implementation of specific goal setting routines might help to increase both effectiveness and efficiency in rehabilitation training.

References


Reduction of noise in electromyogram of respiratory muscles

G.L. Morel, P. Mahul, M. Reche, A. Boyer, S. Molliex, M. Muller, A. Geyssant, C. Auboyer and J.P. Viale

aExercise Physiology Laboratory, University Jean Monnet St Etienne, France
bIntensive care Private Hospital of St Etienne, France
cFaculty of Medicine St Etienne, France
dEIP Jonzieux, France
eIntensive care CHU St Etienne, France
fIntensive care CHU Lyon, France

Introduction: The electromyographic signal EMG and has been widely used in intensive care units for evaluation of neuromuscular activity of respiratory muscles because it gives essential indications on the prediction of the respiratory state of tiredness [1]. To obtain these indications, the signal must be cleaned noises and more particularly artefacts ECG before its exploitation. In such conditions quality of EMG signal is essential and depends on the correct positioning of needle electrodes and probes, but can also be interfered by either movements artefacts (tremor, cough, vibrations, shocks) or electrical perturbations such as electrocardiogram (ECG). The aim of this study was then to apply and compare the effect of three different data treatment, wavelets multi-resolution (WAV) [2], wavelets lifting (WLI) [3] and mathematical morphological (MMO) [4,5] techniques, on the noise reduction of diaphragmatic electromyogram signal (Edi).

Fig. 1. Comparison of three methods of noise reduction (panels b, c, d) with raw signal (panel a).
**Materials and Methods:** Raw EMG (Edi) was sampled (12 bits, 2 kHz sampling rate per channel) using an oesophageal probe on 6 healthy volunteers (age: 20–30 years) also taking part in another study. Algorithms of the different data treatment of Edi were developed under Matlab © R2009b.

**Results:** The Fig. 1 show typical noise reductions obtained by WAV (b panel), WLI (c) and MMO (d) compared to Edi (d). The reduction of ECG could be clearly seen in WAV and with less extension in WLI and MMO. The noise reduction, estimated by ratio \( = \frac{|s|^2}{|n|^2} \), \( s = \text{signal Edi}, n = \text{noises background and ECG} \), was 1.15, 0.90 and 0.88 for respectively WAV, WLI and MMO.

**Discussion and conclusion:** It is noted that the three methods are effective, but the decomposition in wavelets multi-resolution is better than the two other methods. Therefore the comparison and use of such methods are crucial for clinical applications like for monitoring of respiratory muscle in intensive care units. These techniques could be also applied in other clinical domains like in sport medicine, rehabilitation, childbirth monitoring (uterine EMG), urology (enuresis) and muscular diseases (myopathy, dystrophy, myasthenia).

**References**


**What is the best parameter to quantify shocks during heel-toe running?**

P. Samozino\(^a\), J.B. Morin\(^a\), V. Mermet\(^a\), C. Barla\(^b\), R. Oullion\(^a\) and A. Belli\(^a\)

\(^a\)Laboratory of Exercise Physiology (EA4338), University of Lyon, F-42023, Saint-Etienne, France

\(^b\)Biomechanics and Mechanics Laboratory, Research Center, Oxylane, France

E-mail: pierre.samozino@univ-st-etienne.fr

**Introduction:** Repetitive heel-strikes occurring during running, notably for shod runners [4], have been associated with musculoskeletal injuries [4,5]. Quantifying impact severity is particularly important for shoe manufacturers wishing to attenuate shocks by cushioning. Different mechanical parameters have been used to quantify heel-strike intensity at impact [1]. The most common are vertical peak impact force and corresponding loading rate, peak shank accelerations and shock wave propagation speed. However, heel-strike comparisons may differ depending on the parameters used [2], and what is more, for some of these parameters (e.g. peak impact force value), results are contradictory between studies [2,3]. Our aim was to determine, among these various parameters, the one(s) allowing to distinguish heel-strike shock intensity at best between different running conditions.

**Methods:** Nineteen men ran at 3.33 m.s\(^{-1}\) in 8 randomised 5-min conditions inducing various levels of shock intensity: one reference condition (freely chosen stride frequency (FCSF) and neutral shoes), one barefooted condition, two conditions with soft and hard midsole shoes, two conditions with +20% and −20% stride frequency, and two conditions with +20% and −20% vertical loading. Vertical ground reaction force \( (n = 19) \) and shank accelerations \( (n = 9) \) were measured (1000 Hz) on a treadmill dynamometer (HEF Tecmachine, France) and using a uniaxial skin-mounted accelerometer (Analog Devices, USA), respectively. Peak impact force \( (F_{z1} \text{ in Body Weight}) \), time to \( F_{z1} \) (\( T_{Fz1} \) in s), impact loading rate \( (R_{z1} \text{ in BW.s}^{-1}) \), peak shank acceleration \( (A_{S} \text{ in m.s}^{-2}) \) and time to \( A_{S} \) \( \text{(T}_{As}\text{ in s}) \) were calculated for each step and averaged over twenty consecutive right steps during the last minute of each condition. The shock wave speed propagation \( \text{(SP in m.s}^{-1}) \) was obtained as the ratio of the heel-accelerometer distance to \( T_{As} \).

**Results:** ANOVA for repeated measures and Newman-Keuls post-hoc tests, performed for each factor (midsole hardness, stride frequency, body weight), put forward that \( T_{Fz1} \) was the parameter showing the highest number
Table 1

<table>
<thead>
<tr>
<th>ANOVA Results</th>
<th>Stride Frequency Effect</th>
<th>Body Weight Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post-hoc test (effect sizes)</td>
<td>Post-hoc test (effect sizes)</td>
</tr>
<tr>
<td></td>
<td>FCSF</td>
<td>80% FCSF</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>P=0.01</td>
<td>S (0.30)</td>
</tr>
<tr>
<td>Neutral</td>
<td>Soft</td>
<td>S (0.89)</td>
</tr>
<tr>
<td>Hard</td>
<td>Soft</td>
<td>NS (0.22)</td>
</tr>
<tr>
<td>Barefoot</td>
<td>Soft</td>
<td>NS (0.65)</td>
</tr>
<tr>
<td>Neutral</td>
<td>Soft</td>
<td>NS (0.48)</td>
</tr>
<tr>
<td>Hard</td>
<td>Soft</td>
<td>NS (0.27)</td>
</tr>
<tr>
<td>Barefoot</td>
<td>Soft</td>
<td>S (0.48)</td>
</tr>
</tbody>
</table>

Of significant differences throughout the proposed running conditions (11 out of 12 possible differences, Table 1). Sensitivity analysis showed important changes in Rz<sub>1</sub>, SP, T<sub>Fz1</sub> and T<sub>A3</sub> with midsole hardness variations, in Rz<sub>1</sub> and A<sub>S</sub> with stride frequency variations, and in Rz<sub>1</sub>, A<sub>S</sub> and T<sub>Fz1</sub> with body weight variations.

Discussion & Conclusion: In light of these results, T<sub>Fz1</sub> can be considered as the most discriminating mechanical parameter to distinguish heel-strike shocks intensity at best during running. In contrast, Fz<sub>1</sub> and A<sub>S</sub>, widely used in running impact studies, were only slightly influenced by the midsole hardness. In fact, T<sub>Fz1</sub> would represent the cushioning duration, and in turn the resulting level of shock intensity: the lower T<sub>Fz1</sub>, the lower the cushioning duration and the higher the shock intensity.

References


Back stress in sports

B. Schäfer<sup>a</sup>, H. Felder<sup>a</sup> and M. Froehlich<sup>b</sup>

<sup>a</sup>University of Applied Sciences Fresenius, Idstein, Germany
<sup>b</sup>Saarland University, Institute for Sport Science, Germany

E-mail: felder@hs-fresenius.de

Introduction: About half of Germany’s population takes exercise on a regular basis [1]. Apart from all the positive benefits of sports, physical exercise may also have a negative impact on the musculoskeletal and locomotor system in general and the spinal column in particular [2]. Approximately 3% of all sport injuries concern the spinal column [3]. Repetitive physical strain may also cause long term damage to the spinal structures [3]. Existing literature does not yet provide a summary of injuries and changes of the spinal column as a result of physical exercise [4]. The aim of this study is the presentation of injuries and changes of the spinal column within team sports such as American Football, Soccer, Handball and Basketball.

Methods: The systematic analysis of publications covering the topic of injuries and changes of the spinal column was conducted. The data bases Medline, Thieme-Connect, PEDro, Spolit, Spofor, Spomedia, Springer, Science Direct and EBSCO were used and complemented by articles from additional international journals in order to conduct
a systematic review. This review, based on studies of the German and English edition, only includes male test persons aged above eighteen years. The 28 publications used were qualitatively assessed according to the Crombie-Scale.

**Results:** In American Football 3.9–18.9% of all injuries observed concern the spinal column. In addition, sports researched with less body contact resulted with 0–12% in international Soccer, 2.3% in Handball and with 3.6–9% in Basketball. Most spinal injuries identified are distortions, contusions and strains. Furthermore, this report shows correlations between physical activity and long-term changes of the spinal column.

**Table 1**
An insight of the results: injuries and changes of the spinal column in American Football and Soccer

<table>
<thead>
<tr>
<th>Sport</th>
<th>Publication</th>
<th>Level</th>
<th>Injuries/Changes</th>
<th>Occurrences</th>
<th>Crombie-Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>American</td>
<td>Boden et al. (2006)</td>
<td>College</td>
<td>Catastrophic cervical injuries</td>
<td>4.72 of 100,000 Player per year</td>
<td>9/15 moderate</td>
</tr>
<tr>
<td>Football</td>
<td>Cantu/Mueller (2003)</td>
<td>All</td>
<td>Injuries cervical spinal cord</td>
<td>1.55 of 100,000 Player per year</td>
<td>7/15 moderate</td>
</tr>
<tr>
<td></td>
<td>Baltzer/Ghadamgahi (1998)</td>
<td>Professional</td>
<td>Typ-1-injuries</td>
<td>100/530 (18.9%) Player per year</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Torg et al. (1990)</td>
<td>College</td>
<td>Cervical injuries (Fractures, Dislocations, Subluxations)</td>
<td>12.55 of 100,000 Player per year</td>
<td>8/15 moderate</td>
</tr>
<tr>
<td>Soccer</td>
<td>Nielsen/Yde (1989)</td>
<td>Professional</td>
<td>Injuries of the spine in general</td>
<td>0/82 (0%)</td>
<td>8/15 moderate</td>
</tr>
<tr>
<td></td>
<td>Hawkins et al. (2006)</td>
<td>Professional</td>
<td>Injuries of the spine in general</td>
<td>352/6030 (6%)</td>
<td>9/15 moderate</td>
</tr>
<tr>
<td></td>
<td>Gallo et al. (2006)</td>
<td>Professional</td>
<td>Injuries of the spine in general</td>
<td>47/391 (12%)</td>
<td>7/15 moderate</td>
</tr>
<tr>
<td></td>
<td>Delaney/Al-Kashmiri (2005)</td>
<td>All</td>
<td>Fractures and Dislocations Cervical spine</td>
<td>0.014 of 100,000 Player per year</td>
<td>8/15 moderate</td>
</tr>
<tr>
<td></td>
<td>Oztürk et al. (2008)</td>
<td>Former</td>
<td>Disc height L1/2</td>
<td>Significantly higher findings (n = 70)</td>
<td>12/15 high</td>
</tr>
<tr>
<td></td>
<td>Uzunca et al. (2005)</td>
<td>Professionals</td>
<td>Bone Mineral Density</td>
<td>S Significantly higher findings (n = 24)</td>
<td>9/15 moderate</td>
</tr>
</tbody>
</table>

**Discussion:** Due to the different methods, definitions and the notifications of occurrences, the comparability of the publications was impeded. Also the varying time of back stress in these sports should be considered. Most of the studies are epidemiological cross-sectional studies. These studies do not justify drawing a causal relation between physical stress and its impact.

**Conclusion:** Meaningful and impressive results could be found and discussed. These results justify the necessity of preventative measures for sportsmen. Though, these results should be interpreted cautiously as most of the studies are epidemiological cross-sectional studies. To further test causality between physical stress and its impact in sports, more longitudinal studies are necessary.

**References**


Health-related anthropometric characteristics and lifestyle habits in gymnasts of the XIII World Gymnast-nda Dornbirn, Austria 2007 – a cross sectional epidemiological study

J. Taeymans\textsuperscript{a,b}, R. Clijsen\textsuperscript{a,b}, D. Aferenhouts\textsuperscript{a}, P. Deriemaecker\textsuperscript{a}, P. Clarys\textsuperscript{a} M. Hebbelinck\textsuperscript{a} and J. Cabri\textsuperscript{c}

\textsuperscript{a}Laboratory of Human Biometry and Biomechanics, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Brussels, Belgium
\textsuperscript{b}University College Physiotherapy “Thim van der Laan”, Landquart, Suisse
\textsuperscript{c}Faculty of Human Motricity, Technical University, Lisbon, Portugal

E-mail: j.taeymans@physioschule.ch

\textit{Introduction:} Physical activity has been proposed as a health enhancing factor, especially in people of over 50 years of age. The aim of this study was to describe the specific health-related anthropometric characteristics and lifestyle habits in a large sample of physical active 10 to 90 years old subjects.

\textit{Methods:} In 2007, 1273 of the 25000 gymnasts participating in the “XIII World Gymnastrrada” (Dornbirn, Austria) were recruited on-site and volunteered in this study (325 males and 948 females). Physical activity and the degree of physical inactivity were assessed using the short version of the international Physical Activity Questionnaire (iPAQ). Anthropometry was conducted following the guidelines of the “International Society for the Advancement in Kinanthropometry” (ISAK, 2001). Static strength of the upper extremity was tested using a handgrip dynamometer. The total sample was stratified in age categories (15.0–24.9, 25.0–34.9, 35.0–44.9, 45.0–54.9, 55.0–64.9, 65.0–74.9, 75.0–90). For descriptive analyses non-parametric and parametric statistics were used. A one-sample t-test was used to compare the results with the reference data of a general population [1]. Significance was set at the 5% level of confidence.

\textit{Results:} In the total sample ($n = 1273$) males (42.4 ± 17.5 years) were younger than females (45.6 ± 18.0 years) ($p = 0.005$). The median of the degree of physical inactivity was 4 hours sitting per day in both genders ($p > 0.05$). Gymnasts in this study were less inactive than the 74 male (9.8 ± 2.4 hrs sitting/d) and 169 female (7.5 ± 3.4 hrs sitting/d) Australian adults.

In all age groups and in both genders mean static strength values of gymnasts were higher compared to the reference values observed in the general population [1]. Even if no differences were found between mean body weight of gymnasts and the general population, our results suggest a higher functional strength in gymnasts (male and female) of all age groups compared to the general population [1].

For all age groups and for both genders, gymnasts showed more healthy mean values of health-related anthropometric variables than the general population [1].

\textit{Discussion:} In a previous study including the same sample, Taeymans et al. [2] found that participants of the World Gymnastrrada 2007 showed health-enhancing lifestyle habits, such as less smoking and a more important daily fruit and vegetables consumption compared to the general population. This study will be continued during the XIV World Gymnastrrada that will be held at Lausanne in 2011. The same subjects will be invited to participate again. As such, this study will become a longitudinal follow-up study.

\textit{Conclusion:} Compared to the references of a more general population [1], gymnasts of the World Gymnastrrada 2007 show more healthier anthropometric values, health-enhancing lifestyle habits (i.e. a low degree of physical inactivity) and a high degree of functional strength in all age groups and in both genders. Hence, these participants may be better protected against age-related health problems such as sarcopenia.

\textbf{References}

Fat tissue alters quadriceps response to femoral nerve magnetic stimulation

K. Tomazin\textsuperscript{a,c}, S. Verges\textsuperscript{b,f}, N. Decorte\textsuperscript{b,f}, A. Oulerich\textsuperscript{a,d}, N.A. Maffiuletti\textsuperscript{e} and G.Y. Millet\textsuperscript{a,f}
\textsuperscript{a}Exercise Physiology Laboratory, Jean Monnet University, Saint-Etienne, France
\textsuperscript{b}Exercise Research Unit, University Hospital, Grenoble, France
\textsuperscript{c}Faculty of Sport, University of Ljubljana, Slovenia
\textsuperscript{d}Department of Physical Medicine and Rehabilitation, Legouest Army Hospital, Metz, France
\textsuperscript{e}Neuromuscular Research Laboratory, Schulthess Clinic, Zürich, Switzerland
\textsuperscript{f}INSERM ERI17, HP2 Laboratory (Hypoxia Pathophysiology), Grenoble, France
E-mail: katja.tomazin@fsp.uni-lj.si

Introduction: Nerve magnetic stimulation is a new tool to assess neuromuscular function. To be valid, stimulation strength should be supramaximal. It was suggested that stimulation power could be altered by increased coil to nerve distance due to an excessive amount of subcutaneous fat \cite{1}. The aim of the study was to assess the influence of adipose stores on the ability to induce maximal quadriceps contraction using femoral nerve magnetic stimulation (FNMS). For that purpose: (i) quadriceps mechanical and electromyographic responses were compared between overweight and lean subjects and (ii) quadriceps responses were compared using fat animal tissues between the coil and the skin.

Methods: Single femoral nerve magnetic stimulus was used. Vastus lateralis M-wave amplitude (PPA) and knee extensors twitch peak torque (TWP) were measured in 9 lean (body fat: 12.9 ± 2.9\%) vs. 9 overweight (body fat: 18.9 ± 4.6\%) subjects. PPA and TWP were also measured at 8 different 2-mm pig fat thicknesses (from 0-mm to 18-mm), which were placed between the coil and the femoral nerve. Five intensities (80 to 100\%) of a Magstim 200\textsuperscript{2} power output were used.

Results: In overweight group (OW), the maximal response could not be elicited when intensity was 90\% and 85\% of maximal power for TWP (P < 0.001, Fig. 1A) and PPA (P < 0.05, Fig. 1B), respectively. On the contrary, at 80\% of maximal power, the maximal TWP and PPA were obtained in lean (LE) group (Fig. 1). Significant negative correlations between relative TWP changes and inguinal skinfold were obtained (R = −0.50 to −0.65).

When artificially manipulating fat tissue, decreases in TWP and PPA were observed at 100\% of maximal power with 14-mm and 8-mm fat layers in the lean and overweight groups, respectively (P < 0.001).

Discussion: Plateaus in maximal TWP and PPA were obtained only in lean subjects; larger adipose thickness at the stimulation site is associated with lower quadriceps response due to increased coil to nerve distance. With
artificially added fat thickness, the curves of quadriceps responses were shifted to the left at the same stimulation intensity in overweight compared to lean group.

**Conclusion:** Special caution should be taken by clinicians, when overweight or obese subjects are tested with FNMS.

**Reference**

---

**The efficiency of eccentric training in supraspinatus tendinopathy**

J. Weber, S. Müller, I. Gutschow, L. Diepgen and F. Mayer  
*University Outpatient Clinic, Sports Medicine and Sports Orthopaedics, University of Potsdam, Germany*  
E-mail: jweber@uni-potsdam.de

**Introduction:** Supraspinatus tendinopathy (T_{SSP}) is frequent in overhead sports. Pain is usually relieved at rest and during physical activity. Peak torque in abduction (Abd) and external rotation (ER) is often reduced. Intervention studies on the lower extremity could show that the combination of physiotherapy and eccentric training is efficient in the treatment of Patella and Achilles tendinopathy [1]. However, it remains unclear if this effect is valid for T_{SSP} as well. The purpose of this study was therefore to examine if a combination of physiotherapy and eccentric training is efficient (pain reduction, peak torque enhancement) compared to physiotherapy alone.

**Methods:** 27 athletes with unilateral T_{SSP} were randomized to a control group (PT, n = 12, physiotherapy, 8 weeks) and an intervention group (ET, n = 15, eccentric training and physiotherapy, 8 weeks). Shoulder Pain and Disability Index (SPADI) and peak torque (Abd, ER in 90° Abd, Contrex MJ®, 60°/s, concentric) were measured pre (M1) and post (M2) intervention (8 weeks). Physiotherapy comprehends of ice, deep frictions, electrotherapy and ultrasound. The eccentric training was divided in 6 exercises for shoulder muscles especially for M. supraspinatus (for example: "empty can"- position, self pass and shot exercise with additional load). Physiotherapy was frequented 2 times a week, eccentric training 3 times per week. Mean differences between both groups were analysed by two-way ANOVA and post hoc Tukey Kramer test (α = 0.05).

**Results:** SPADI results showed a reduction in PT (M1: 34 ± 3; M2: 17 ± 3) and ET (M1: 20.4 ± 2.8 M2: 10.9 ± 2.8). Differences between groups were statistically not significant (p > 0.05). Peak torque for Abd and ER showed differences between measurements and between groups (Table 1) (Abd p < 0.05; ER > 0.05).

**Table 1**  
Differences pre and post Intervention are shown. Peak torque for isokinetic concentric abduction (Abd) and external rotation (ER) of the shoulder displayed for both groups (PT, ET) with mean ± SD [Nm]  

<table>
<thead>
<tr>
<th>group</th>
<th>PT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M1</td>
<td>M2</td>
</tr>
<tr>
<td>Abd (p &lt; 0.05)</td>
<td>33.5 ± 1.06</td>
<td>32.3 ± 1.06</td>
</tr>
<tr>
<td>ER (p &gt; 0.05)</td>
<td>21.7 ± 0.84</td>
<td>22.6 ± 0.84</td>
</tr>
</tbody>
</table>

**Discussion:** Eccentric training had no additional effect on pain reduction and peak torque in Abd and ER compared to standard physiotherapy. Therefore the pain reduction in both groups might be due to physiotherapy.

**Conclusion:** In T_{SSP} additional eccentric training in combination with physiotherapy (ice, deep friction, electrotherapy and ultrasound) is not superior compared to physiotherapy alone.

**Reference**