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Speaker Abstracts

Evidence–Based Data in Rehabilitation

Physical exercise for children with chronic diseases

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For a long time all children with chronic diseases were not allowed to perform exercise at all. Nobody really knew the effects of sport on an ill organism and everybody lived in fear of malign side effects.

Now we know and value the positive influence of physical activity, especially for chronic ill children. That is: improved aerobic exercise capacity, improved muscle strength and endurance resulting in prevention of muscle atrophy and injury, improved flexibility resulting in prevention of joint contractions, increased lean body mass and decreased body fatness. These effects are well known and also the beneficial metabolic effects or the positive influence on bone mass. There is no reason to withdraw these positive effects from ill children all the more further positive effects are to be expected for defined chronic health conditions.

The question is not any more if physical activity or exercise is helpful, but rather which kind of exercise and at which intensity. Regardless of the kind of chronic disease exercise could be prescripted as it is known from drugs. First you have to know the diagnosis and severity of the disease including information of possible affected organ systems which could alter physical performance. You need an educated preparticipation examination and you need some knowledge of the physical requirements of sport which should be performed. Ideally the physician is also an active athlete or the physician is in a close contact with the trainer or specialist for sports medicine. The aim is to combine the possibilities of the children with these of the sport without putting the kids at health risk. Further questions are regarding the existing motor skills and possibilities in the surrounding of the kid. Parents or even trainer or teachers could help to answer.

It is senseless to recommend a sport activity, which will not be accepted because of a lack of opportunities. You could compare it with an allergy against drugs you have to ask for or bad compliance.

Sometimes it is better to run the risk of little danger when advising a sport than to loose physical activity by prescripting save but boring sport. You ever have to keep in mind that children, healthy or ill want fun, want to explore themselves and their environment. A sport program needs to be advised with the child’s interests , skills and weakness in mind. Successful would be a program with activities performed together with healthy peers as good as possible. Children with chronic diseases often are overprotected and suffer from their abnormal way of life, because physical activity is a potential part in every children’s life. Well-being and self esteem is closely correlated to sport.

In many cases it is not necessary to restrict physical activity at all but it is necessary to redefine this decision dependent on changes in the disease. Ideally the team including the child should meet regularly to exchange ideas and to find out the best ways to highest possible physical, mental and social facilities of the child.

There are a lot of disease oriented training programs in existence and at least recommendations for physical exercise in the other chronic diseases. Wide spread are exercise programs for children with obesity in combination with diet-programs and psychosocial attendance. Special holiday camps or well designed ambulant training programs are offered for obese children. Also asthma camps are known where children learn how to exercise without pulmonary problems sometimes in combination with pre exercise drug therapy.

For a lot of other diseases special physical training is recommended, but performed alone or together with unaffected peers. To mention are children with cystic fibrosis, arterial hypertension, cardiac malformations, diabetes

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etc. In the case of musculoskeletal disorders such as chronic rheumatoid arthritis or metabolic muscular diseases the gap between therapy and sport is small but important. Right here children will profit a lot from being powerful and flexible as good and as long as possible for well-being and self esteem. As a kind of psychic disorder hyperactivity should mentioned where sport could lower the activity rate and help to find a social accepted way of life. Especially climbing seems to be of advantage.

All children should be encouraged to perform to their best ability and to experience all which is within their power. Our job is to help them to achieve this goal, without damaging their physical and mental health.

Postural control training in Parkinson's disease

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Introduction: Apart from tremor, rigidity and bradykinesia, postural instability (PI) is regarded as one of the cardinal symptoms in Parkinson's disease (PD). From a pathophysiological point of view several functions are discussed for being responsible for this disability. With respect to the progression of PD, Jankovic et al. [1] speculate about a worse overall prognosis for subjects with a marked postural disturbance. Furthermore PI is connected with a higher risk of falling and the risk of traumatic injuries or death respectively [4]. An essential problem consists in the fact that PI can not be treated effectively by medication. Moreover it is speculated that chronic L-DOPA treatment leads to worsen of PI. On the basis of the results of earlier studies the aim of this experiment was to analyse changes in postural control in PD patients treated by oscillating mechanical stimuli.

Methods: Forty PD patients participated in this study. They were divided in different groups depending on their Hoehn & Yahr stage and their postural disturbance. All subjects were withdrawn over night from L-DOPA to exclude the influence of the medication. Apart from motor examination done by the UPDRS motor score several biomechanical analyses were performed in order to get quantitative data. One test is based on standing on an instable platform lasting 30 seconds each series. Another test consisted of generating an abrupt and standardized ballistic anterior shift of the platform. Three series were performed of both tests each pre and post treatment. Platform shifts were analysed by the use of a two dimensional acceleration sensor. EMG analyses of various muscles were registered additionally. The treatment consisted of applying 5 series of whole-body-vibration ($\hat{y}$: 3 mm, f: 6 Hz) lasting 60 seconds each (Fig. 1).

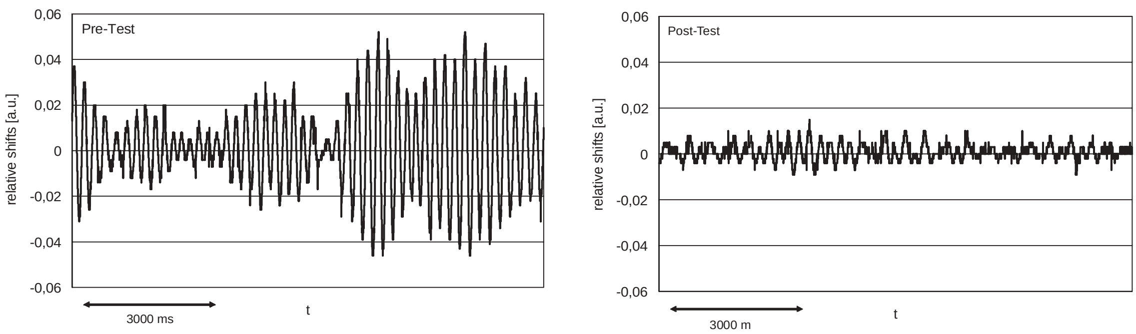

Fig. 1. Example of anterior-posterior platform shifts in balance test pre and post treatment.

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Results: The analyzed patients show spontaneous improvements in balance depending on their postural disturbance and the test procedure. The increase in postural control became evident primarily in anterior-posterior direction and less in medial-lateral. The electromyographic analyses showed reduced muscular activation in the post test which seems to be connected with a quicker correction of platform shifts. This hypothesis is confirmed by the results of spectral analysis that identified a shift of the predominant peak in some patients. However, the results are characterized by a high inter individual variety. Some patients show hardly any effect; others improved balance up to 40%.

Discussion: Since vibration affect physiological functions on various levels different aspects can be responsible for these balance improvements in PD patients. Based on the results of animal experiments, one hypothesis deals with changes of neurotransmitter concentrations. Another explanation refers to the stochastic character of the generated vibration which requires a successive adaptation of the neuromuscular control by selecting relevant from irrelevant information quickly. It can be speculated that this process influences the pathologically changed information selection in PD.

Conclusion: Mechanical stimuli can be regarded as an additional device in PD therapy. This is based on the fact that postural instability can not be treated effectively by medication [2,3]. However, earlier studies showed that improvements of motor control depend on the character of the vibration (e.g. frequency) strongly.

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Effects of 12 weeks combined aerobic and resistance pool exercise training and detraining on isokinetic strength and quality of life in women with severe fibromyalgia syndrome: Randomized controlled trial

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Introduction: The most prominent symptoms in Fibromyalgia Syndrome (FM) are neuromuscular alterations such as decreased maximal muscle strength and endurance. Although several exercise interventions on land has been reported to be effective to improve muscle function of FM patients, the effects of warm-water training remains unclear. In addition, the warm-water may impose positive effects on physical function, distress and other symptoms. The purpose was to evaluate the effects of waist-high warm-water at 33 °C pool exercise program on neuromuscular function and Health related Quality of Life (HrQoL) in FM women.

Methods: Thirty-one women [mean (sd) age 50 (9), duration of symptoms 20 (9) years and number of tender points 17 (1)] with FM were randomly assigned to a training group (FMT, $n = 17$) perform either 12 week pool training including aerobic, propioceptive and strengthening exercises or to a control group (FMC, $n = 14$). The HrQoL was assesed by the EuroQol 5-D and the FIQ questionnaires. Maximal unilateral concentric isokinetic of the knee extensors and flexors at 60°/s and 210°/s, maximal unilateral eccentric isokinetic torque of knee extensors at

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60°/s, and shoulder abductors and adductors at 60 °/s were recorded. Statistical comparison between the groups was made by using analysis of co-variance (ANCOVA) adjusted by age.

Results: The FIQ improved by 18% ($p = 0.043$) and EuroQoL by 111% ($p = 0.005$) in FMT during the training and remained unaltered and decreased during detraining, respectively. In FMC HrQoL remained relatively unchanged during the whole follow-up. Maximal unilateral force at 60 °/s of the knee extensors at 60°/s increased (p: from 0.05 to 0.02) by 32–31% in concentric and by 16–22% in eccentric action after training and moderately decreased moderately after detraining in FMT, while remained unchanged in FMC. In contrast, the maximal torque of the shoulder abductors and adductors at 60 °/s as well as torque of the knee muscles at 210 °/s remained unchanged.

Discussion: The combined aerobic and resistance pool exercise training led to higher increases in lower body muscle strength than earlier reported with programmes on land. However, the lack of water-resistance above water level limited the training effects in the upper-body. The improvement in HrQoL was partially improved by social support in the group program.

Conclusion: The present pool exercise programme not only improved muscle strength, but was also effective to improve the emotional and mental health in women with severe FM.

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Advances in Muscle Function

Neural adaptations with chronic changes in physical activity pattern

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Introduction: Although the role of neural mechanisms in the adaptations associated with changes in habitual physical activity has been controversial, there is now compelling evidence that they are, in some conditions, as important as the changes that occur in the musculo-skeletal system [1]. Arguments in favour of a significant role for neural mechanisms has been accumulated from conditions where chronic physical activities have been increased (strength training) or reduced (immobilization; ageing). The presentation will first review some of the evidences for neural mechanisms and then consider the locus and implications of these adaptations. The changes that occur with ageing will be emphasised.

Evidence of neural adaptations: When a subject participates in a strength training program, for example, the improvement in performance is greatest for the tasks that are similar to the training task and less for other ones that involved the trained muscles [4]. Such finding indicates that the functional gains cannot be explained solely on the basis of muscle hypertrophy or cytoskeletal remodeling, but must also involve the patterns of muscle activation. The converse effect has been observed after several weeks of reduced use. It has been found, for example, that the peak force achieved during a maximum voluntary contraction (MVC) after 6 weeks of limb immobilization was much less than could be evoked from the muscle by electrical stimulation [2]. This dissociation in maximum force for the two contractions indicates that subjects were unable to realize the full potential of the muscle during a voluntary contraction.

Locus of neural adaptations: The neural adaptations associated with alterations in the chronic patterns of physical activity appear to occur at all levels of the neuraxis (Fig. 1; see [1]). Studies have reported adaptations that can occur in the cortical maps (a), the motor (central) command (b), the descending drive (c) the distribution of activity

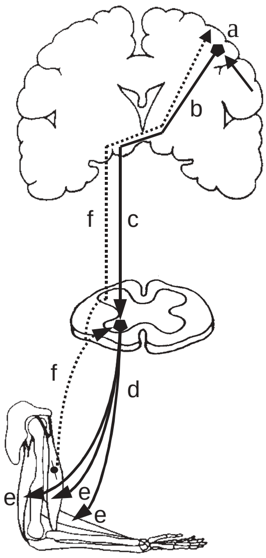

Fig. 1.

among the involved muscles (d), the motor unit activity within a single muscle (e), and the sensory feedback (f). Although interventions such as strength training and limb immobilization are often used to examine the adaptive capabilities of the neuromuscular system, they do not represent polar conditions along the spectrum from increased use to decreased use. In contrast the locus of the neural adaptations appears to be specific to the intervention.

Neural changes with ageing: Senescence is generally accompanied by a marked decline in physical activity and capabilities of the motor system. Although the profond motor unit remodelling [6] with ageing, elderly showed similar or only slightly greater decline in muscle activation during maximal contraction compared with young subjects. It is, however, well established that more complex movements requiring a certain amount of skill or motor coordination are more drastically impaired with ageing. Such changes result more specifically from reduced sensory information and impaired ability to coordinate activity among synergist muscles [6]. At the spinal level, decreased number of motoneurones and of their maximal discharge rate [5], as well as a greater discharge variability at submaximal contraction force [3] should also contribute to alter muscle performance.

Conclusions: The alterations in the chronic patterns of muscle activation with training, immobilization or ageing can cause adaptations in neuromuscular performance that are, in part, mediated by mechanisms distributed along the entire neuraxis. However, the types of adaptations that occur are specific and not simply proportional to the change in the level of physical activity.

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Free rectus femoris muscle transplant – Effects on force/power balance between legs

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Introduction: The rectus femoris muscle is considered an excellent donor muscle for reconstruction of the biceps-, quadriceps- and foot-lifting reparation as well as for dynamic reconstruction of the abdominal wall and reconstruction of established facial paralysis. The first clinical use of this muscle as a free transplant in a human was reported by Schenk [1] to repair the traumatic loss of all flexors. One concern is to reduce the loss of strength and intermuscular coordination in those movements (day-to-day or athletic), which can be negatively influenced by the removal of the rectus femoris muscle. The purpose of this study was to examine force/power balance between legs in patients undergoing free rectus femoris muscle transplant.

Methods: Force/power balance between legs in four patients after reconstruction with free neurovascular rectus femoris muscle was examined through a series of strength/power tests in which the leg with no rectus femoris muscle (NRF-leg) was compared with the contralateral leg with an intact rectus femoris muscle (IRF-leg). The three testing devices were: 1) the Con-Trex Legpress, in which the force and power of right and left leg extensions at 0.2 m/s and 0.4 m/s in a knee angle from 50° to 90° were tested separately; 2) the isometric power tester (IPT), which evaluated the unilateral isometric leg extension (knee angles: 50°, 70° and 90°); and 3) the "SP-Force Platforms" on which patients performed counter-movement jumps to compare the legs during a single dynamic movement through measurement of ground reaction forces and calculation of maximum force and jump height.

Results and Discussion: For the purposes of this abstract, only the Con-Trex and IPT results are discussed. The Con-Trex test results were surprising in that the patients (with one exception) demonstrated a nearly balanced relationship between the NRF and IRF legs (Table 1). The removal of the rectus femoris muscle had no negative effect on the measured dynamic leg strength. Patient 2, was the only patient showing a large strength deficit, but in the IRF leg. Retests with Patient 2 after a 3 month extensive rehabilitation and training program. showed decreased strength deficits. Patient 1 and Patient 3 had power results up to 16% higher, but in the NRF leg. Patient 4 was the only patient who had well-balanced results in both strength and power parameters. Similar results were seen at 0.4 m/s.

Table 1
Results of the Con-Trex Legpress test with v = 0.2 m/s

patient	Abs. dyn. strength [N]		ratio [%]	Rel. dyn. strength [N/kg]		Abs. dyn. power [W]		ratio [%]	Rel. dyn. power [W/kg]	
	NRF	IRF	NRF/IRF	NRF	IRF	NRF	IRF	NRF/IRF	NRF	IRF
1	1518	1505	99.1	19.05	18.88	177.0	160.0	90.4	2.22	2.01
2	867	383	44.2	15.03	6.64	92.2	52.2	56.6	1.60	0.90
3	1556	1562	100.4	16.64	16.71	200.1	167.7	83.8	2.14	1.79
4	1705	1694	99.4	23.13	22.99	251.7	256.3	101.8	3.42	3.48

In the IPT results, Patient 1 had bilateral strength deficits of 10%, 7% and 16% at knee angles of 50°, 70° and 90°, respectively, but in the IRF leg. Patient 3 had similar results, with the maximal isometric strength greater in the NRF leg at all knee angles measured, with a difference between 5% and 11%. The high absolute and relative strength values for Patient 4 elicited different patterns for the various angles. At 50° the maximal isometric strength in the NRF leg was 7% higher, but at greater angles the IRF leg was stronger. The measured maximal isometric strength at 70° and 90° was 9% and 16% less, respectively. Patient 2 demonstrated large isometric strength deficits similar to the Con-Trex Legpress dynamic tests.

Conclusion: The removal of the rectus femoris muscle in our patients showed very little negative effects on dynamic and isometric leg strength measurements at various knee angles The authors concluded that there is no limitation in the strength of the donor leg after removal of the rectus femoris muscle and consequently no functional imbalances. For the realization of such results the intraoperative linking of the vastus lateralis muscle with the vastus medialis muscle, especially in their lower third, and an extensive postoperative rehabilitation and training program are essential.

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ε_{dyn} – A useful quantity to quantify differences in neuromuscular efficiency and its changes due to therapy?

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Introduction: It is assumed that changes in neuromuscular regulation with resultant reduction in strength capacity are causally associated with complaints of the muscle-tendon apparatus [2,4]. In Achilles tendonitis patients it could have been shown that isokinetic peak torque at 60°/s and 180°/s were significant discriminators between healthy and injured subjects [3]. Furthermore strength training is successfully used in therapy of Achilles tendon complaints [1]. However, it remains unclear whether these changes are due to muscular atrophy or due to differences in neuromuscular control. There is no quantity that takes "input" and "output" into account. Therefore we tried to quantify dynamic neuromuscular efficiency by defining the new quantity $\varepsilon_{\mathrm{dyn}}$. The study was designed to validate the new quantity in runners with chronic Achilles tendonitis (AT) compared to healthy runners (CO) and in different treatment strategies for Achilles tendonitis.

Methods: The quantity $\varepsilon_{\mathrm{dyn}}$ was defined as intraindividual quotient of EMG-amplitude and isokinetic peak torque. Therefore the maximum eccentric (Ex, 60°/s) and concentric (Con 60°/s) torques (PT) of plantar flexion (PF) and dorsal extension (DE) were determined in the ankles of 49 runners (AT $n = 29$; CO, $n = 20$). In parallel, an elctromyographic amplitude analysis (MVC-normalized, $\mathrm{A}_{\mathrm{EMG}}$) was made of the Mm. tibialis anterior (TA), gastrognemii (GL and GM) and soleus (SOL) Measurements before (M1) and after (M2) 4 weeks of treatment in AT (physical therapy (PT, $n = 9$), insoles (IS, $n = 10$)) were compared to the data of a healthy control group (CO) and an AT-group without any therapy (CP) (ANOVA, $\alpha = 0.05$) (Fig. 1).

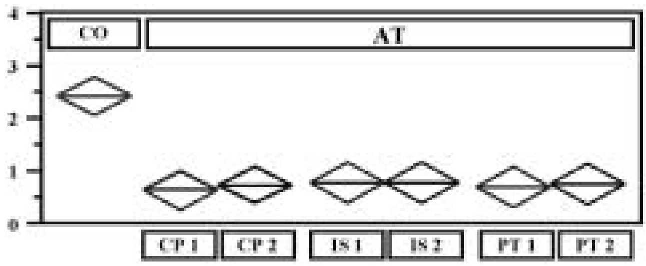

Fig. 1. $\varepsilon_{\mathrm{dyn}}$ (PF, Con 60, GL) in healthy (CO) and AT-runners before (1) and after (2) 4 weeks of treatment (physiotherapy (PT), Insoles (IS), no therapy (CP)).

Results: $\varepsilon_{\mathrm{dyn}}$ showed statistically significant differences between AT and CO in PF, unlike in DE, at the initial measurements ($p < 0.05$). There were lower values for AT compared to CO in all tested muscles and all contraction modes. However no statistically significant changes due to therapy could be determined in none of the groups ($p > 0.05$).

Discussion: It has been found that runners with Achilles-tendon complaints show in dynamic plantarflexion higher activation of the exercised musculature, despite lower strength performance capacity resulting in a lower dynamic neuromuscular efficiency (expressed by a lower quotient $\varepsilon_{\mathrm{dyn}}$). It seems that the newly-defined quantity $\varepsilon_{\mathrm{dyn}}$ can be applied as an useful measure for assessing dynamic neuromuscular efficiency despite the fact that it was not possible

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to detect changes after 4 weeks of therapy. It might be that a therapy phase of 4 weeks is probably not long enough to evoke measurable changes in the complex sensomotoric regulation and compensation mechanisms or that training stimuli did not reach a certain threshold to elicit positive adaptation.

Conclusion: The newly-defined quantity $\varepsilon_{\mathrm{dyn}}$ can be applied to quantify dynamic neuromuscular efficiency. Further research is needed to asses whether it is possible to provoke changes in neuromuscular efficiency by sensomotoric training and whether these possible changes can be measured by $\varepsilon_{\mathrm{dyn}}$. Moreover, modification of the quotient may be helpful to analogously investigate neuromuscular efficiency in other dynamic movements as the gait cycle.

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The influence of flexibility on eccentric exercise-induced muscle damage

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Introduction: Exercise involving eccentric contraction frequently causes muscle damage resulting in delayed-onset muscle soreness (DOMS). This phenomenon presents a large individual variability. The etiologic factors to explain this variability are unclear. Mechanical stress is supposed to be the major contributing factor for inducing muscle damage. This damage could result from excessive stress on the passive elements. The present study was designed to measure the relationship between the intrinsic flexibility of the muscle and the eccentric exercise-induced muscle damage.

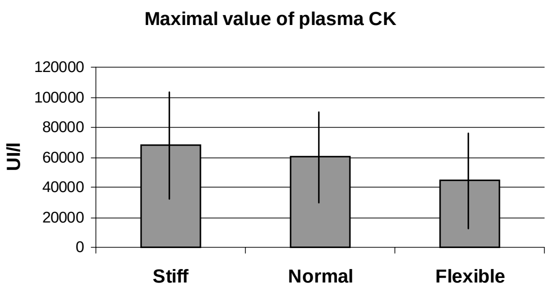

Fig. 1

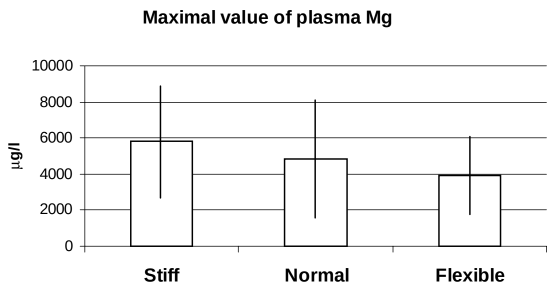

Fig. 2

Fig. 1 & Fig. 2: Plasma muscular enzyme activity, response between the groups. T-test for independent samples ($p > 0.05$).

Methods: Twenty-two healthy male volunteers were included in this study. They were sampled into three groups characterized by their passive left hamstrings flexibility (flexible group: $n = 7$, normal group: $n = 9$ and stiff group: $n = 6$). The flexibility of hamstrings was assessed using 5 different tests: active and passive bilateral hip flexion (straight leg), and the sit-and-reach test. All subjects were submitted to an isokinetic "provocation test" consisting in

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3 concentric contractions (60°/s) of the left hamstrings followed by 5 sets of 5 eccentric contractions (60°/s). After the provocation test at time 0, 24, 48, 72 h., subjective intensity of DOMS using a visual analogic scale, flexibility were evaluated and increase of creatine kinase (CK) and myoglobin (Mgb) serum levels was measured. All these parameters were used as indices of exercise-induced muscle damage. At time 72 h, the residual maximal forces of the left hamstrings (3 concentric and 5 eccentric contractions) were also evaluated.

Results: In this study, we have observed the same clinical signs as previously mentioned in the literature such as loss of flexibility and strength, increase of soreness and plasma muscular enzyme rate. For the entire population, no relation has been observed between flexibility (before the provocation test) and muscle soreness, serum level of CK and Mgb, loss of flexibility and force at 24, 48 and 72 h post-test. A unique significant negative correlation ($r = -0.53$) was observed between flexibility of the right leg (before the provocation test) and serum level of CK at 72 h. At time 24, 48 and 72 h, no significant difference was observed between the groups for the entire analyzed parameters. In spite of insignificant difference between groups, increase of the maximal serum level of CK (Fig. 1) and Mgb (Fig. 2) could suggest influence of hamstrings flexibility on these parameters.

Conclusion: The DOMS phenomenon represents a complex syndrome with a multifactorial etiology. It appears that flexibility is probably one of these factors. Therefore, muscle stiffness should be considered as a factor risk in the development of severe DOMS. These results are useful to implement training and rehabilitation programs including eccentric exercises.

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Standards in Testing and Training

Standards in exercise testing – The Heart Rate Performance Curve – A diagnostic tool?

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Introduction: The Heart Rate Performance Curve (HRPC) is a simple possibility to assess non-invasively sub maximal markers of aerobic performance. However, the HRPC was shown to be neither linear nor uniform in various groups of subjects. The well described deflection of the HRPC [1] was used to determine the anaerobic threshold [2]. Several attempts have been made to compare this heart rate turn point (HRTP) to other threshold and turn point concepts. However, the main criticism of the method was the lack of a physiological explanation of the HRTP-concept and the physiological relationship of the HRTP with muscle metabolism. Several investigations from our HRPC Study Group will be presented showing the relationship between the HRTP and other turn point and threshold concepts with special regard to maximal lactate steady state (MLSS). A second aim is to present data on the role of β1-adrenoceptors and their relationship to the HRTP. New aspects about the physiological basis of the HRTP will be presented. A third aim is to show the practical implications of these findings with special regard to the %HR$_{\max}$ method and the Karvonen formula [4,7].

Methods: Aim of our studies was to investigate the relationship between different threshold concepts and the MLSS, the possible physiological mechanisms to explain the HRTP concept and to prove the implications and consequences for the practical application. All studies were performed using the same protocol (principle) the method of turn point determination and in most cases subjects from a homogenous group of sports students. All subjects performed a maximal incremental cycle ergometer exercise test (20 W/min). The first (LTP_1) and the second (LTP_2) lactate turn point, the heart rate turn point (HRTP) as well as the degree and the direction (kHR) of the HR performance curve (HRPC) and ventilatory turn points were calculated by means of computer aided analysis.

Results: The HRPC shows three different patterns. A regular one showing a clear deflection near maximal HR, a linear one without any deflection and an inverted one with a deflection in the other direction compared to the regular HRPC. Turn points in heart rate (HRTP), blood lactate concentration (LTP_2) and ventilation ($VETP_2$) were shown to be significantly related, not significantly different from each other and significantly related to the MLSS. Candidates to explain the HRTP were myocardial function, blood lactate and pH, catecholamines, parasympathetic influences, mechanical constraints, and others. As catecholamine response was similar in groups with different HRPC the receptor cite was one target of investigation. Beside the expected reduction of HR at all work load levels, β1-selective adrenoceptor blockade changed the pattern of the HRPC response. This change was not uniform and was significantly related to the degree and the direction of the deflection of the HRPC. The more the deflection was regular in placebo conditions the more pronounced was the decrease of HR at LTP_2 under blockade (Fig. 1).

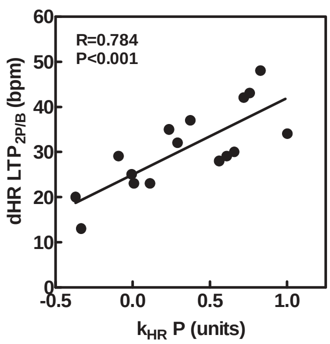

Fig. 1. Relationship between the degree and the direction of the deflection (k_{HR}) of the HRPC and the change of heart rate at the second lactate turn point from placebo to bisoprolol conditions.

Discussion: The results of several studies of our HRPC Study Group will be discussed with special regard to the relationship to other threshold concepts, the MLSS [3,6] and with respect to a physiological explanation of the HRPC deflection [5] and its practical consequences [4,7].

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Evaluation of heart-rate monitoring method to measure energy expenditure under different working activities

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Introduction: Measurements of energy expenditure (EE) under free living conditions are often subjective, expansive, or not practicable. The aim of our study was to evaluate the HR-Monitoring method, which is based on the individual relationship between HR and VO_2, for the measurement of EE under free living conditions. The HR-FLEX-Method was applied to calculate EE under different conditions of physical activity.

Methods: HR and VO_2 were recorded for 11 adults (G1: 28 $\pm$ 3.2 years; BMI 23.6 $\pm$ 1.5) and 5 children (G2: 13 $\pm$ 0.7 years, BMI 19.3 $\pm$ 3.4) from rest till maximum performance having the subjects completed three pretest-protocolls on a treadmill (TM), steptest (ST) and on a cycleergometer (CE only G2). Afterwards, individual HR-VO_2-regressions were calculated. HR-FLEX divides resting metabolism, where only a poor correlation between HR and VO_2 can be observed, from working metabolism, where a strong relationship between HR and VO_2 can be determined. Individually derived VO_2-values for resting metabolism are used when HR<HR-FLEX, whereas energy expenditure above HR-FLEX is determined by using the regression equation of the steptest individually obtained for each subject. For the validation of calculated EE with HR-FLEX-Methods, we used spirometric measurements of VO_2 for 1.5 h (G1) and 1 h (G2) for the working activities PC-Work (PC), Walking (W), Basketball (BB), Football (FB, G2) and Isometric Strength Unit (IS, G2: Climbing). The results were compared with the HR-FLEX and HR-FLEX+10 calculations.

Results: The HR-VO_2-regression of the pretests for G1 were $R^2 = 0.969 \pm 0.03$ (TM) and $R^2 = 0.976 \pm 0.05$ (ST) and for G2 $R^2 = 0.969 \pm 0.01$ (TM), $R^2 = 0.9520.01$ (ST) and $R^2 = 0.956 \pm 0.02$ (CE). There were no significant differences of the regression parameters between all pretests. Mean deviations between the spirometry measurements and the HR-FLEX and HR-FLEX+10, were respectively for G1: (PC) -11.5 ± 14.7% (-5.6 ± 8.7%); (W) -6.7 ± 19.3% (1 $\pm$ 27.9%); (BB) -2.6 ± 7.1% and (IS) -74.5 ± 36.5% (-74.1 ± 34.6%) (see Fig. 1). Mean deviations for G2 were: (PC) -5.5 ± 6.6% (-5.5 ± 6.6%); (W) 14.2 ± 11.4% (21.8 ± 17.6%); (BB) 8.1 ± 1.5% (8.1 ± 1.5%); (FB) 4.8 ± 2.3% (4.8 ± 2.3%) and (IS) -54.8 ± 29.9% (-54.8 ± 29.9%).

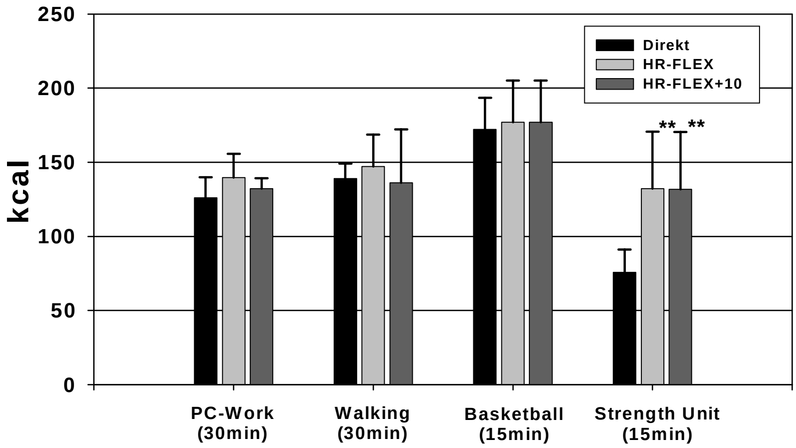

Fig. 1. Energy expenditure measured by Spirometry and calculated by HR-FLEX and HR-FLEX+10 for the adult group G1 ($^{**}p \leqslant 0.01$).

Discussion: For the calculation of HR-VO_2-regressions from moderate work till exhaustion, all modes, cycleergometer, treadmill and steptest, can be used. Mean differences between spirometry measurement and HR-FLEX calculations are not significant in both groups except for the isometric strength unit. The comparison between HR-FLEX and HR-FLEX+10 showed no significant differences for the activities Walking and PC-Work (G1) and no significant differences for the activity Walking in group G2.

Conclusion: The HR Monitoring method is (except from static strength loads and partially for work loads at the critical HR-FLEX-Point) for both children and adults, an objective and practical method to quantify EE under free living conditions.

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Cross transfer effects on muscular training: Preliminary approach to optimise training parameters for rehabilitation

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Introduction: Partial and total immobilisation of the upper leg after injury or surgery are known to delay the rehabilitation process by hypothrophy of for example the knee extensor muscles. Therefore, it is important to avoid hypothrophy of these muscles in an early stage of immobilisation. To optimise the muscle activity during such a rehabilitation phase, "cross effect training" is an appropriate method to retard or minimize hypothropy. However, training parameters of the contralateral leg for an optimal training effect of the ipsilateral leg are not described in detail. Thus, the purpose of this study was to determine appropriate training intensity to evoke co-innervation of the ipsilateral muscle to prevent or reduce hypothropy during immobilisation.

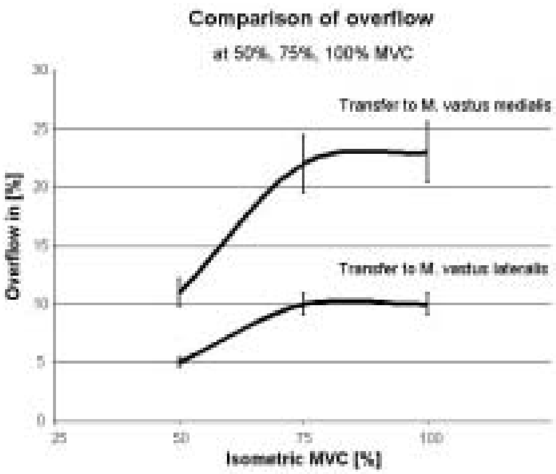

Fig. 1.

Methods: Three different isometric muscular strength tests of 50%, 75%, and 100% of the maximum voluntary contraction (MVC) of a single leg were performed in 24 healthy young subjects on an isokinetic dynamometer. Surface EMG activity (IEMG) of the contralateral quadriceps (part M. vastus medialis and vastus lateralis) were recorded during the isometric MVC's tests (best of 2 repetitions, dominan leg). This EMG activity of the contralateral leg was expressed by a percentage of the EMG activity of the contralateral leg in rest. This ratio yields to the overflow parameter.

Results: Single leg isometric muscle strength tests of 75% to 100% of MVC evoke significant ($p < 0.05$) higher co-activation of the contralateral lower leg muscles (see figure, population mean $\pm$ SD). Moreover, this co-innervation is significant ($p < 0.05$) higher than the co-innervation induced by 50% of the MVC's. In addition, 50% or less of

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the MVC evoked no significant higher co-activation on the contralateral leg muscles. Furthermore, the overflow rate might depend on the type of the muscle (see Fig. 1).

Discussion: The results of this study have shown that in isometric contractions more than 50% of MVC of the ipsilateral leg evoke overflow activity in the contralateral leg. The overflow rate of more than 20% found in this study is known to facilitate a positive effect on physiological and morphological changes of the muscle. To reduce negative side effects of muscle activity due to immobilisation, an advanced training method like cross effect training has to be refined. However, the kind of muscle has to be considered, too.

Conclusion: This study provides preliminary insights into the practical use of the optimal intensity for cross effect training. In future, randomised controlled trials will provide more information for new guidelines, recommendations and techniques for cross effect training.

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Dynamic contrast enhanced MRI (DCE-MRI) as a diagnostic tool for monitoring lower leg muscle perfusion in training and therapy

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Introduction: Recently, major effort is made in the VICORA-project, a virtual institute for integrated and efficient research and development in medical image processing [2], to improve DCE-MRI-diagnostics for widespread applications. This is not only limited to improving the accuracy of diagnostic imaging in radiology [1], DCE-MRI also seems to be a promising diagnostic tool for different applications in the field of training and therapy including the non-invasive assessment of blood perfusion in skeletal muscle [3]. Therefore, the purpose of this study was to provide first data on lower leg muscle perfusion before and after an isolated training procedure for the plantar flexor muscles.

Methods: In this feasibility- and proof-of-concept-study 6, healthy subjects (3 athletes/ 3 control subjects) underwent a complex test design: Preceeding the MRI-procedure a standardized test was performed to quantifiy maximum isometric force of the plantar flexor muscles on a specially designed measuring device (MR-PEDALO ®) with strain gauge sensors (Digimax®). The DCE-MRI studies were performed on a Magnetom Expert 1.0 Tesla System (Siemens®) before (pre) and after (post) 1 minute of repetitive concentric plantar flexor action against an individually given resistance. At each scanning session 3 anatomical slices of the lower leg were chosen and scanned in a standardized DCE-MRI procedure (dynamic series of 73 gradient echo FLASH images (0.11 Hz); automatic injection bolus of 0.1 mmol/kg BW gadopentate dimeglumine (Gd-DTPA, Magnevist ®), 2.0 ml/sec). Arterial, venous and muscular (triceps surae (TS), tibialis anterior (TA), peronaeus (PE)) blood flow was calculated by analyzing contrast enhanced signal-intensity curves (SI) over time of tissue Gd-DTPA concentration (DYNAVISION, Mevis®).

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Results: For all subjects the measured SI-curves of muscle blood flow in the post-test have similar shape but different magnitude and show an earlier onset and increased slope compared to the pre-test. The increase in the slope of the SI-curves after exercise varies between muscles and subjects but seems to be largest in PE and TA and smaller in TS for athletes, while less trained control subjects mainly respond only in a large increase of the slope of the PE-SI-curve (Fig. 1).

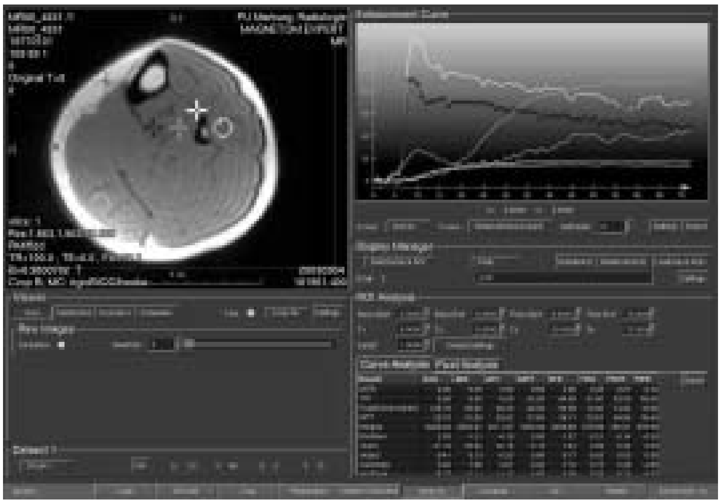

Fig. 1. DCE-MRI derived SI-curves of arterial, venous and muscular blood flow of the lower left leg of one subject.

Discussion and conclusion: DCE-MRI derived data seem to enable non-invasively monitoring of exercise response in lower leg muscle perfusion. First data indicate that an exercise-induced rise in blood-inflow is shown by an earlier onset and increased slope of SI-curves but no uniform response in blood perfusion and blood distribution between synergistic and antagonistic muscle groups can be detected.

Ongoing future research of the VICORA-project with large groups of subjects will focus on standardization of DCE-MRI procedure after exercise in order to detect individual effects and systemic response of peripheral blood flow regulation and distribution between synergistic and antagonistic muscle on exercise. Furthermore, DCE-MRI will be evaluated as a diagnostic tool for important therapeutic applications, e.g. the evaluation of effects of different treatment strategies on patients with peripheral arterial occlusive disease.

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Reliability of testing the hamstring activity after mechanically induced tibia translation and a time-dependency evaluation of the hamstring latency due to tibia translation velocity

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Introduction: Frequently a functional instability is observed apart from a mechanical instability after injuries of the anterior cruciate ligament (ACL). This functional instability has been attributed to a disturbed function of the involving histologically identified sensorimotor receptors of the knee joint. Clinically it is characterized by a giving-way pathology. The hamstrings as a synergist of the ACL may play a key role in knee rehabilitation regarding to movement protection of the tibia translation and restoration of sensorimotor function. To measure the latency of the existing direct reflex pathway between the hamstrings and ACL to a tibia translation might be a tool to validate the successful therapeutic treatment after an ACL rupture. Previous studies have reported multiphasic hamstring responses which have shown a wide range of latencies. Therefore our study was focused on the reliability of testing (1), on measuring the hamstring latency under the given conditions (2) and on an investigation if the hamstring latency was influenced by tibia translation velocity (3).

Methods: The experimental setting was performed accordingly to Beard [1]. For reliability testing three investigators carried out the testing procedure. 44 volunteers (34 for reliability testing (1 + 2), 10 for time-dependency evaluation (3)) were tested standing upright with a 30° knee flexion and 5° outer rotation of the knee. An accelerated piston driven by a pneumatic cylinder generated a transmission force (300 N (1 + 2), 50–300 N (3)) in a posterior-anterior direction 10 cm below the knee joint gap parallel to the tibia plateau. Tibia translation was monitored by a linear motion sensor applied to the tuberositas tibiae. The EMG of the hamstrings was derived from surface electrodes. It came to a 1000 fold pre-amplication directly behind the electrodes, the sampling rate was 5000 Hz. Raw data were taken without frequency filter. For evaluation the EMG-data were synchronised, rectified and a 10 Hz high pass filter was performed. For statistical analysis SPSS software was used. The mean latency and SD for each subject were calculated. Significance levels for differences between means were assessed with Student's t-test. A p-value < 0.05 was considered significant.

Results: No significant differences as to reliability testing were found between the three investigators. The mean latency response was 38.9 ms (± 4.2 ms) and classified as a medium latency response (MLR) of the hamstrings. Predominantly in addition to the MLR a short latency response (SLR) after 20.3 ms (± 3.5 ms) was also observed. The mean anterior tibia translation was 3.2 mm (± 0.8; range: 2.2–4.6 mm) and the mean tibia velocity was 0.057 m/s (range: 0.05–0.07). The results of the time-dependency reflex activity due to tibia translation velocity showed that a threshold value of 0.03 m/s was necessary to evoke a reliable response in all investigated subjects.

Discussion: The results demonstrate a high reliability of the present testing procedure. Independent of the investigator the sensorimotor function of the human knee could be determinated. Further on the potential of the test is high in respect to the asessment of surgical intervention and postoperative rehabilitation programmes after anterior cruciate ligament ruptures. The performance of the measurement is inartificial considering the exact standing conditions of the tested person. The assertive threshold for a reliable hamstring reflex response permits measurements in healthy and injuried humans particularly after ACL restoration because the extent of force transmission (300 N) does not adversely affect ligament structures of the knee. The present founding of mostly multiphasic reflex patterns after a tibia translation does not correspond with previously described data and latencies [1,2]. This could be explained as a result of varied used methods and testing conditions. The origin of the detected SLR and MLR might be modulated by Ia- and II-affarents, respectively. Which sources of receptor activity underlie these triggered signals remain ambiguous.

Conclusion: We confirmed the existence of direct reflex pathway between hamstrings and ACL. Even more we could demonstrated a testing procedere for evaluation of sensorimotor pathways of the hamstrings. A tibia translation minimum speed of 0.03 m/s was identified to generate a reliable multiphasic reflex reponse. Due to the fact that the used force transmission (300 N) lies clearly subthreshold to the rupture risk of the ACL the measurement could be performed in the postoperative period to estimate the restoration of the ACL and the regeneration of the sensorimotor function, respectively.

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Treatment Evaluation in Low Back Pain

Physiotherapeutic treatment strategies in low back pain – Still a daily challenge

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Introduction: Low back pain is a complaint which is very common in the largely sedentary Western world. Whereas most of the patients recover within a few weeks after an acute episode of low back pain, a distinct percentage of patients progress to permanent disability. Additionally, a high percentage suffers from recurrence of pain.

There is a general agreement that low back pain is associated with mechanical disorders of the lumbar spine and related joints or structures (i.e. the sacroiliac joint) leading to muskuloskeletal dysfunction [1]. A relation to structural abnormalities (like a disc prolapse) may exist but in many cases does not explain pain sensation [1].

The physiotherapeutic approach to manage low back pain consists of three main steps: 1) consideration of mechanisms underlying dysfunction by analyzing pathomechanics and pathophysiology of low back pain 2) investigation of the structures and functions linked to low back pain 3) treatment to recover from several dysfunctions based on the diagnostic results.

Pathomechanics and pathophysiology: Pain is arising from structures containing pain-mediating receptors (mainly free nerve endings). Consequently, with respect to low back pain the facet joint capsules, the ligaments and fascia, the intervertebral discs, the vertebrae, the dura and the nerve root sleeves, but also the muscles have to be considered. Pain originating segmentally (radicular symptoms) or extrasegmentally (non-radicular symptoms like irritation of the dura mater) has to be differentiated. In addition, low back pain is associated with several functional changes in the lumbar spine. These functional changes may include: 1) loss of the ability to move segments (changes in the discovetrebral and facet joints) and consequently the whole lumbar spine in a physiological range of motion (ROM); 2) development of muscle spasm and muscle tenderness (i.e. caused by muscular hyperactivity for pain avoidance) which, in turn, is related to myofascial dysfunction. In addition, moyfascial dysfunction (i.e. in terms of existence of trigger points) may induce referred pain in other body regions; 3) complex changes in segmental mechanics will lead to loss of proprioceptive function terminating in sensorimotor deficits; 4) loss of normal muscular activity (i.e. hyperactivity of some global-acting muscles and hypoactivity of some local-acting muscles) resulting in decreases in strength and fatigability of trunk muscles and in flexibilty of trunk muscles and muscles of the lower extremity; 5) changes in the neuromeningeal structures.

Diagnostics: The basis of physiotherapeutic treatment strategies is a detailed analysis of joint, myofascial and neuromeningeal function. The physiotherapeutic diagnostics include several groups of tests which are conducted to to localize the structural and functional changes. The main steps are: 1) testing of joint-play and ROM in the physiological directions of movement (flexion/extension, side-bending and rotation); 2) neurological testing (observations on decreased efferent motor function and disturbed sensibility; reflex-testing and nerve stretching tests); 3) palpation of myofascial structures (testing for tenderness of the fasciae or trigger/tender points; 4) palpation of other joint-function related structures (i.e. the ligaments).

Therapy: Manual therapeutic interventions build up the basis of physiotherapeutic treatment. Important aspects are mobilisation of joints to restore a physiological ROM accompanied by treatments to regenerate the function of myofascial and neuromeningeal structures. Restoration of myofascial function is realized by trigger and tender point treatment. Additionally, muscle energy techniques and techniques of reciprocal antagonistic inhibition are used to reduce muscle spasm and tenderness. Recovery of neuromeningeal function is conducted by means of eliminating the cause of dysfunction (i.e. relaxation of M. piriformis to reduce the strain on the sciatic nerve) and following mobilization of the respective structures (i.e. nerve mobilisation). Another important aspect of physiotherapeutic management of low back pain is the normalization of local and global muscle function. Several stretching techniques assist in reducing the consequences of hyperactivity of some muscles (i.e. the M. quadratus lumborum). Low-load dynamic mobilization help to restore a normal ROM in different joints (i.e. the hip internal rotation). Regeneration of muscle function requires sensomotoric contents (training forms consisting of reflex-mediated muscle contractions) as well as strength training to normalize activation (reinnervation of hypoactive muscles), strength and fatigability of local- and global acting spine muscles. Finally, the integration of the restored joint and muscle function into complex movement strategies at the level of the central nervous system has to be realized (complex training contents like walking, balancing and simulation exercises of real-life conditions).

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The functional stability of the lumbar spine – impact of flexible lumbar corsets

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Introduction: Low back pain as well as injuries of the lumbar spine, constitute a common problem of modern society [2]. It is well known that low back injuries are often a result of sudden unexpected movements such as slips or falls [1]. To avoid these injuries, flexible lumbar corsets have been recommended to stabilize and protect the lumbar region. Therefore, the purpose of the study was to evaluate the influence of flexible lumbar corsets on the angular displacement of the lumbar spine and the neuromuscular activity of the trunk muscles during an unexpected simulated slip.

Methods: Forty seven subjects (34 male/13 female; age: 42.7 ($\pm$ 7.7)) with no history of spine injury took part in the study. The subjects stood on a treadmill which was moved suddenly and unexpected in a forward direction. The treadmill acceleration provoked a hyperextension of the lumbar spine and an involuntary response of the trunk muscles. A three dimensional ultrasonic movement analysis system (Zebris®) was used to determine the angular displacement of the lumbar spine. Surface electromyograms (EMG) were recorded from M. erector spinae, M. rectus abdominis and M. obliquus externus abdominis. For each trial the EMG was integrated during the first 300 ms after acceleration of the treadmill (iEMG 0-300). For statistical analysis paired t-tests on 5% level were calculated.

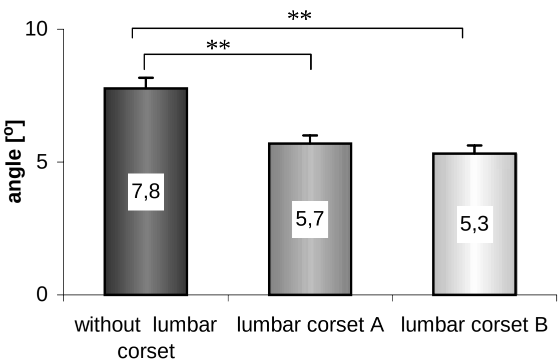

Fig. 1. Maximal hyperextension of the lumbar spine during simulated slips on a treadmill ($N = 46$).

Results: The maximal hyperextension movement of the lumbar spine was significantly reduced by wearing a flexible lumbar corset (Fig. 1). Interestingly, there was almost no change in the iEMG of the M. erector spinae during the first 300 ms after acceleration of the treadmill (Fig. 2).

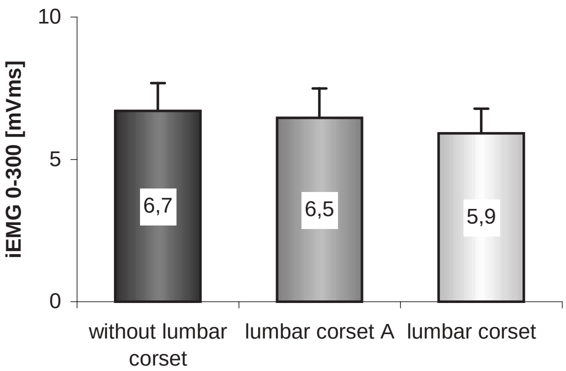

Fig. 2. iEMG of the M. erector spinae during simulated slips on a treadmill ($N = 42$).

Discussion: The hyperextension movement of the lumbar spine which is a potential cause for injuries in this region was effectively counteracted by wearing a flexible corset. Interestingly this mechanical stabilisation was not accompanied by a reduction in neuromuscular activity of the trunk muscles.

Conclusion: On the basis of our results flexible lumbar corsets can be recommended for everyday life with the restriction that almost no consolidated knowledge about the effects of a long-term application is available. Due to this fact further research is necessary to clarify the influence of a long-term application of flexible lumbar corsets on the neuromuscular activity of the trunk muscles.

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McKenzie care versus physiotherapy exercises in low back pain patients with reducible derangement-syndrome. Design of a randomized controlled trial

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Background: Numerous conservative treatment approaches exist for low back pain (LBP). On the basis of a comprehensive literature review, the international Paris task force on back pain concludes, that treatment consisting of physical exercises should be applied to most non-acute LBP patients. However, the same task force could not find evidence for specific techniques and therefore recommends programs combining strength, fitness and stretching exercises [1]. Opposed to the Paris task force and other reviews, new studies show superior treatment approaches using specific exercises for subgroups [2,3].

The McKenzie care is a widely used and acknowledged method for classifying and treating back pain patients all over the world. The main objective of this “Mechanical Diagnosis and Therapy” is not the determination of a specific anatomic structure responsible for the pain, but the formulation of an effective treatment strategy.

During assessment and treatment patients are classified depending on the appearance of specific pain and movement patterns into certain clinical subgroups, in which the reducible derangement syndrome is one of the most common.

According to the McKenzie concept specific postures and/or movements in one direction can be identified, which improve the clinical presentation for patients categorized into this subgroup. If so, treatment emphasising this direction should produce better outcome than treatment without special emphasis on a direction.

High quality studies dealing with the effectiveness of the McKenzie therapy existing so far, missed to classify patients into syndrome groups and therefore could not really evaluate the treatment effects according to this concept of directional preference.

Design: Prospective, open, randomized, controlled, pragmatic, multicenter trial, participating centers: German outpatient physiotherapy clinics, randomisation: random blocks with different lengths, stratified by trial site, setting: secondary and tertiary care (referred patients from general practitioners or specialists), inclusion criteria: subacute low back pain (current pain episode $\geqslant$ 14 days and $\leqslant$ 3 months) with or without radiation of pain, reducible derangement, pain intensity in the last 48 hours $\geqslant$ 40 mm on a 100 mm visual analogue scale, exclusion criteria: infection, spinal tumor, spinal fracture, osteoporosis etc., primary outcome measure: Roland-Moris Disability Questionnaire, secondary outcome measures: pain intensity, German version of the McGill pain questionnaire, recurrence of LBP, absence from work, etc. follow up period: 12 months, experimental intervention: McKenzie care, 6 sessions over 4 weeks, booklet "Treat your own back", control intervention: physiotherapy exercises without explicit emphasis on a directional preference, 6 sessions in 4 weeks, LBP information of a German health insurance company, co-intervention: Swedish massage, any form of local hyperthermia, sample size estimation: minimum of $n = 63$ per group, based on an expected standardized response mean of 0.5 (two-sided $\alpha = 0.05$, $\beta = 0.80$), statistics: 2 factorial Repeated Measures ANCOVA, intention-to-treat analysis.

Discussion: The study design compares a specific with a non-specific, evidenced based treatment approach [1] for a LBP subgroup. The McKenzie approach appears to be especially suitable for patients with reducible derangement syndrome, because movement directions identified to decrease symtoms during assessment are also used for treatment [4,5]. Most studies dealing with effectiveness of LBP treatment up to this time have not classified their patients into different treatment subgroups. Therefore certain patients might not show the optimum of treatment results.

Conclusion: Further research is needed to demonstrate which LBP patients are best suitable for which kind of treatment.

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Physiological effects of local heat application

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Introduction: Cardiovascular disease is considered as a contraindication for local heat application in physical therapy. This is based on the belief that hot packs and hot mud applications (fango) have an effect on heart rate and blood. In a preliminary study on healthy subjects ($n = 20$) we found no influence of local heat therapy (Fomentec pack) on heart rate and blood pressure [1]. The aim of this study was to investigate the local effects of local heat application (treated skin site) and the systemic effects (heart rate and blood pressure).

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Methods: Eighteen healthy subjects (11 women, 7 men) volunteered in this study (age 23.7 ± 3.8 yrs). Heat therapy was applied on the back of the subjects, using a 1 cm thick fango mudpack with a 2500 cm ^{2} surface at 42°C. Subjects were lying on their back covered by a blanket during twenty minutes before testing. Fango was applied during 21 minutes. After heat application, subjects stayed in supine position for further 21 minutes. The following variables were measured every three minutes, during and after heat application: heart rate, diastolic and systolic blood pressure (Omron); while skin temperature (thermo-couple thermometry), skin redness (skin surface colorimetry) and perfusion of the micro-circulation (Laser-Doppler instrument) was measured at a treated and untreated skin site.

Kinetics were statistically analysed using the Manova procedure while pre- and post- application values were compared using a paired t-test.

Results: Resting heart rate (HR) was 70.5 ± 9.9 bpm. During heat application HR increased and peaked after six minutes (78.8 ± 10.5 bpm; $p < 0.05$). At the end of fango application, HR decreased (75.5 ± 10.5 bpm). Mean HR rate decreased further within 3 minutes after cessation of fango application (71.1 ± 10.0 bpm; n.s. when comparing with pre-application values).

Resting systolic blood pressure (SBP) was 102.9 ± 9.8 mmHg. During fango application SBP decreased (98.7 ± 8.2 mmHg; $p < 0.05$). At the end of the post-application period SBP was at baseline level again (101.5 ± 9.8 mmHg; n.s.).

Diastolic blood pressure (DBP) increased slightly within three minutes of fango application (from 59.8 ± 6.3 to 61.2 ± 6.5 mmHg; $p < 0.05$). Three minutes later diastole blood pressure decreased (57.4 ± 6.5 mmHg; $p < 0.05$) and at the end of the 21 minutes fango application period DBP was 54.3 ± 6.0 mmHg (n.s.).

Baseline skin temperature (ST) was 35.5 ± 0.4 °C. When the hot mud pack was applied ST increased immediately (44.3 ± 1.2°C; $p < 0.05$). At the end of the fango application ST was still elevated (40.3 ± 0.6 °C; $p < 0.05$). ST decreased within 3 minutes after fango removal (37.2 ± 0.4 °C). 21 minutes post-application ST was at baseline level again (36.1 ± 0.4°C; n.s.).

Skin redness (SR), estimated by the a* colour parameter, increased significantly during fango application (17.9 ± 1.9; $p < 0.05$). SR did not reach baseline values 21 minutes after removal of the mud pack (15.8 ± 2.2; $p < 0.05$).

Baseline perfusion of the microcirculation was 23.2 ± 8.8 perfusion units (p.u.). During application perfusion increased immediately and peaked after 6 minutes at 197 ± 49 p.u ($p < 0.05$). At the end of the fango application perfusion decreased (159 ± 52 p.u.; $p < 0.05$). 21 minutes post-application perfusion of the microcirculation was still elevated (48 ± 39 p.u; $p < 0.05$).

Discussion: We conclude that local heath application resulted in significant changes at the treatment site (increased skin temperature, increased perfusion of the microcirculation and increased skin redness) but the overall systemic effects were rather weak. Systolic blood pressure decreased slightly, while heart rate and diastolic blood pressure increased slightly during application. However, these modest variations seem to be of no clinical relevance. The observed changes for the systemic parameters may be the expression of the redistribution of the blood towards the more superficial veins as part of the thermoregulatory response. Verification of a similar procedure in heart patients is required to exclude if cardiovascular disease is a contraindication for fango therapy.

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Strength and Balance Training in Elderly

The effect of hip and trunk stiffness on posture control – Possible implications for exercise therapy to prevent falls in the elderly

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Introduction: Appropriate postural control of hip and trunk motion is important for effective balance control. Recent studies have shown that upper body responses, particularly in the roll direction, differ between elderly and young persons [1] and in several diseases [2]. This is due possibly to increased joint stiffness, preactivation of muscles or a stooped posture or a combination of these, to which the elderly do not adapt their postural responses adequately [1,2]. The aims of the current study were firstly to examine whether biomechanical and muscular responses in healthy young subjects, whose hips and trunk were artificially stiffened, resembled those of elderly subjects, secondly to examine whether artificially stiffened young persons would adapt better than the elderly to their changed biomechanical environment.

Methods: To examine the effect of artificially increased stiffness of the hip and the trunk, five healthy young adults (3 men, 2 women; mean age 27 years) were studied while they wore one of two types of corset or nor corset at all. One type, the “half-corset”, increased hip stiffness only and the other, the “full-corset”, increased stiffness of the hip and the trunk. A dual-axis rotating support surface delivered unexpected random perturbations (7.5 deg, 60 deg/sec) to stance through 6 different directions in the pitch and the roll planes. Biomechanical measures included pitch and roll measurements of the lower leg and trunk angle, head roll acceleration and ground-reaction forces. Centre of mass (COM) displacements and velocities were calculated collected by placing infrared diodes on 18 anatomical landmarks using a 3D optoelectronic camera system. EMG outcome measures included measurements from the lower leg, trunk, and arm.

Results: With increased stiffness of the of the hip and the hip and the trunk, roll perturbations had a destabilising effect on the COM (Fig. 1A, population mean) compared with the normal condition. Three major effects on movement strategies were found. First, the more drastic effect of stiffening was observed for roll perturbations which caused the trunk to move in the same direction as support surface tilt (Fig. 1B, population mean). The trunk reaction which was like that previously described in the elderly [1] (and oppositely directed to the normal reaction of the young) was not compensated by changes in leg or trunk muscle activity. Rather, the young relied more on arm movements to restabilise themselves. Second, for pitch perturbations forwards, stiffening had little effect presumably because most movement occurs around the ankle and knee joints stiffness changes were well compensated by reductions in ankle muscle responses. Third, for pitch rotations backwards stiffening of the hip caused the trunk to move faster forward.

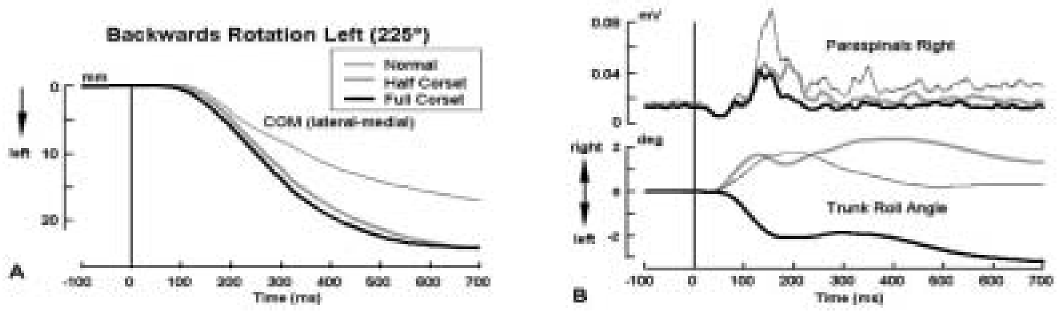

Fig. 1.

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Discussion: These results indicate that young healthy normals do not modify movement strategies sufficiently to account for changes in link flexibility following increases in hip and trunk stiffness. The major differences in trunk motion support the concept of a multi-link pendulum with different control dynamics in the pitch and roll planes as a model of human stance. With the full corset, young subjects have roll responses resembling those of the elderly [1, 3].

Conclusion: These findings provide evidence that increased trunk stiffness particularly in roll might be an additional cause of trunk instability in the elderly. Therefore, exercise therapy for elderly should focus more on improvement of trunk flexibility and pre-programmed arm movements for possible cushioning reactions and to enhance balance control. In future, research should focus more on the effect of exercise therapy interventions with emphasis on trunk flexibility and arm movements.

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Training induced adaptations in reflex – Characteristics of elderly men

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Introduction: It is well documented that the aging neuromuscular system is affected by various degenerative processes leading to a general slowing down of neuromuscular performance and an increased risk of falling [4]. Two main mechanisms are responsible for the high incidence of falls in the elderly. First, a decrease in maximal voluntary contraction (MVC) and rate of force development (RFD) [2]. Second, an impaired postural stability due to detrimental effects on reflex activity [3]. Several studies [2] dealt with the impact of heavy resistance training (HRT) in the elderly on MVC and RFD. However, only little is known concerning the influence of HRT and sensorimotor training (SENSO) on reflex-characteristics in the elderly. In fact, the impact of HRT and SENSO on the ability to compensate for gait perturbations has not yet been investigated in the elderly. Therefore, the purpose of the study was to examine the influence of HRT and SENSO in elderly men ($>$ 60 years) on unexpected treadmill and platform perturbations.

Methods: Sixty healthy males between the ages of 60 and 80 years (age 66.5 $\pm$ 4.6 yrs; body-mass-index 25.34 $\pm$ 2.6 kg/m^2) volunteered as subjects in this study. They conducted a twelve week training program with three training sessions a week. A one week pre training period was also part of the study. Group one (strength-group – $N = 20$) realized a lower limb HRT (80% of 1RM). Group two (senso-group – $N = 20$) carried out a SENSO on wobble boards, on sissles and on uneven surfaces. In a weekly interval, intensity of the training regimen was progressively increased for both intervention groups. A control group ($N = 20$) was also incorporated in the study.

Pre- and post measurements involved: (a) treadmill deceleration: switches implemented in inlays of the right shoe were used as a trigger for decelerating the treadmill at heel contact. Treadmill velocity was decelerated from 3.5 km/h to a backward velocity of 0.6 km/h in 0.4 s. (b) one-legged postural stabilization on a two-dimensional platform (POSTUROMED®) for 10 s following a medio-lateral perturbation. The analysed time interval for both measuring sections was 120 ms after the first physiological response in the goniometer signal. EMG activity was recorded from M. tibialis anterior (TA), M. soleus (SO) and M. peronaeus of the right leg using surface electrodes. EMG data were quantified by integrating and time normalizing the rectified and averaged emg-signals (MAV). MAV of the TA during the perturbation was also normalized on MAV of TA during the swing phase of a regular gait cycle. The ankle joint movements were indicated by a goniometer fixed along the Achilles tendon. For statistical analysis, paired t-tests on 5% level were calculated. Data are presented as group mean values $\pm$ SE.

Results: (a) Treadmill deceleration: after the 12 week training period MAV of TA increased significantly in the senso-group from 0.18 $\pm$ 0.015 to 0.22 $\pm$ 0.02 mV ($=$ 22%; $p \leqslant 0.01$). Normalized MAV of the TA was also enhanced from 50.5 $\pm$ 4.01 to 59.9 $\pm$ 6.7% ($=$ 18.6%; $p < 0.05$). Mean angular velocity (plantar-/ dorsal flexion) was reduced in the senso-group from 48.4 $\pm$ 4.6 to 39.35 $\pm$ 3.4 deg/s ($=$ 18.7%; $p < 0.05$) and maximal angular velocity (plantar-/ dorsal flexion) from 106.4 $\pm$ 9.8 to 90.5 $\pm$ 6.03 deg/s ($=$ 14.9%; $p < 0.05$). Maximal angular velocity was also decreased in the strength-group from 116.1 $\pm$ 11.2 to 94.4 $\pm$ 9.6 deg/s ($=$ 18.6%; $p < 0.05$). All analysed parameters didn't change significantly in the control-group. (b) Platform perturbation: MAV of TA significantly increased in the senso-group from 0.21 $\pm$ 0.02 to 0.25 $\pm$ 0.02 mV ($=$19%; $p < 0.05$). Mean angular velocity (inversion/ eversion) was reduced in the senso-group from 30.3 $\pm$ 2.95 to 24.8 $\pm$ 3.04 deg/s ($=$ 18%; $p < 0.05$) and maximal angular velocity (inversion/eversion) from 56.76 $\pm$ 5.6 to 42.33 $\pm$ 4.8 deg/s ($=$ 25.4%; $p < 0.01$). All analysed parameters didn't change significantly in the strength-group and the control-group.

Discussion: The investigated parameters indicate that SENSO has an impact on spinal mechanisms in the elderly, in contrast to HRT. This can be seen in a facilitated neural drive in the TA during the perturbation impulses accompanied by a decrease in mean and maximal angular velocity. Three adaptational mechanisms in the neuromuscular system could account for the improved ability to compensate for treadmill- and platform perturbations. First, a more efficient transmission and processing of sensory information in the central nervous system. For the fact that gait perturbations are most likely to be detected by group-II-afferents [1], it seems possible that an improved temporal and spatial summation of group-II-afferents could be the reason for the increase in reflex contraction. This might be due to the fact that the performance of one-legged exercises on unstable platforms elicits an intense reflex activation in muscles encompassing the ankle joint. Second, SENSO could result in a reduction of the increased presynaptic inhibition of group-II-afferents in old age. Third, an enhanced sensitivity of muscle spindles via the gamma motor system might lead to an improved afferent sensory input which again influences the efferent muscular output. From this it follows that SENSO seems to be able to restore neuromuscular function in old age. Therefore, SENSO appears to be a well-suited method for fall preventive programs in elderly people.

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Strength training and balance performance compared to combined strength and agility training in elderly over 80 years: A three months RCT

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Introduction: Physical fitness, defined by the WHO as "the ability to perform muscular works satisfactorily" [1], includes (amongst others) components such as muscular strength and balance. Compared to young people, older persons perform worse on tests for strength and balance [2]. Exercise confers the benefit of influencing both domains. However, the specifics of exercise prescription for optimal prevention of for instance falls in the elderly are not well established, especially in those who are at particular risk of falling. Thus, the purpose of this randomised controlled trial was to examine the effects of two different types (strength training versus combined strength and agility training) of exercise regimens on static and dynamic balance in elderly aged 80 years or more.

Methods: Thirty-three residential care facility inhabitants 80 years of age and up were randomised to one of the following two groups: twice weekly individual strength training (F) or twice weekly individual strength training combined with once a week agility training (F&A). Participants were required to attend 75% of the scheduled training sessions. There were two measurement sessions: baseline and 12 weeks. Outcome measures were: a) static and dynamic balance ability measured with a Biodex Balance System, b) a task performance exam with the Tinetti Assessment Tool [3] and c) isometric quadriceps strength.

Results: Our preliminary results indicate that there is a 25% strength increase for the F group, whereas the F&A group gains 40%. There is a significant increase in Tinetti test score for the F group, the F&A group, however, does not significantly improve on this score. Both groups remain on constant values for the static balance score measured with a Biodex Stability System. The dynamic stability test performance does not change for the F group. There is a significant improved dynamic stability test in the F&A group (Table 1).

Table 1
Outcome measures (mean ± SD) for both training groups at baseline and 12 weeks

	Baseline (F)	12 weeks (F)	Baseline (F&A)	12 weeks (F&A)
Quadriceps strength right/left	15.7 ± 4.5/15.4 ± 4.7	19.2 ± 5/18.4 ± 6.5	13.7 ± 7.5/12.3 ± 6.4	17.5 ± 8.6/16.2 ± 7.7
Tinetti score	25.5 ± 2.3	26.1 ± 1.9	25.8 ± 2.4	27 ± 1.1
Static balance	4.1 ± 1.9	2.8 ± 0.9	3.6 ± 2.4	2.7 ± 1
Dynamic balance	7.3 ± 9.4	6.9 ± 9.1	11.2 ± 11.6	17 ± 11.1

Discussion: Both strength and agility training are feasible and safe for older people. Both types of training are believed to be effective for fall risk reduction. Additional agility training, however, is expected to improve functional abilities in older subjects with more success. The results of this study confirm this observation. This study indicates that strength training alone does not serve as a predictor for functional improvement in dynamic stability performance.

A remarkable difference exists in strength gain between the two groups. The F&A group has 15% more gain in strength compared to the strength training only group. Whether this gain in strength might be attributed to a better improvement of intramuscular and intermuscular coordination as well as a more economic recruitment should be concern in future research. Heitkamp showed that a balance training only was able to cause strength performances of around 12% [4].

Conclusion: This study confirms former observations which indicated that strength training alone does not improve, or even has adverse effects on balance in older women and men [5]. Further research to determine optimal training components to improve balance in the elderly is needed.

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Muscle functioning, the effect of aging and running

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Introduction: In relation to gait instability, muscle weakness has often been assessed as a reduced maximal knee extension moment. This approach neglects that different muscles contribute to a joint moment. Moreover, it does not take into account that stability is determined by the concerted action of individual extensor and flexor muscles.

Therefore, to be able to evaluate the effect of changes in muscle properties for gait, it is necessary to discriminate between adaptations in mono- and biarticular flexor and extensor muscles. Whereas ageing is known to affect muscle performance negatively, physical activity is known to improve it. In a previous study we showed that running leads to specific adaptations in muscle [1]. If anything, running induced adaptations might be most suited to counterbalance the effect of ageing on gait stability. In this study the hypothesis is tested that running is effective to maintain the balance between knee extensors and flexor moment) was determined.

Methods: Forty subjects participated in this study. They were divided over four groups: young-active, young-inactive, elderly-active and elderly-inactive. All physical active subjects were selected from a group of runners. On a Cybex II dynamometer all subjects exerted maximal, voluntary, isometric knee flexions and extensions. These contractions were performed at combinations of five knee joint and four hip joint angles. Thus the extending and flexing knee joint moments were determined. Moreover this approach allowed discriminating between the contribution of mono- and biarticular muscles to these joint moments. To evaluate the balance between extensors and flexors the HQ-ratio, being 10log(extensor/flexor moment) was determined.

Results: The maximal extensor moment was significantly larger in the young active subjects (231 Nm) than in all other groups (153 Nm; Fig. 1). The other groups did not differ. The minimal extensor moment was only affected by age, respectively 53 and 40 Nm in young and older subjects. Minimal extensor moments occurred at extended knee joint angles. The maximal flexor moment was affected significantly by age, 111 vs 73 Nm. The minimal moment of this muscle group differed significantly between both activity and age groups. As a consequence, the HQ-ratio is not constant; it differs between groups and within groups as a function of knee and hip joint angles. A relative dominance of extensor muscles in elderly at small knee joint angles was found. The differences in the extensor moment were found to be attributable to differences in the contribution of the mono-articular vasti. The contribution of the biarticular rectus femoris was not affected by age or activity. The biarticular flexor muscles occurred to be responsible for the differences in extensor moment with age.

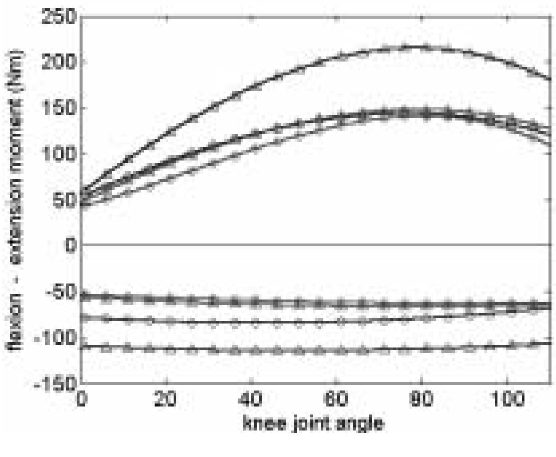

Fig. 1. Knee extension and flexion moment as function of knee joint angle. Triangles represent physically active subjects; dotted data of elderly.

Discussion and conclusions: Running cannot fully compensate for effects of ageing on muscle properties. An interaction between effects of ageing and physical activity appears to exist. However, the consequences of this interaction are different from our initial approach. Running does not prevent effects of ageing to occur; rather, lack of physical activity at young age seems to promote ageing effects.

Ageing affects the balance between knee joint flexors and extensors. Differences in joint moments are not equally distributed over mono- and biarticular muscles. From this study it can be concluded that interventions aiming at the most affected muscle groups should focus on the vasti and biarticular part of the hamstrings.

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Effects of aging and physical activity on gait strategy

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Introduction: When asked to walk at a self-selected speed old adults choose to walk slower and with smaller steps compared to young adults [1]. This may be the result of a reduction in muscle strength with increasing age, which can be as much as 40% [2]. The purpose of the present study was two-fold: a) to evaluate if an altered gait in elderly people is accompanied by an altered recruitment pattern of the major leg muscles, b) to study whether a physically active life style allows elderly to retain normal gait and muscle recruitment patterns.

Methods: Forty subjects participated in this study. They were subdivided in four groups of 10 subjects based on age and level of physical activity; young-active (YA), young non-active (YN), old active (OA) and old non-active (ON). Young subjects were on average 22.7 $\pm$ 2.1 years old and elderly subjects were on average 67.6 $\pm$ 5.4 years old. The index of activity determined with a questionnaire was significantly different between active and non-active subjects.

The subjects were asked to walk over a 12 m level walkway at their voluntary speed and a test speed of 1.5 m/s. The following data was collected; a) 2-d segmental positions in the sagital plane from video images (50 Hz) of reflective markers, b) ground reaction forces (Kistler type 9281A) and c) EMG (K lab) of the major muscle groups.

Results: The main results of this study are: a) the voluntary speed of the elderly was significantly lower (1.32 vs. 1.57 m/s) compared to young adults. Compared to young adults, elderly took significantly smaller steps (0.7 vs. 0.82 m) at a lower pace (112 vs. 115 steps/min.), b) the elderly had less stance phase knee flexion and smaller plantar flexion at push-off, c) a physically active lifestyle had no effect on these gait characteristics, d) the duration of knee extensor muscle activity and extensor-flexor co-contraction was significantly longer in elderly subjects (Fig. 1), e) a physically active lifestyle had a minor effect on these parameters, f) the horizontal impulse during impact and push-off was significantly smaller in the elderly (Fig. 2). This effect was independent of walking speed and level of physical activity.

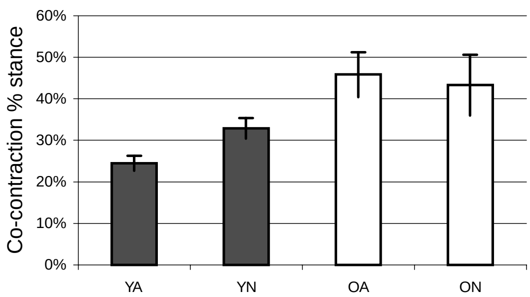

Fig. 1. Co-contraction at the knee during stance.

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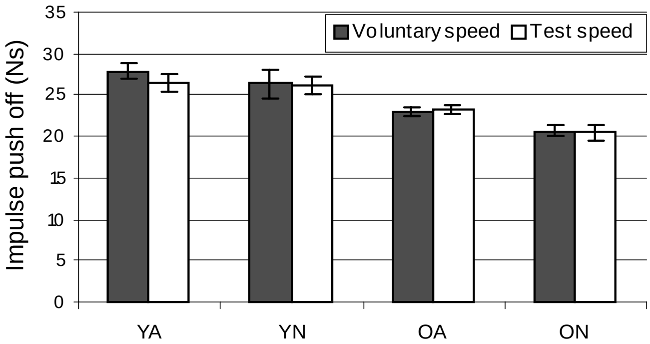

Fig. 2. Horizontal impulse during push-off.

Discussion and conclusions: The changes in gait and muscle recruitment patterns found in our study revealed that elderly walk with stiffer legs compared to young adults. Analysis of the kinetics indicates that elderly use this strategy to reduce the energy fluctuations during walking. It is hypothesized that this is an effective way to compensate for reduced muscle strength. Contrary to our expectation, we could not find any beneficial effects of a physically active life style in elderly. It is concluded that it takes more than an active lifestyle to induce substantial gait improvements, it is expected that more rigorous training will lead to the desired improvements.

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Recreation, Sports and Lifestyle

Interaction between lifestyle, body composition and activities of daily living

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Lifestyle and body composition are significant variables influencing the scenario of morbidity and mortality in our population. In combination with genetic factors, lifestyle and body composition are responsible for the development and progression of chronic diseases such as insulin resistance, type II diabetes, hypertension and coronary heart disease. People are eating more and exercising less resulting in a positive energy balance and an increase of body weight. Therefore, as much as half of the adult population in high income countries are overweight and more than 25% obese. For population and intervention studies, body mass index (BMI) is generally accepted as a measure of body fatness. Unfortunately, BMI has been shown to be an imprecise measurement of fat and lean body mass; and in addition, there is evidence that BMI does not sufficiently reflect the individual metabolic and endocrine function of the adipose tissue. However, valuable information about both, body composition and the control of adipose tissue, is substantially necessary for preventive as well as therapeutic applications, e.g. weight gain or loss, during aging, in combination with physical activity and the nutritional status, for managing obesity, insulin resistance and hyperlipidemia. Furthermore, recently given recommendations for disease control and prevention have intensified implementation of nutrition, physical activity and weight control, and have combined these components into a new therapeutic lifestyle change (TLC) treatment plan. The recommendations are based on the observation that activities of daily living and regularly done physical exercise enhance body composition and reduce morbidity and mortality associated with atherosclerotic and inflammatory diseases. In agreement with our own findings we confirm that lifestyle changes are effective methods of reducing abdominal fat mass and enhancing adipose tissue control. Nevertheless, more detailed aspects about the complex control of energy homeostasis have to be investigated and risk determinants have to be evaluated in the medical management of overweight and physically inactive individuals.

Measuring daily energy expenditure and daily activity pattern in normal weight and obese children under free living conditions

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Introduction: So far, there is only little data on total daily energy expenditure (TDEE) and intensity of physical activity of obese children (OC) in comparison to normal weight children (NC) under free living conditions. In our pilot-study, we examined parameters of energy expenditure by applying the heart rate (HR) monitoring method in combination with the HR-FLEX-method and an activity diary reported by the children simultaneously. Additionally, we focused on the role of non-organized physical activity (NOPA) for enhancing TDEE.

Methods: Ten normal weight children (NC, 12.3 $\pm$ 1.0 years old, BMI $=$ 19.0 $\pm$ 1.6, 57.0 $\pm$ 20 percentile, %body fat $=$ 14.2 $\pm$ 2.7) and 6 obese children (OC, 11.0 $\pm$ 1.3 years old, BMI $=$ 26.4 $\pm$ 3.1, 98.0 $\pm$ 2 percentile, %body fat $=$ 28.7 $\pm$ 2.5) performed a graded maximal exercise test (GXT, WHO protocol starting at 25 Watt) on a cycle ergometer. Oxygen consumption was measured by indirect calorimetry during rest (lying, sitting, standing), walking at a speed of 3.5 km/h and during GXT. Regression lines between HR and oxygen consumption (VO_2) were determined individually. Following the initial testing, HR was measured on 3 school days and on 2 days on the weekend for 12 hours. All children reported their activities minute wise in a diary during all 5 days. Based on the individual regression line, energy expenditure was calculated by using HR-FLEX-method. HR-FLEX is the HR zone, where a stepwise rise in V_{O2} occurs due to increasing physical activity. HR-Flex was determined graphically and by averaging mean HR while standing and mean HR while walking at a speed of 3.5 km/h. HR below HR-FLEX are classified as physical inactivity, HR>HF-Flex as physical activity consisting of HR>HF-FLEX $<$ 50% VO_2max as low physical activity (LPA), HR $\geqslant$ 50% VO_2max $<$ 70% VO_2max as moderate physical activity (MPA), and HR $\geqslant$ 70% VO_2max as vigorous physical activity (VPA). NOPA is determined as physical activity (HR $>$ HF-FLEX) subtracting organized exercise sessions.

Results: V_{O2}max reached 2.11 $\pm$ 0.52 l/min (44.6 $\pm$ 5.9 ml/min/kg) in NC and 1.49 $\pm$ 0.15 l/min (24.9 $\pm$ 2.8 ml/min/kg) in OC. Average individual regression lines were different between NC and OC. Average HF-FLEX was set at 95 $\pm$ 7 bpm in NC and 113 $\pm$ 9 bpm in OC. 12h-HR-monitoring revealed that the activity period in NC lasted 88 $\pm$ 44 min per day longer than in OC, and thus, energy expenditure through physical activity was higher by 409 $\pm$ 170 kcal per day ($p < 0.05$). TDEE reached 2336 $\pm$ 302 kcal (51 $\pm$ 8 kcal/kg) per day in NC and 2019 $\pm$ 324 kcal (36 $\pm$ 6 kcal/kg; $p < 0.01$) per day in OC. NC spent more calories on doing LPA and on participating in organized exercise sessions. Time and energy expenditure for MPA and VPA were not different between NC and OC. Physical activity was enhanced on school days in comparison to days on the weekend. 83 $\pm$ 14% of the time spent by physical activity relates to NOPA. Absolute energy expenditure in NOPA was higher compared to the energy expenditure in exercise sessions, in which more kcal per minute were being expended though.

Discussion: In our study, we determined TDEE and intensities of energy expenditure in normal weight and obese children in a practical way. Energetic differences were found between NC and OC and between school days and days on the weekend. On average, all children spent enough calories to reach the recommendation of 3–5 kcal/kg energy expenditure and at least 30 min time spent for MPA or VPA. However, many children failed to meet the recommendation on a daily basis, especially on the weekend days. NOPA is important to raise energy expenditure. Both, energy expenditure and duration of NOPA within physical activity outperformed energy expenditure and duration through exercise sessions in school and in sports clubs. The use of an activity diary supports a detailed description of the childish movement patterns and improves data interpretation.

Conclusion: The HR monitoring method can be used in clinical or ambulant settings for interventions with overweight and obese children. Special focus should be set on enhancing energy expenditure through NOPA.

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Ageing and disability – A new crossing between physical activity, social inclusion and life-long well-being

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Introduction: One of the most important changes in Europe over the last 50 years has been the rapid increase in the number of people living into their 70 s, 80 s and beyond. Today, the people of 75 years old and over form 7.5% of the overall European population, but in 30 years this percentage will rise to 14.4%. Most of those ageing people will have some physical or mental disability, regardless the fact if they acquired this disability at birth or obtained it later in life or just it happened as a consequence of the normal process of ageing. The "Eurostat" data estimate that by the end of 2040 the severely impaired adults will be 6.5% of the total population in Europe, or 24.5 million people.

Ageing is a process that often affects and restricts the people who are growing old, on physical, psychological and social level. Numerous research projects have demonstrated that the benefits of planned physical activities for health for elderly are indisputable. As older adults are the fastest growing age group, attention needs to be given to them as a special population in the area of exercise and sport. Qualified professionals in the area of physical activity for the elderly have to be prepared now, so they can meet the new demands of the future.

A Thematic Network is needed to create and implement the subject of physical activity for the elderly in the European higher education curricula, in order to compensate for the current lack of information and resources in that specific domain.

Methods: By using a comparative study, we are going to identify the extend to which the topic of physical activity and sport for the elderly is included in the academic curricula across Europe, to define the best found practices and programs and to prepare teaching materials and courses at un unified level. A comparative study for establishing the level of active life style of the elderly in the different European countries is needed as well.

Results: The expected results from the project are:

- Including the subject of physical activity for the elderly in the European higher education curricula
- Improving the quality of education in the field of physical activity and exercise for the elderly
- Increasing life-long well-being of the older adults
- Reducing the health care costs for the elderly

Discussion: This summer on a congress in Salzburg, Prof. Owen Neville reported that the direct health care costs of the physical inactivity of elderly in the USA is 77 billions dollars per year. By 2040 the number of older Americans will double, which is likely to double the medical care costs as well. The European statistics predicts the same worrying data, related to the grow of the elderly population. Given this ageing trend, the impact of a lack of physical activity on the public health system and on the costs of medical and social services will also increase. Regular physical exercises significantly decrease the need for medical treatment and also extent the time that older adults can continue living without special support. One the missions of this Thematic Network is to promote physical activity and sport for the elderly, by providing opportunities, motivation and encouragement for the older adults to lead independent active lifestyle. And this is very strong argument emphasising the cost efficiency of our project proposal.

Conclusion: The project is aimed at providing enough knowledge and information for the students in order to motivate them to work in the field of ageing and disability, which indirectly will benefit the elderly people towards maintaining of an active and healthy life style. The collected data will also reveal a lot of future possibilities for research in that specific area.

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