

Abstracts

# The Stabilizing System of the Spine and Comprehensive Modern Approaches to Back Pain



## The Czech and Slovak Society for Myoskeletal Medicine

Clarion Congress Hotel, Prague, Czech Republic, 14–15 October 2011

Congress dedicated to Prof. Lewit's 95th birthday

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**Annie O'Connor** Comprehensive Approach to Musculoskeletal Spine Care: Using Classifications Systems to Direct Treatment and Resources

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Maintain an open mind, because what you are doing & teaching today you will have to modify in view of new facts. The task is enormous, there is a generation's work. Go step by step - Prof. Karel Lewit

## Comprehensive approach to musculoskeletal spine care: Using classification systems to direct patient care

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*To be effective, treatment must somehow reach and reverse the painful process at its source in a lasting fashion. If one is not successful reversing the pain-generating disorder, it will persist, allowing pre-existing psychosocial factors to become operative, flourish, and even dominate.* (James Cyriax, MD)

A comprehensive approach involves utilizing a team, each discipline responsible for deepening the diagnosis and active care plan for each individual patient. At the Rehabilitation Institute of Chicago (RIC), USA, the medical team and physical and occupational therapy team both utilize different classification systems to direct patient care and to assure understanding of all inputs to the patient's pain experience.

*Medical doctor – International Classification of Diseases (ICD-10)*

- Groups patient according to anatomy, etiology, and pathology.

*Physical therapy (PT) – Treatment Based Classification Systems*

1. Pain Mechanism Classification System (PMCS) – Primary

- Groups according to the underlying neurophysiological mechanisms in the peripheral nervous system (PNS) and central nervous system (CNS) responsible for the pain generation/maintenance.

2. Mechanical Diagnosis and Treatment – McKenzie method (MDT) – Secondary

- Groups according to movement and pain responses to repeated end range spinal movement and kinetic chain activation dysfunctions.

These classification systems position doctors and therapists to improve clinical reasoning and decisions regarding individual patient's care. Establishing accurate prognosis, to predict outcomes and identify quickly 'at-risk' patients who will require more than customary resources for maximum benefit. Lastly, classification systems provide more effective treatment with better outcomes to improve the interpretation of findings and quality of clinical research design. The evidence on classification systems supports the recognized benefits. Patients treated as part of a classification system do better.<sup>1,2</sup> Subgroups respond better to one type of intervention than another.<sup>3-6</sup> Only 5 out of 68 studies sub-classified patients. Meta-analysis showed a statistically significant difference in favor of classification-based treatment over control for

reduction in pain ( $P = 0.004$ ) and disability ( $P = 0.0005$ ).<sup>7</sup>

The RIC utilizes the PMCS developed by Butler and Gifford.<sup>3</sup> Brief definitions for each pain mechanism is as follows:

1. Nociceptive pain: Inflammatory – pain from neurons of target tissues (e.g. muscle, ligament, bone, tendon, fascia, cartilage, etc.)
2. Nociceptive pain: Ischemia – pain from neurons of target tissues (e.g. muscle, ligament, bone, tendon, fascia, cartilage, etc.)
3. Peripheral neurogenic – pain from neural tissue 'outside' dorsal and medullar horns (e.g. nerve root, nerve trunk, nerve axon.)
4. Central sensitization – pain related to altered CNS circuitry and processing occurring within the spinal cord and dorsal root ganglion (e.g. thoughts, beliefs, fears, etc.)
5. Affective pain mechanism – pain from central pathways and circuits related to emotions and their perception. These include anxiety, depression, psychological stress disorders, and significant life-changing events (e.g. trauma, disease, abuse, neglect, anger, blame, etc.)
6. Motor/autonomic pain mechanism – Pain related to a cortical dysfunction of the output systems of the brain. Involuntary systems (sympathetic and parasympathetic) show involvement and are influenced by somatic-motor systems and autonomic system contributions. It is not uncommon to see other systems involved, such as the neuroendocrine and immune systems. This is indicative of a more involved patient.

The PMCS supports physiological/pathophysiological processes of pain in sensory, cognitive, and emotional dimensions. Despite the location of pain, any or all of these mechanisms may contribute and may dominate the patient's pain experience. PMCS evidence supporting use in PT practice started with pain science advancement and the recognized limitations of the medical/disease classification system in explaining many complex clinical pain presentations. Another reason for which the PMCS has been recommended is the main cause of treatment failure is the difficulty in identifying the pain mechanism in musculoskeletal pain.<sup>8</sup> PMCS has been advocated by many physiotherapists, medical and scientific authors as a classification system for musculoskeletal pain.<sup>3,8-15</sup> An argument for PMCS is that it is essential for physiotherapists to be effective in decision making, identifying characteristics associated with complex clinical pain presentations.<sup>10,16,17</sup> Recently, the

PMCS gained support in scientific literature with this web-based three-round Delphi survey of 103 clinical experts where they showed agreement with subjective and objective clinical characteristics for nociceptive, peripheral neurogenic and central pain mechanisms.<sup>18</sup> In addition, the study concluded preliminary evidence supporting the reliability of clinical characteristics for PMCS on low back ( $\pm$ ) leg pain. RIC has chosen PMCS as the physical and occupational therapists' primary diagnosis classification system.

When pain mechanisms are dominated by the periphery, movement appears closely related to the symptoms and therefore an additional mechanical classification is beneficial. Mechanical diagnosis and treatment – McKenzie method (MDT) groups problems according to pain location changes and movement responses based on repeated movements to end range of spine or extremity. Despite the location of pain, one or two of these syndromes may contribute. This classification system supports all PNS mechanical nociceptive pain mechanisms. The McKenzie syndrome definitions are:<sup>19</sup>

1. Derangement – An internal disturbance of the resting position of affected joint surfaces or disc material, causing deformation of the capsule, peri-articular and annular ligaments. Pathology: displaced or disrupted tissue.
2. Dysfunction – Mechanical deformation of impaired soft tissues may be a product of previous trauma or inflammatory or degenerative process, causing contraction, scarring, adherence, or adaptive shortening and weakness. Pathology: degenerative, contracted, scarred, adhered, shortened, and weak connective tissue.
3. Posture – Mechanical deformation of soft tissues from sustained end range postures which deprives vascular transmission and creates abnormal forces. Soft tissues affected: articular, muscles, tendons, periosteal insertions, spinal disc, and peripheral nerve. No pathology presence.
4. Other – Mechanically inconclusive, non-mechanical, or chemical-dominant pain mechanisms. Pathology example: stenosis or poor quality motor activation pattern for function, i.e. kinetic chain impairment.

The evidence supporting MDT is strong with reliability but is dependent on how much training a therapist has. A systematic review of certified physical therapists had best reliability for both neck and lumbar spine.<sup>20</sup> Reliability using MDT for the lumbar spine was established early and repeated by other researchers.<sup>21,22</sup> McKenzie-trained therapists and students showed consistent kappa values with inter- and intra-rater reliability using MDT for neck pain.<sup>23</sup> MDT reliability is dependent on the assessment of repeated end range movements and the ability to classify a McKenzie syndrome. Identifying pain location changes based on mechanical assessment

allowed improved outcomes.<sup>24</sup> Inter-tester reliability is strong with assessing patterns of pain response to repeated end range spinal movements to identify McKenzie syndromes.<sup>25</sup> MDT reliability between therapists lies in syndrome classification and directional preference identification using repeated movement exam.<sup>26,27</sup> MDT literature on syndrome of derangement lies within research on directional preference and centralization. MDT literature supports certain mechanical syndromes needing a specific direction of movement for best outcome. A systematic review found four out of five studies showed better outcomes vs. comparison group when patients classified based on exercise direction.<sup>28</sup> The question 'Does it matter which exercise?' was answered with a randomized controlled trial where patients were treated with their directional preference significantly and rapidly improved while those patients treated with the opposite to the preferred direction rapidly worsened in the lumbar spine.<sup>1,24</sup> The same scenario was identified with the cervical spine where they found in a group of patients with neck and radicular pain to the hand, that a directional preference had an effect on distal hand symptoms in addition to EMG nerve root compression findings.<sup>29</sup> When a directional preference is identified, a phenomenon of centralization is occurring, with the distal symptoms in both upper and lower extremity receding distally to proximally. When this phenomenon occurs strong predictability of good to excellent outcomes can be predicted. Many papers have investigated prognostic value of centralization.<sup>1,24,30–33</sup> All agree when comparing outcomes of centralizers vs. non-centralizers. Centralization was correlated with good/excellent outcomes, greater reduction in pain intensity, higher return to work rates, greater functional improvement, and less continued healthcare usage.

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## A randomized controlled trial comparing a multi-modal intervention and standard obstetrical care for low-back and pelvic pain in pregnancy

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**Objective:** Musculoskeletal pain in pregnancy is commonly viewed as transient, physiologic, and self-limited. Many women report either low-back pain (LBP) or pelvic pain (PP) during pregnancy but are rarely formally treated. This study tested the hypothesis that a multimodal approach of manual therapy, exercise, and education for LBP/PP in pregnancy is superior to standard obstetrical care for the reduction of pain, impairment, and disability in the antepartum and postpartum periods.

**Study design:** This is a prospective, randomized, clinical trial that compared standard obstetric care (STOB) to a multi-modal musculoskeletal and obstetric management (MOM). A single masked chiropractor performed a baseline evaluation at enrolment between 24 and 28 weeks of gestation with follow-up exams at 33 weeks of gestation and 3 months post-partum.

Subjective questionnaires included the numerical rating scale (NRS), Quebec disability questionnaire (QDQ), and personal pain history (PPH). Objective physical tests included straight leg raise (SLR), posterior pelvic pain provocation (P4), and long dorsal ligament tests (LDLT), which were used to quantify pain, disability, and physical function at each assessment. Patients in both the STOB and MOM group received routine obstetrical care. The MOM group also had visits with a chiropractic specialist who provided manual therapy, stabilization exercises, and patient education.

**Results:** STOB ( $n = 82$ ) and MOM ( $n = 87$ ) groups were demographically similar and baseline evaluation showed no differences in pain, disability, or physical assessments between the two groups. Compared to baseline, patients in the MOM group demonstrated a

significant reduction in NRS, QDQ, PPH, and SLR scores at the 33-week visit (all  $P < 0.05$ ). STOB patients showed improvement in QDQ alone ( $P < 0.05$ ). The STOB and MOM groups were similar in all parameters studied at the post-partum visit.

Conclusion: A chiropractic approach to musculoskeletal LBP/PP instituted in the late second and early third trimesters of pregnancy benefits patients above and beyond standard obstetrical provider care.

Supported by Grant # R18HP07640.

### The effects of chronic pain in the upper quarter on sensorimotor control

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Differences exist among individuals with chronic pain in the upper quarter (CUQP) and healthy individuals in functional tasks of proprioception and graphesthesia. These differences, although clinically observed, have not been objectively quantified. This study quantifies the sensorimotor deficits present in individuals with CUQP, which will provide a foundation for comprehensive rehabilitation protocols aimed at improving upper quarter functional tasks. This was accomplished by having participants perform drawing tasks on a SMART white board where the subjects drew repeated figure 8s, circles, and line drawings. Geometric differences in the drawings were calculated with a visual basic program and compared between the two groups. Subjects also performed upper extremity proprioception tests and body image estimation tests. Twenty control and 19 experimental subjects with CUQP participated in the study. Differences between the experimental and control groups were measured and compared using ANOVA and two-tailed *t*-tests. Differences were seen between the experimental and control group in graphesthesia and kinesthetic drawing tests of figure eight, and straight line drawing tasks. Significant differences were seen in the ability to correctly identify numbers drawn on the skin over the painful area where the experimental group demonstrated a decreased ability to correctly identify the number drawn compared to the control group. Significant differences were found in the drawing tasks where the shape of the figure eight in the experimental group had a greater change in figure area than subjects in the control group.

Significant differences were also found in the x-error during the straight line drawing task, indicating that the experimental group either over or undershot the target compared to the control group. No significant differences in the body image estimation tasks and the circle drawing tasks were seen between the experimental and control groups, although differences are often seen clinically. Individuals with CUQP often over-estimate their body image size compared to the actual measurements. These individuals will often demonstrate a tendency for the circle drawings to drift and to change in overall area similar to the differences seen in the figure 8 drawings. When somatosensory function is disrupted, muscular control may be compromised predisposing the surrounding joints to instability, and re-injury, further precipitating the chronic pain cycle. The kinesthetic changes seen may have occurred secondary to abnormal sensory processing in the presence of chronic pain, which can greatly alter the ability to perform functional upper extremity tasks. This may be especially true when the individual is performing upper quarter activities that require precise motor control. Therefore, effective treatment of individuals with chronic pain must consider both peripheral and central processing mechanisms to fully address the factors that may be contributing to the persistence of pain. Incorporating sensorimotor training into a comprehensive rehabilitation program may be necessary to ensure that proper joint biomechanics are restored, thus reducing the likelihood of re-injury and reducing the chances of further precipitation of the chronic pain cycle.

### The functional approach and its future

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The most influential specialists to treat the motor system are the orthopedic surgeons. In their terminology, 90% of painful disorders of the motor system are without pathological (structural) changes and are termed to be 'non-specific', i.e. without diagnosis and therapy. Unfortunately, this 90% constitutes the majority of patients in musculoskeletal medicine. They are labeled the same in journals dealing with manual medicine, rehabilitation, osteopathy and chiropractic. At best, the term 'mechanical lesion' is used – as though in a highly developed organism any mechanical stimulus would not be processed by the nervous system resulting in a change of function.

This is true in the first place for manipulation. No 'adjustment' is achieved but only the ability of joints or movable segments to adopt the position, which is the most favorable in certain conditions. There cannot be a constant position in a mobile structure of numerous elements.

By clinical examination the following changes in painful conditions may regularly be found:

1. Joint movement restriction
2. Muscular dysfunction, mainly trigger points (TrPs) which restrict movement
3. Muscular dysfunction on a central level, i.e. changes of muscular stereotypes or muscular patterns causing muscular imbalance
4. Changes in tone and mobility of soft tissues, in particular of fascias and visceral organs
5. Changes of all tissues in 'active scars' including visceral organs
6. Insufficiency of the muscles of the deep stabilization system of the trunk, shoulder blades, feet, and upper cervical spine
7. Changes of sensitivity, including proprioception and awareness of one's body scheme

8. Assessment of interdependence of these changes within pathological lesions.

The problem of clinical examination, especially palpation: The palpating hand unlike the eye or ear makes sense of a great number of receptors at the same time and in addition it produces a feedback relation with the patient. This is most precious, but irreproducible. Something similar is true of personal history which, too, is essential for clinical medicine. What is not reproducible is not considered scientific.

Consider the following absurdities: Every experienced manual therapist can feel the patient's painful spots. Increased tissue tension is related to pain, typically in TrPs; release of the TrPs achieves relief from pain. Yet, algology ignores a correlation between tension and pain. It also contradicts human experience as expressed in language. If we can rely on something, we call it manifest, a 'palpable truth'. Essentially, medicine will never be a purely technical science, as pain and the way we use our motor system have important psychological aspects. Frequently, laboratory and imaging techniques cannot tell what is relevant and to rely purely upon such techniques leads to an ever-increasing number of patients self-referring to alternative and complementary therapists. It is the clinician who must decide which of the findings is the most important and how to deal with the patient.

Owing to the conditions under which the motor system has to function in modern technologically advanced society, patients presenting with changes in function will constantly increase in number and severity – pollution of the motor regime – and a diagnosis of non-specific pain in the motor system will not suffice. Therefore, the functional approach will have to be accepted sooner or later.

### Three levels of motor control: assessment and treatment of the motor system

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Current clinical and experimental studies suggest that our motor behavior is genetically predetermined. Initially 'primitive reflexes' organized on spinal and brain stem level (e.g. supporting reflex, Galant reflex, suprapubic reflex, etc.) are in control, later more complex sensory-motor functional relationships, organized on higher central nervous system (CNS) levels, including the 'old' cortex, become activated. Such motor patterns occur as a result of CNS maturation.

During motor development, characteristic muscle synergies stored in the brain, as a matrix, responsible for body posture and locomotion movement comes

into play. The baby realizes how to lift the head, grasp a toy, roll over, or crawl; however, this is not purely a process of learning but rather an automatic progression resulting from CNS maturation. This function is genetically determined. Muscles are organized for postural function based upon optic orientation and emotional need. 'Primitive reflexes' and postural function suggest stages of CNS maturation. Assessment of primitive reflexes and postural function not only help us to determine the baby's developmental age but also to recognize any early signs of pathological development.

'Primitive reflexes' may re-appear again, for instance if a lesion of the 'higher levels' of the CNS, e.g. after stroke or in brain injury, occur.

During development, the motor control hierarchy starts from spinal and brain stem level, gradually approaching the highest level of control, i.e. cortical level. This highest, i.e. cortical, level of integration allows for the ability to develop new skills to imagine and plan the movement. If this ability is disturbed, dyspraxia may be diagnosed.

Gnostic (sensory, perception) and motor (executive, expressive) dyspraxia can be distinguished. Gnostic dyspraxia is related to sensory processing of

information either from one sensory system (one modality – proprioceptive, tactile, vestibular, optic, acoustic) or it may be multi-sensory.

Executive disturbance can be recognized as impaired selective movement, disturbed postural adaptation, inability to relax, disturbance of balance control, inadequate strength adaptation, poor fluency, or rhythm adjustment.

It is not easy to diagnose dyspraxia. The only standardized tests are the Movement Assessment Battery for Children (MABC) and the Bruininks–Oseretsky Test of Motor Proficiency (BOTMP).

## Sensory–motor approach to the stabilization system of the spine in patients with chronic back pain

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A comprehensive concept in the treatment of instability, particularly in the lumbar spine, is that it should bring relief, to at least to some patients with chronic pain in the lumbo-sacral region. There are many primary disorders which secondarily change the biomechanics of the lumbo-sacral area, leading to overload of other spinal segments, and there is no other conservative way of recapturing physiologic stability than by means of activation of all levels of the stabilizing muscles. If the concept is to be really comprehensive, a psychologist must take part in the treatment as nobody nowadays questions the significance of stress to the onset of chronic pain. The limbic system, like the other central regulating circuits, belongs to the indivisible locomotive system. The aims of this study start with verification of the assumption that the concept of the therapy, as pursued by Professor Janda, is beneficial in light of statistical assessment and can be recommended to be used in clinical practice. The result could be taken as an argument for payers of health insurance in the discussions on what is an economical method of therapy that ought to be covered from the means of public insurance. Some sensomotor elements could then be included into preventive programs.

**Aim of the study:** The aim of this study is the assessment of efficacy of exercise therapy in pain conditions of the locomotive system involving the lumbar spine region. This is done utilizing the *Brief Pain Inventory* questionnaire, analyzing the pain condition and its progression.

First, the effect on the course of the disease after 3 weeks of intensive hospital therapy in 250 patients, both in the input and output assessment of pain:

- The most severe pain in the last 24 hours
- The slightest pain in the last 24 hours
- Average pain in the last 24 hours

- Current intensity of pain
- How pain influences total activity
- How pain influences mood
- How pain influences walking
- How pain influences working ability
- How pain influences relations with other people
- How pain influences sleep
- How pain influences living life to the fullest.

Second: the influence of the degree of disability of the patient on the effect of therapy.

Third: the influence of age of patients on the effect of therapy.

The fourth and final: influence of gender on the effect of therapy.

**Methodology:** We examined 250 patients, 91 men between the age of 19 and 101 years and 159 women aged 28–88 years, mean age being  $59 \pm 15$  years. The patients were examined in hospital. The mean duration of the therapy was 3 weeks, in the intensive therapeutic rehabilitation ward of the Department of Rehabilitation Medicine of Královské Vinohrady University Hospital, Third Faculty of Medicine of Charles University in Prague.

The group included the following patients:

- chronic pain in the lumbo-sacral region
- lasting at least 6 months
- not responding to medical treatment up to now
- not responding to exercise therapy up to now.

Conditions recommended for inpatient rehabilitation therapy were:

- chronic radicular syndromes
- pseudoradicular syndromes
- degenerative spine disease – spondylarthrosis
- chronic low-back pain syndrome
- ischiodynia
- lumboischiodynia
- discopathy

- prolapse of intervertebral discs
- conditions after spine surgery
- failed back surgery syndrome
- osteochondrosis
- stenosis of spinal canal.

Conditions excluded from the group:

- acute radicular symptomatology
- worsening symptoms with indications for surgery
- bone cancer
- acute inflammatory spine disease – discitis
- organic disease of viscera.

Patients were excluded with objective findings indicating dominant troubles:

- decompensated advanced coxarthrosis
- scoliosis
- rheumatological disease (in our patients it was spondylitis).

**Therapy:** The therapy is based on a medical examination and a physiotherapist's kinesiological analysis at admission. The program of muscular imbalance alteration not only attempts to influence the degree of activation of individual muscles, relaxation of hypertonic, hyperactive muscles, and facilitation of hypoactive muscles, but also influences the central activation of those which are reduced at higher CNS levels. Long-term change of locomotive stereotypes can lead to abolition of some muscles, especially phasic, from the locomotor pattern and their strengthening must be connected with their physiological facilitation. Peripheral facilitation may be through the exteroceptors of the skin over the relevant muscle (for example, by brushing, using balls, stroking, etc.), or by activation of proprioceptors by facilitating muscle techniques. It involves both direct stimulation of the hypotonic muscle (e.g. repetitive stretching against weak resistance), as well as of complex motions, in which these muscles are involved. These programs are very popular and widely used.

In the effort to modify the movements to normal it is necessary to include myofascial procedures directed at the correction of limited mobility or elasticity of soft tissues. Long-lasting limitation of the range of motion in locomotor segments of the spine and limbs leads to gradual retraction of skin and subdermal tissues and ligaments in the region of hypomobile joints and it brings about another cause of reduction of the total range of motion in the segment, as well as modified afferents from mechanoreceptors of the skin.

Simultaneously with the therapy to facilitate muscle and soft tissue change, mobilizations of blocked joints was carried out. This is to ensure a full functional range of motion in all joints and thus enable motion in the most correct, i.e. physiological way, and restoration of physiological afferent input from afflicted joints.

The rehabilitation therapy finished by activation of muscles involved in functional stabilization both of individual segments and of the whole spine. As has been mentioned previously, we utilized the concept of sensomotor stimulation according to Janda, when, taking into account the fitness, somatosensory control and, last but not least, the ability of the patient to cooperate during the exercises. The therapist, within the framework of the stabilization model, gradually destabilizes the patient by different methods, and thus provokes activation of protective postural reflexes, as these are an integral part of stabilization of the axial skeleton as well. Because of our knowledge of chains of muscular activity achieved by different methods in destabilization, it is practical to choose exercises on cylindrical and spherical segments for stabilization of spinal segments.

Back school is also a part of the therapy, where we focus education on the most suitable working processes in activities of daily life with the aim of minimizing the negative impact of everyday work, including the movements or position during the working process. The most important items include practice of heavy load lifting, correct sitting, etc.

This program of therapy lasts 3 weeks. In our view a longer time would be better; we must respect, however, the rules of general health insurance and the principle of regressive payment for exceeding the recommended time of hospitalization.

Pain was assessed using the Brief Pain Inventory questionnaire. Each patient filled out the questionnaire immediately after being admitted to the clinic ward, and again when being discharged from the hospital. The patient marks individual aspects of quality of his life on the scale from 0 to 10 (10 indicates the worst possible affect and 0 means no problem).

**Results and conclusions:** 1. The results of treatment efficacy of pain conditions in the lumbar spine region, evaluated by means of the subjective questionnaire before and after the therapy, proved that 3-week intensive rehabilitation therapy in the hospital ward decreased statistically significantly the most severe pain in the last 24 hours, the slightest pain in the last 24 hours, average pain in the last 24 hours, and current intensity of pain. Our therapy improved total activity, mood, walking, working ability, relations with other people, and sleep influenced by pain as well as total quality of life ( $P < 0.05$ ).

2. On the basis of our results, we can conclude that the measure of improvement, i.e. reduction of pain, does not depend on the degree of disability; this was calculated by using linear regression analysis with determination of coefficient of significance.

3. Similarly, there was no significant difference in treatment efficacy according to age in the whole set of patients.

4. Linear regression analysis also showed that treatment efficacy is not influenced by the gender of the patient.

### Observations on supporting and stabilizing function in clinical practice

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A precondition for any movement is stability. Stabilization can only be achieved by firm *co-activation providing the basis for support*. Our observations show that the supporting function – especially the support function through the lower limbs – is deficiently used in everyday lives, both with regard to its quality (centration) and in quantity evaluations. Such deficiencies consequently cause insufficient engagement of the deep stabilizing muscles and overload other structures and areas of the movement system. This disturbed function especially affects the surface muscle groups that ensure postural *reactions*. As a result, we suffer dysfunction and pain.

These processes affect not only patients but also the clinicians themselves. In the course of day-to-day practice, examination and manual care, or when involved in the administrative part, the supporting function of the limbs is not fully introduced. These imperfections are responsible for imbalances in the stabilizing functions in the locomotor system.

During manual examination of our patients, we should fully apply the support function of our limbs to ensure correct co-activation and postural functions. We can make our work be a genuine source for optimization of our locomotor system and movement patterns. Each activity should be performed initially, with conscious engagement of the stabilizing function of diaphragm thus activating the entire deep stabilizing system of spine (DSSS). Only then, with the correct 'set up' of postural function in place, should we perform our work. After some time this process should ideally become automatic.

We suggest activation of the support function of the lower extremities (LE) especially when using gross motor function (sitting, transitional phases between sitting and standing, stance, and gait) and activation of the support function of the upper extremities (UE) when using motor dexterity (writing, stamping, etc.). Such an approach allows for more physiological correct activation of the stabilization function of the locomotor system.

Some forms of support function are used via different types of resistance in mobilizing methods (reciprocal inhibition, post-isometric relaxation). We use the support function for *self-mobilization* of the *axial musculo-skeletal* apparatus. It is done directly by

pressing the axial apparatus against a base, or indirectly involving pressure through the limbs. By means of mobilization with the support function (MSF), the patient *uses* maximum pressure against the base and actively performs a movement in the segment of the body where the movement is limited.

To influence the stabilizing function of spine and limbs (feet) balancing methods may also be used, although it is not always a targeted performance for single dysfunction. It was Professor Lewit and his daughter Helena, who already in the 1970s were pioneers of hippotherapy (HT) whereby an unstable, live (horse) platform was introduced, influencing the locomotion system in a complex fashion, but especially affecting its stabilizing function. We have also recognized the statistically significant effect of this. Clinically, it was observed on 30 patients<sup>1</sup> with cerebral palsy, and also stabilographically (TA [total area measurement] with closed eyes on a foam rubber base) on 10 juveniles with poor posture.

In HT we also used lateral sways in attempts to stabilize ontogenetically younger positions. Via the movement from the horse-back we apply and facilitate the support function of the limbs. Based on postural development, in different positions we can see the lateral shifting of the gravity centre of the human body as one of the first postural and locomotor activities in a child.

Walking, as an essential stereotype of the movement for the human body, is a very important action. The interrelations of incorrect support function of the foot, through muscle chains in the lower limb, the pelvic floor, and diaphragm unfavourably influence the entire stabilizing system of the spine. We want personally to draw your attention to hard (noisy) and quick walking. We diagnosed 'the symptom of hard walking' in 79% of 2580 patients suffering from pain in the locomotor system. Furthermore, we found, when testing 52 pupils of a basic school age, the occurrence of this hard walking in 67%.<sup>2</sup>

We tested effects of the balance shoe for the stabilizing function of the foot and leg. We examined 14 patients after 5 weeks of wearing the balance shoes and observed a statistically significant decrease in the occurrence of hard walking, minimization of foot

surface–contact area. We examined 14 patients before and after wearing the balance shoes. These shoes (MBT) are like a balance board. We found that after 5 weeks their gait was not so hard, the surface–contact area of their feet was less and the centre of gravity of the body was closer to the heels. Our stabilograph reported lower amplitude and increased speed of sway in the antero-dorsal and lateral directions. Our continuing results suggest a certain positive influence for foot and leg function, which can indirectly affect support function and as such the whole stabilizing system of the lower limbs and spine.

Currently, we are convinced that the optimal method for affecting the stabilizing function of spine is the utilization of dynamic neuromuscular stabilization (DNS) according to Kolář. During exercises, especially with patients who start activation of the deep stabilizing system of the spine (DSSS), we recommend the performance of active movements at the end point of breathing in, or breathing out, not before. We assume that the most intense activation of DSSS is at those moments. Since DNS is recommendable for a wide spectrum of patients, due to technical reasons, we teach our patients in groups of six. In 47 patients with a developing radicular syndrome, the

pain decreased significantly after five sessions of DNS-based exercises in a group setting. For pain evaluation the visual analogue scale was used in combination with other questionnaires to evaluate the patient's satisfaction with the DNS method, instruction provided by the clinician, clinician's approach, exercising in groups up to 6, etc.<sup>3</sup>

We believe that the physiological engagement of the stabilizing function of spine, in combination with the correct use of the support function, especially the limbs, is of primary importance in the prevention and treatment of a wide spectrum of dysfunctions of the locomotor system.

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## Viscero-somatic relationships and its influence on spinal stabilization

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Functional and biomechanical reciprocal relationships exist between internal organs and the locomotor system. The internal organ system and the locomotor system are functionally connected, constantly complementing and influencing each other in both a positive and negative sense – i.e. dysfunction in one system may result in dysfunction of the other and vice versa.

This functional relationship between the internal organ system and movement system is usually called the viscero-spinal relationship. Although this term has been widely used, it is misleading since it suggests that internal pathology results in spinal dysfunction only. However, reflex changes resulting from visceral dysfunction (or structural pathology) have consequences in the whole movement system including muscles and soft tissues (skin, subcutaneous tissues, and fascia).

Thus, we find the term 'viscero-somatic relationships' to be more appropriate, indicating that irritation from internal organs has consequences in the whole motor system. Visceral irritation causes a whole complex of reflex changes called visceral patterns, being very characteristic for each organ. In clinical

practice, the most important aspect of these visceral patterns is possibly a change in muscle function.

Special attention should be paid to the relationship between visceral function and the muscle complex called the deep stabilizing system of the spine (DSSS). The DSSS is generally considered to be a functional unit; however, the definition of which muscles precisely form the DSSS is not clear. Since not only short and deep muscles are responsible for trunk stabilization, but also bigger and rather superficial muscles are involved in spinal stabilization, we prefer the words integrated stabilizing system of the spine (ISSS).

Muscles constituting the ISSS are: deep intrasegmental spinal muscles (transversospinal muscles and interspinal, intertransversarius muscles), pelvic floor muscles, transversus abdominis, diaphragm, deep neck flexors (longus colli and capitis, rectus capitis lat. and ant). Some authors also consider the oblique abdominal and intercostal muscles to be a part of the ISSS as well as certain sections of the iliopsoas muscles.

We will focus on viscero-somatic patterns resulting from gastrointestinal tract (GIT) dysfunction. GIT

dysfunction forms a group of diseases without any clear structural pathology, presenting with a strong influence on the motor system and an increasing incidence of problems (such as an increasing incidence of back pain).

**Dysphagia:** Symptoms of dysphagia may develop as a result of impaired swallowing which can be disturbed at various levels – orofacial, pharyngeal, and oesophageal. It frequently presents with compromised passage of the food bolus or with sensory problems like painful swallowing or a *globus* sensation. If swallowing is disturbed in the area of the pharynx or upper oesophageal sphincter, a compensatory stereotype of swallowing often develops, presenting by means of forward-drawn head posture combined with neck rotation. Usually, increased tension in the suprahyoid muscles, the scalenes, and short neck extensors can be identified. If the problem becomes chronic, the muscles' hypertonus and abnormal head posture becomes fixed. Therefore, patients with dysphagia frequently complain of headache and neck pain and an additional diagnosis of dysfunction in mid and lower cervical segments and cervico-thoracic (C/T) junction is made.

In a 'lower type of dysphagia' such as achalasia or diffuse oesophageal spastic disturbance, mobility and function of the upper and mid-dorsal segments as far down as T6/7 is limited. Here, intensive visceral irritation also causes dysfunction of the ribs related to the changed position in the upper and mid-dorsal segments. An antalgic posture of the thoracic spine and the shoulder blades develops. The thoracic spine becomes kyphotic and functionally shortens the oesophagus (which is a prerequisite of functional swallowing); however, spinal pain, C/T junction instability, abnormal position of the shoulder blades and even spinal scoliosis may occur. In addition to dysphagia these patients often complain of thoracic spine pain.

Dyspepsia, pyrosis (heartburn), and regurgitation are other types of GIT dysfunction. These diagnoses are often related to diaphragmatic dysfunction. The diaphragm fulfills a function as an external oesophageal sphincter as well as many other functions. Being partly innervated by the vagus nerve, the diaphragm is very sensitive to any changes in stomach and intestinal tonus. GI reflux irritates the lower third of the oesophagus, influencing the muscle tone at the crural part of the diaphragm as well as impairing stability of the thoraco-lumbar (T/L) junction. Changed gastric and/or intestinal tone, especially the transverse colon, irritates the diaphragm in its sternal part, preventing its neutral position and a physiological breathing stereotype. Impaired breathing is related to increased tension in the pectoral and superficial neck muscles, and the postural function of the diaphragm becomes insufficient and the low-back stability is consequently compromised.

Gas-bloat syndrome and flatulence are often caused by chemical changes and abnormal intestinal microflora. Increased flatulence changes abdominal wall tension as well as the position of the diaphragm, which becomes more cranial; and caudal movement of the diaphragm becomes more limited. Flatulence inhibits one of the functions of the transversus abdominis muscle while tonus of the rectus abdominis increases and the muscle develops numerous trigger points (TrPs). Flatulence may thus result in very similar reflex changes (patterns), as those we can see in typical 'postural disturbances' with compromised muscle tone distribution.

In irritable bowel syndrome (i.e. spastic colon) increased tone is frequently diagnosed in the iliopsoas, quadratus lumborum, and levator ani muscles. Abnormal sensory perception results in an antalgic posture with semiflexion, thus impairing spinal stability especially at the level of T/L and L/S junctions; short inter-segmental muscles become insufficient in their postural function and hypotonus of the abdominal muscles and diaphragm occurs. By contrast, the pelvic floor muscles become hypertonic and sacroiliac joint dysfunction frequently become part of the clinical picture.

GIT dysfunction may lead to many other clinical pictures in the locomotor system, which is outside the scope of this presentation. In functional diagnosis of the motor system it is critical to consider the viscerosomatic relationships as a possible aetiopathogenetic factor.

**Conclusions:** 'mere' GIT dysfunction may have a great influence on a patient's health; its consequences are rather complex, and also reflected in the function of the locomotor system. It is essential to bear in mind that in patients with internal organ pathology, irritation and reflex changes (muscle TrPs, joint blockages, soft tissue dysfunction, altered motor stereotypes) in the locomotor system occur as a rule. Patients with diagnoses involving the internal organ system are thus important potential clients of rehabilitation specialists.

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### Stabilizing work on lower limb

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The stabilizing activity of the lower limb in the locomotor system is a complex function, always involving more than the immediate region.

After the infant achieves the upright posture completely, the lower limbs are the only contact with the ground in bipedal locomotion, and at the same time the only foundation for the trunk, with the remainder of the body freely organized in space.

Characteristics for optimal stabilizing function are: a timely reaction from the periphery (toes) of the foot, minimal power, the ability of an active differentiated inhibition, and variability. We consider these stabilizing activities as a movement, even if all that is required is standing.

The determining conditions for an optimal stabilization of the trunk in space at the entering (perceptual) level are: the perception of inner space, its interconnections, and its outreaching to the outside and the ability of recognize individual motoric possibilities in the body and their variability.

The region of hips and lower back: The hip represents a very deep structure; and it is related to the pelvis, and to the structures of the trunk like the pelvic floor and diaphragm. The position of the hip largely determines the knee's possibilities for movement. The hips are the upper end of the lower limb and the base of the trunk at the same time.

The ideal position of the pelvis over the hips is a kind of lowering of the lumbar spine down 'through

the pelvis', not retroflexion, nor too much lordosis. The hip suffers the most under pressure, losing the upper joint space, but also because too much looseness of tissues (joints, ligaments, capsule), as a result changes of motor behavior and the changing standard of our diet and genetic equipment.

Sitting and walking in artificial surroundings does not give enough stimuli. The possibilities for movement of the hips are reduced, and without proper stimulation fade away. A child needs adequate stimuli to evolve a full consciousness of the hip region, both motor, and the sensory stimulation, e.g. full and free flexion of the hip without barriers ('pampers', clothes) in different postural situations. Otherwise full flexion of the hips may be lost, and transfer to other structures (lumbar spine): the result may well be a too flexible a lumbar kyphosis, that will be the first choice in the future sitting positions, leading to overstrain.

An adequate sensory stimulation for the region of the lower trunk is, for example, some discomfort i.e. dry-wet: the child, if it wets itself, feels slightly uncomfortable, and gives a signal, then has to wait for the solution. When it is being dried, it feels the touch of the hand: the closeness makes the image of the intimate region of the inner area of the thigh more accurate through the experience. It examines by touch, turns away from the discomfort of the outer environment, and tries to find a solution. More typical today is a less demanding

situation, the natural need of adaptation disappears, there is no need to signal discomfort, the closeness is only relative, and the ability to wait fades away. Everything is fast, easy, and possibly destabilizing in the long run. The ability to distinguish between the movement of the hip and lumbar spine did not develop.

The knee region: The knee is a region that functionally relies on impacts from the periphery, especially the foot. The optimal position of the knee is always the combination of effort, both above and below the joint itself. Functionally it is a large region, easily observable and vulnerable because of its position in the center of the lower limb. It is more a recipient than a source of problems.

By flexing and extending the lower limb, it allows steps as well as movement toward the ground and away from the ground. It is necessary to develop the perception of the knee as a link, connecting the center and periphery, along with the optimal possibilities of its movement in the axis and beyond the optimal axis of the lower limb, by using rotations, or moderate flexion; the work is soft and accurate. The knee suffers the most when working beyond the limits of possibilities (in front of the toes, or when too medial or lateral), as well as under influence of shock transmitted by a non-functional foot, and the powerful work of the hip (quadriceps femoris as the source of overworking into extension).

The foot region: A very movable region, capable of both rapid and soft stabilizing movements; it is the base, connecting to the ground, and a sensory information processor about the terrain. The foot is also active in thermoregulation.

The calcaneus is included in the muscular and ligament pulls of the plantar aponeurosis and triceps surae; it forms the connection between the less mobile proximal parts, which is followed by the very mobile peripheral part. For good stabilization we need to consider the sole from the heel to the active support of the toes, both arches taking part. A highly arched longitudinal arch is not a guarantee for optimal stabilization; a dysfunction of the transverse arch is a frequent source of periosteal pain. Perception of the foot is rarely optimal: we lose

adequate proprio- and extero-ceptive information already in childhood. Nobody would consider giving a newborn child gloves to keep on permanently – yet the development of the foot is equally as important as the development of the hand. The foot of a child needs variable input. Giving shoes before the upright posture is fully achieved means the foot cannot feel, and therefore cannot learn. Thus, feet do not develop optimally, and this becomes the norm. In maturity we do not have anything to lean on, as the stabilizing function did not come to full effect. But the demands in the vertical position are huge. What follows is overuse by strength and speed, non-optimal stabilization through big muscles and their big powers become a must, which we short-sightedly complement by a passive support (inner sole, sprung shoes, etc.).

The rehabilitation of the stability of the lower limb is cyclic and repetitive work. In therapy we adjust the perception for the patient by establishing the functionally optimal impulse, gradually increasing demands, depending on the patient's reaction. The ability to accept and to distinguish information input develop, oversensitivity decreases, low sensitivity increases. Optimum muscular tension is the precondition for stabilizing function; the closer to the optimum, the better further advancement is. The most advantageous tension is needed in all elastic components (skin, hypodermis, fascia, muscle). In the case of joint blockages soft mobilizing techniques are followed by techniques of stabilizing.

For stabilization we use a soft but tangible intermittent approximation into the joint, at first in neutral, later also in demanding situations; change the starting position and direction of work (from the periphery towards the center and the other way round). Soft tapping on the joint as an information input is often included. At first we stabilize one functional segment, later we link them.

We close the cycle of movement (passive, half-passive and active) with relaxation. Work in different postural situations, always from the easier, less demanding; we figure out working and living applications, in increasing dynamics, in larger spaces, and in natural surroundings.