Donau-Universität Krems
Universität für Weiterbildung

# "Sensory motor training for active completion of the osteopathic treatment."

„Sensory motor training for active completion of the osteopathic treatment"
Marcel Maetzler, MSc Thesis, Donau-Universitaet Krems, 2006.

For Sofie and Emma.

„Und ich habe mir bewahrt, alles für möglich zu halten. Das ist doch spannender, als nichts für möglich zu halten, oder?“

„And I have kept the options open that everything is possible. This is more exciting than thinking nothing is possible at all, isn’t it?”

Felix Mitterer in „Sibirien“

## PREFACE

Osteopathy is a fascinating way of looking at people and the world. It opens up new dimensions in the treatment of patients, for the osteopath as well as for the patient himself. It creates space for health and personal development.

During the osteopathic treatment the osteopath mostly takes action, while the patient is being treated to activate or liberate self-healing mechanisms.

The fascination about the possibilities and abilities an osteopath is able to develop may bear the risk of ignoring the fact that patient activity and exercising is an important factor in the orientation of patient self-responsibility and holistic osteopathic treatment.

Sensory motor function is a highly adaptive quality (Weineck 1994). Lack of activity has a negative influence on the sensory motor function of the body. Many practitioners from different medical professions point out the ever-increasing sensory motor disability of patients, even in the very young population.

An unstable shoe construction (USC) is a very simple means to introduce sensory motor quality into activities of daily life (ADL). This way, sensory motor quality can be trained without having to invest additional time, which makes is much easier for many people to take responsibility for their own well-being.

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**DECLARATION**

I herewith declare that I am the author of this thesis and the following work is my own and all references are listed. This thesis has not been previously accepted for a higher degree. Citations are marked and referenced and have been consulted. Tests describes have been applied according the specific references.

Andelsbuch 10/10/2006

Marcel Maetzler

## ABSTRACT


### „SENSORY MOTOR TRAINING FOR ACTIVE COMPLETION OF THE OSTEOPATHIC TREATMENT"

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***Objectives.*** To investigate changes in the Standing Flexion Test (SFT) through sensory motor training with an unstable shoe construction.

***Design.*** A standard test has been used to assess and re-assess iliosacral function.

***Background.*** Routine re-assessment for quality standards of the osteopathic treatment has suggested that pelvic function and function of the iliosacral suspension system was improved in a group of patients with low back pain (LBP) treated with osteopathy and a combined sensory motor training compared to a control group treated with osteopathy only by over 30%.

***Methods.*** A single blinded randomised controlled trial (RCT) has been designed for a group of normal subjects (normal control group n=21, normal intervention group n=20) and an other group of diabetic subjects (diabetic control group n = 22, diabetic intervention group n=24) and the SFT was tested before and after a 6 weeks period.

***Results.*** After a 6 weeks period of sensory motor training with an unstable shoe construction, both intervention groups improved in the SFT test by 46% and 50% respectively, while the control groups only improved insignificantly.

***Conclusion.*** Sensory motor function is important in the treatment of pelvic integrity and the iliosacral suspension system. Combination of osteopathic treatment and sensory motor training with an unstable shoe construction seems to improve the long-term results for the Standing Flexion Test (SFT) for over 30%.

# CHAPTER I - Introduction

## 1.1 General osteopathic procedures

In the osteopathic practice, patient assessment and re-assessment is a standard procedure to evaluate treatment outcome and objectify treatment goals. The osteopath, therefore, uses a set of tests to evaluate intervention effects (Peace 2004). One of these routine tests commonly cited in literature, and one of the most frequently applied ones (Peace 2004), is the Standing Flexion Test (SFT) as suggested by Fritsch (1993), Greenman (1996), Lewit (1992), Gerz (1996), Stone (1996), Hall (1981), Winkel (1992), Murtagh (1997), Lomba (1997), Buckup (2000), Kolster (1995), Tilscher (1983), Eder (1988), Peace (2004), Mitchell (1999), Di Giovanna (1991), Kuchera (1994), Heinking (1997), Bourdillon (1992), Egan (1996), and many others.

The SFT is a very global test for identification of general musculoskeletal (Jung 2004) or visceral dysfunction or compensation (Stone 1996, Greenman 1996, Peace 2004) and the quality of the pelvic suspension system (Klein 2004, Sturesson 2000). It is used in daily osteopathic practice and is highly valuable for patient assessment and re-assessment. Although, in literature it is debated as a diagnostic tool for evaluating joint motion in the sacroiliac joint (van der Wurff 2000) due to it's poor inter-tester reliability (Vincent-Smith 1999, Potter 1985), while intra-tester reliability is moderate (Vincent-Smith 1999) and is most probably dependent on the experience of the tester (Peace 2004).

Egan (1996) concludes that factors other than sacroiliac joint dysfunction are likely to be the cause of a SFT. Almost one third of the subjects in his study were tested false positive while the subjects were asymptomatic, but presented with pelvic skeletal asymmetry. Egan (1996) concludes that it is much more likely that structural (e.g. ligamentous, muscular, fascial) and neuromuscular functional adaptation to the skeletal asymmetry over the years produced the observed asymmetry of movement.

Gutenbrunner (2000) came to the conclusion that different sacroiliac tests assess different dysfunctions and that these dysfunctions do not really correlate with the intensity of low back pain (LBP).

Senn (1997) compared 12 manual sacroiliac tests with the results of sacroiliac articular infiltration and found that positive sacroiliac tests were not able to identify the results for sacroiliac articular infiltration. He concludes that sacroiliac dysfunctions may be of peri-articular origin and that manual sacroiliac test results need to be interpreted with care.

Moderate to poor reliability of the SFT could be due to the fact, that the self-locking mechanism goes into effect when the pelvis is loaded during standing (Sturesson 2000) and the SFT test actually does not test joint mobility as such but rather the quality of the pelvic suspension system (self-locking mechanism (Sturesson 2000), self-bracing mechanism (Snijders 1993))! This may lead to false-negative tester reliability results in some of the above-mentioned references (e.g. research programs set up to test joint mobility, while the SFT is actually a test to evaluate the quality of the self-locking mechanism during standing!)

Diagnosis and treatment of the sacroiliac joint is difficult and all known tests have questionable validity. Presently there is no gold standard testing procedure to confirm the presence of sacroiliac joint dysfunction (Peace 2004). Because of the diverse soft tissue attachments on to the posterior sacrum and the variability of bony anatomy of the sacrum and ilia, comparing relative positions of bony landmarks may give a false impression of the motion relations between these bones (Stone 1999). Palpation of bony landmarks has recognised limitations. Reliability may be reduced by anatomical variation of bony prominences from left to right, lower limb inequality, obesity of patient, examiner skill and experience or the presence of pain (Peace 2004).

All this does not necessarily negate the whole concept of sacroiliac testing and treatment but indicates the need for caution in being dogmatic with findings (Stone 1999). The pelvis is an enormous complex area, and successful treatment can give enormous benefit throughout the body. However, if some aspect of the pelvic torsion/movement problem is not recognized/addressed, the patient may continue to suffer a variety of symptoms for years, despite continuing treatment (Stone 1999).

Despite the poor reliability of clinical tests of the sacroiliac joint in general, as reported in 11 studies found by van der Wurff (2000), the SFT has been described in osteopathic and manual medicine literature as a valuable test for the assessment of general loco motor function on numerous occasions, underlining the ever present gap between the daily clinical work of an osteopath and research based evidence of reliability of the techniques applied.

### 1.2 Assessment of Quality Standards

Assessment of quality standards at the osteopathic practice is part of the osteopathic professional development and postulated by the osteopathic codex (OEGO 2006).

Routine re-evaluation for quality standards of a random group of patients treated at the REHA-MED Rüscher practice in Andelsbuch, Austria, for Low Back Pain (LBP) has pointed out that a high percentage of these patients with a negative SFT at discharge showed a positive SFT six weeks later.

Comparison of this outcome to the outcome of another random group of patients treated for LBP, who performed a sensory motor training by means of an unstable shoe construction (USC) on a daily basis during the osteopathic intervention period and the following six weeks period showed that the percentage of positive SFT was significantly lower for this group!

These results suggested that sensory motor training had an effect on the continuity of pelvic integrity and may be important to ensure long-term benefit of the osteopathic treatment for pelvic integrity in a high percentage of the patients seen at the practice.

### 1.4 The research project

To test this thesis, a randomised controlled trial (RCT) was set up for a group of normal subjects (n=43), which was divided into an intervention group and a control group. SFT was tested and then re-tested 6 weeks later. During the 6 weeks period the intervention group used an USC for sensory motor training for at least 4 hours per day. Percentage of change in SFT was compared for the two groups.

Since the intervention procedure was sensory motor training, a group of subjects with known impaired sensory motor function was tested in addition to strengthen the outcome of the RCT described above. A relatively homogenous group of subjects with sensory motor function deficits are patients with mild to moderate polyneuropathy of the legs, found frequently in patients suffering from diabetes mellitus. A group of 53 polyneuropathic diabetic subjects was randomly divided into an intervention group and a control group as described above. After 6 weeks, the percentage of change in SFT was compared for the two groups.

The objective of this project was to reduce intervention variables to one variable only (standard sensory motor intervention without osteopathic intervention) and look at the change in SFT introduced through sensory motor training with a USC in different subject groups over the period of 6 weeks.

The resulting research question is: Is it possible to change a positive SFT in normal subjects through sensory motor training with a USC, and is this possible even for subjects with a sensory motor deficit?

# CHAPTER II - Background

## 2.1 Structural Diagnosis of the sacroiliac joint

For many years the idea of motion at the sacroiliac joints was denied vigorously by the orthodox profession (Stone 1999). However, mechanical dysfunction within the pelvic girdle and its contribution to LBP has long been recognised and treated by manual therapists (Fowler 1994). Sacroiliac motion possibilities, although small, are incredibly important for efficient biomechanical function, with many factors influencing their function (Walker 1992). 90% of the Australian osteopaths are of the opinion, that the sacroiliac joint can be mechanically dysfunctional but not necessarily painful (Peace 2004). In the past, asymmetry of pelvic landmarks has been used in isolation to diagnose dysfunction within the pelvic girdle and to direct the subsequent treatment. This has lead to the mobilisation of many normal sacroiliac joints and the false incrimination of the unit as the source of pain (Fowler 1994).

Structural diagnosis and management of the pelvic girdle are important to the postural structural model (Greenman 1996). The pelvis links the highly mobile extremities with the trunk in the highly complex mechanism of ambulation. Management of the pelvic girdle restores functional symmetry to the three bones and joints of the pelvic girdle during the walking cycle (Greenman 1996), has a significant effect on the vertebral column, is important in the respiratory circulatory model, and has an influence on the craniosacral mechanism (Greenman 1996).

Pelvic dysfunction rarely occurs in isolation (Fowler 1994). During normal daily activities dysfunction of the sacroiliac joint is usually compensated and unrecognised by the patient (Badke 1993). These dysfunctions do not have to be painful at all, but they will modify the motor-dynamic stereotype in any case (Badke 1993). Studies have implicated the sacroiliac joint as the main problem in as many as 50-70% of adults with LBP (Haldeman 1992).

## 2.2 Structural analysis of the sacroiliac joint

The essence of the sacroiliac joint is that it is a stress-relieving joint (Bogduk 1997). There is a potential conflict between torsional forces acting on the sacrum form above and those acting from below. In osteopathy, lesions caused by torsions acting from above are termed “sacroiliac” lesion, while lesions caused by torsions acting from below are termed “iliosacral” lesions (Stone 1999).

This potential conflict can be appreciated by imagining what would happen if the sacroiliac joint did not exist. A rigid ring would be exposed daily to large twisting forces, particularly during walking (Bogduk1997). Insufficiency fractures of the sacrum occur in elderly individuals, particularly females, in whom the sacroiliac joint is relatively ankylosed and in whom the sacrum has been weakened by osteoporosis (Bogduk 1997).

Twisting forces are absorbed into ligaments and thereby reduce the tendency of the pelvic ring to fracture. At the same time, the sacroiliac joint must be strong and stable in order to transmit the forces from the vertebral column to the lower limbs (Bogduk 1997).

The structure of the sacroiliac joint can, therefore be anticipated. For its longitudinal functions, it will exhibit osseous features that lock it into the pelvic ring. For its anti-torsion functions it will exhibit, in a para sagittal plane, a planar surface that can allow gliding movements, but it will be strongly reinforced by ligaments that both retain the locking mechanism and absorb twisting forces (Bogduk 1997). The sacroiliac ligaments, which reinforce the sacroiliac joint capsule, are the strongest ligaments in the body (White 1990).

Figure 1: Posterior ligaments of the sacroiliac joint.

Figure 2: Anterior ligaments of the sacroiliac joint.

Palpation of the sacroiliac joint is not always easy (Stone 1999). To get to the sacroiliac ligaments, skin, subcutaneous soft tissue, and the fascia of the major gluteus muscle, which is connected to the thoraco lumbar fascia and fascia of the erector trunci muscles, have to be taken away (Winkel 1992).

After resection of this superficial soft tissue, proximally of the sacroiliac joint the structures of M. erector spinae become visible, while distally the M. gluteus maximus appears. In the area of the spinous processi it is impossible to separate the superficial soft tissue from the underlying tendons of M. iliocostalis and the deeper M. multifidus. (Winkel 1992).

Figure 3: Ligaments of the lumbar spine.

Fascial structure in this area suggests that M. gluteus maximus and M.erector spinae mutually influence the forces acting between Os ilium and Os sacrum (Winkel 1992).

Underneath the M. gluteus maximus the sacrotuberal and sacrospinal ligaments appear. The dorsal fascia of the M piriformis and sometimes fibres of the M biceps femoris connect to the sacrotuberal ligament (Vleeming 1989, Winkel 1992). Thus, these muscles seem to be able to actively support the self-bracing mechanism (Klein 2004).

Figure 4: Sacrospinal and sacrotuberal ligaments.

The sacroiliac joint capsule is reinforced by a group of anterior and posterior ligaments (White 1990). The anterior sacroiliac ligament connects the sacrum and the ileum horizontally in the area of the joint and inserts directly into their periosteum (Klein 2004). The posterior sacroiliac ligaments are anatomically defined into 3 layers: a superficial layer inserting at the intermediate sacral ridge, a profound layer inserting at the lateral sacral ridge (lateral of the sacral holes), and a deep layer: the sacroiliac interosseus ligament (Klein 2004). This ligamentous structure connects the iliac tuberosity with the sacral tuberosity. Different authors have defined the iliosacral joint axis within this structure (Klein 2004).

Wyke (1982) has reported that the sacroiliac joint capsule contains a dense plexus of unmyelinated nerve fibres indicative of a nociceptive receptor system analogous to other synovial joints. According to Duckworth (1970), segmental derivation of this nerve supply can range from as high as L2 to as low as S4.

Figure 5: Superficial layer of the posterior sacroiliac ligaments.

The joint surfaces within the sacroiliac joint capsule are not plane, but show advances and profundities. The side of the ileum is rather convex, while the sacral part is rather concave. The joint surfaces are L-shaped, with a long side which is orientated rather horizontally and posteriorly (Stone 1999, Klein 2004). The short side is orientated approximately vertical compared to an outer anatomical reference system (Klein 2004). These two parts define a mean angle of 110 +/- 11° (Geudvert 1991). The sacroiliac joint extends from the S1 to S3 segment (Klein 2004).

The two joint surfaces are orientated obliquely in the anatomical reference system (Klein 2004). This orientation is defined by and angle of 12-20° in the sagittal plane and 75-85° in the transversal plane (Hefzy 2003). This rather vertical orientation requires quite a strong ligamentous and muscular stabilisation system (Klein 2004).

Figure 6: Sagittal articular orientation.

Figure 7: Vertical articular orientation.

## 2.3 Anatomy of the pubic joint

The pubic joint is an oval amphiarthrosis. The two hyaline joint surfaces are not exactly parallel but build an anteriorly open angle. This gap is filled with an interpubic disc (Klein 2004). The interpubic disc is also defined as interosseus ligament. On the posterior side of the pubic joint there is fibre soft tissue.

Figure 8: The pubic joint.

On the top of the joint there is a strong ligament called the superior pubic ligament, while at the inferior side of the joint there is another very strong ligament: the arcuatum pubis ligament (Klein 2004): At the front the ligamentous structures are reinforced by fibres from five different muscles: M. rectus abdominis, M. pyramidalis, M. obliquus abdominis externus – the medial curx, M. adductor longus, and M. gracilis (Klein 2004).

Figure 9: The superior pubic ligament.

Figure 10: The arcuatum pubis ligament.

## 2.4 Sacroiliac and pubic mobility

The interlocking surfaces of the adult sacroiliac joint result in a tram-rail-like arrangement, with the motion occurring along a roughly circular pathway. This would place the axial centre of rotation behind the joint surface in the vicinity of an extra capsular iliac tubercle (Haldeman 1992). In fact, each articulation can move independently of the other, as necessary, especially during walking (Dontigny 1995). However, the two articulations always move as a closed kinematic chain with a total range of motion (ROM) of 2-4° (Klein 2004). Resection of the iliolumbar ligament increases sacroiliac joint mobility in the sagittal plane (Pool-Goudzwaard 2003).

Figure 11: The iliolumbar ligaments.

Nutation is a nodding movement of the sacrum between the innominates with the sacral base moving anteriorly and inferiorly and the sacral apex moving posteriorly and superiorly. Counternutation occurs when the sacral base moves posteriorly and superiorly and the sacral apex moves anteriorly and inferiorly. This is the sacroiliac movement that occurs in two-legged stance with trunk forward-bending and backward-bending (Greenman 1996).

During couternutation there is a superior translatory movement. Bilateral symmetry of anterior-posterior nutation depends on the symmetry of the two sacroiliac joints. With asymmetry of a patient's two sacroiliac joints being so common, asymmetry of this anterior-posterior nutation is also quite common (Greenman 1996).

The nutational movement in normal walking is anterior on one side, return to neutral, and anterior to the opposite side, and return to neutral. Counternutational movement does not appear past neutral in the normal walking cycle (Greenman 1996).

The sacroiliac mechanism can also be viewed from the perspective of each innominate articulating with the sacrum. The motion can be described as one innominate moving on one side of the sacrum (iliosacral movement). Each innominate in the walking cycle rotates anteriorly and posteriorly around the anterior axis at the symphysis pubis and anteriorly and posteriorly with each side of the sacrum in a posterior axis. Different authors report that vertical movement of the pubis is normal from 2 to 5 mm (White 1990).

In anterior innominate rotation, the innominate rotates forward in relation to the sacrum with the anterior superior ilia spine being carried anterior and inferior, the posterior superior iliac spine being carried anterior and superior, and the ischial tuberosity being carried posterior and superior (Greenman 1996).

Movements in the sacroiliac joints of younger subjects are measurable and palpable in vivo (Winkel 1992). Colachis (1963) found, that the movement of the PSIS will not be more than 5mm during forward bending.

## 2.5 The sacroiliac suspension system in sagittal plane

The sacroiliac joint is considered a self-locking mechanism, where the complexity of ligamentous and muscular relations tries to overcome the dilemma of stability versus mobility (Dorman 1995). The vertical loads are resisted by irregular surface of the joint and the wedge-shaped configuration of the sacrum. The separation of the pillars (the femora) is prevented mainly through the tension created by the tensile resistance of the large sacroiliac ligaments posteriorly and the interosseous ligament. The effectiveness of their coapting mechanism is due to the fact that it becomes increasingly stable with increasing loads (White 1990). With increasing load during standing and walking, iliosacral ROM decreases. This self-locking or self-bracing mechanism may be even improved through muscular activity (Vleeming 1995b, Snijders 1993a,b) in the sense of an iliosacral clutch, which is engaged through muscular activity (e.g. M. piriformis) at homolateral heel strike.

It seems that the joint achieves a strong shock-absorbing function through the structure of its ligamentous arrangements (Wilder 1980, Klein 2004) and that the pelvis is capable of storing a degree of elastic energy (which helps in locomotion and stability (Dorman 1995). When weight acts from above, the posterior/inferior ligamentous fibres can absorb and limit sacral excursion into nutation, and provide elastic recoil potential to help return the sacrum to a neutral position (Stone 1999). Thus, a unilaterally positive SFT may indicate a locked iliosacral joint failing to disengage.

The weight of the body mass above the pelvis accounts for 65% of the total body weight. It is mainly transferred through the sacrum to the two sacroiliac joints (Winkel 1992). The sacroiliac joints, therefore, must resist downward shear loads in the range of 300 to 1750 N in daily activities (Miller 1985) and may get jammed in a self-locking position (nutation).

The sacrotuberous and sacrospinal ligaments transfer forces acting through the thoracolumbar fascia and sacrum to the inferior pelvic outlet, where they join a sort of annular arrangement of fibres that sweeps forwards from the tuberosities, along the inferior pubic ramie to the inferior part of the symphysis pubis (Stone 1999).

Muscular attachment to the pelvic girdle is extensive, but muscles that directly influence sacroiliac motion are difficult to identify. Movement of the sacroiliac mechanism appears to be mainly passive in response to muscle action in the surrounding areas (Greenman 1996). Even small imbalances of the myofascial system may have an influence on the balance within the pelvis (Klein 2004). Imbalance of the abdominal muscles, the hip muscles, or the pelvic diaphragm effect pelvic girdle function (Greenman 1996). Iliosacral dysfunctions of the rotational type are very common and appear to be the result of muscle imbalance during the walking cycle (Greenman 1996). The actions and biomechanics within the lower limb have a strong influence on pelvic mechanics and lumbosacral function (Dananberg 1995).

During such actions as gait there is a requirement for the whole pelvis to move on the femur. Thus activity of the lower limb and hip girdle muscles can play a significant role in pelvic motion (Stone 1999). The hip is the joint that determines pelvic and body symmetry (Rolf 1989). Proximal muscles are used in such a way that they help dissipate forces acting throughout the limb during shock absorbency, whereas the more distal muscles are more concerned with the fine orientation of the individual joints of the limb during the activity (Stone 1999).

Treatment of the pelvic girdle should always be accompanied by the diagnosis and treatment of muscle imbalance above and below the pelvis to prevent recurrence of dysfunction and to enhance the therapeutic outcome (Greenman 1996).

Many practitioners feel that, in order for the spine to be balanced, one must start at the foot and work upwards (Stone 1999). The role of the foot in neural control mechanisms of whole-body movement is important in that the general function of proprioceptive reflexes involved in the stabilisation of posture depends, in part, upon the presence of contact forces opposing gravity (Stone 1999). Pelvic function is in close relationship with foot and leg function. Thus, the human organism is a holistic functional system, which begins at the foot and ends at the top (Klein 2004).

Other activities are thought to influence sacral and iliac motion, for example, sitting in a very flexed position, having the low back very extended, kicking a ball harshly or landing heavily on one foot.  All of these things could lead to the ligamentous suspensory mechanism that holds the pelvis being injured or stressed/strained in some way, leading to a slight giving in the structural integrity of the pelvis (Vleeming 1995) and allowing lesion patterns to appear.

Clinical treatment of the sacroiliac joints should be aimed at improving the stability of the surrounding soft tissues and at reducing mechanical stresses and strains from poor posture (Harrison 1997) and gait. However, a functional self-bracing mechanism only works if there is normal movement in the two sacroiliac joints (Klein 2004).

### 2.6 The sacroiliac suspension system in frontal and transversal plane

For the frontal plane the suspension system can be thought of as the classic biomechanical model of hip balance, with the sacroiliac joint included (Klein 2004). The existence of the interosseous sacroiliac joint as well as their strength and their cranial situation in respect to the sacroiliac joint support this view (Klein 2004). Additionally, Miller (1987) has been able to show small in-vitro mobility in the sacroiliac joints in frontal plane.

In the transversal plane the self-bracing mechanism could be analysed as well: external rotation of the hip induced by piriformis activity helps to counteract lower leg internal rotation through subtalar eversion during loading of the foot (Klein 2004).

## 2.7 The role of sensory motor training

Diseases of the musculoskeletal system have become epidemic and represent a huge socio-economic factor. Diseases of the musculoskeletal system and soft tissues are the 2$^{nd}$ most reason for sick leave in Austria (Statistik Austria 2004) and account for the single most number of days off sick. Also, diseases of the musculoskeletal system and soft tissues are the number one reason for early retirement in Austria (Statistik Austria 2004). The vast increase of musculoskeletal problems over the last years is quite apparent, suggesting that modern lifestyle including sitting and lack of movement (Verein Sicher Leben 2004) and modern environment (industrial surfaces, concrete floors, footwear) change movement patterns (Oeffinger 1999) and posture and are partially responsible for general sensory motor deficits, even in the very young population (Verein Sicher Leben 2004).

Osteopaths postulate a holistic view of patients and their symptoms. This includes the assessment (and treatment) of the whole patient from head to toe, as well as the time factor (the case history), and the different functional levels (structural, visceral, emotional, cognitive), and also the environment.

Holistic treatment, therefore, must include a change of lifestyle and/or active measures such as sensory motor training to compensate for factors known to have an effect on pelvic integrity, such as e.g. asphalt surfaces.

## 2.8 The unstable shoe construction (USC)

The USC applied for sensory motor training was produced by SWISS MASAI AG, Roggwil, Switzerland. The MBT ACADEMY of SWISS MASAI AG teaches an empirical gait concept based on balancing called the Masai

Barefoot Technology. It teaches the use of an unstable shoe construction: the MBT. Similar to other unstable therapeutic tools like the wobble board, soft mat, mini trampoline, etc. the MBT forces the body to actively stabilise the musculoskeletal system from its base, the feet. This results in stabilisation of the ankle joints (Ritter 2004, Rojacher 2004), upright posture (Vernon 2004), and reduction of up to 27% of the load on knees, hip joints and the lower back (Nigg 2004, Vernon 2004).

However, the important difference between the usual unstable training tools and the USC is that the USC can be fixed to the foot to firstly, create a transfer of sensory motor training into dynamic movement, e.g. walking, and secondly, increase the amount of repetitions applicable, i.e. through walking in the USC throughout the day. Therefore, the USC is a sensory motor training device, which may be integrated into activities of daily living.

The idea of an unstable shoe construction is by no means unique. Prof. Karl Janda has introduced a wobble sandal during the 1980s. However, only modern engineering has made possible a unique and patented construction, which combines comfort, design and functionality.


Figure 12: The unstable shoe construction (USC).

The unique, special design is based on MBT research:


Figure 13: Construction of an MBT.

1: Despite repeated use there is practically no sign of wear to the shock absorbing wedge called the heel sensor.
2: The 3-D shaped synthetic base is manually coated on both surfaces with a special textile material.
T: Tilting rollway with integrated step to assist proprioceptive muscle tuning.
3: Rubber sole
4: PU-middle sole

# CHAPTER III - Methodology

## 3.1 The procedure of osteopathic quality assessment

Assessment of quality standards at the osteopathic practice is part of the osteopathic professional development and postulated by the osteopathic codex (OEGO 2006).

The General Osteopathic Council (1998) states in this context:
“Recognised professional status demands a total commitment to the maintenance and development of high standards of osteopathic care for patients. Such standards must incorporate the recognition of the primacy of the health care needs of a patient thus reflecting the principles of osteopathic care and management. Osteopaths must appreciate the role of professional self-evaluation and development in maintaining standards of care in accordance with the Code of Practice *Pursuing Excellence*. “

“All osteopaths must be committed to the need for Continuing Professional Development (CPD) and Continuing Osteopathic Education (COE) activities based upon the honest and conscious recognition of their identified limitations of osteopathic knowledge, skills and experience. Osteopaths will be committed to documenting a continuous evaluation of all aspects of their osteopathic practice and using this to plan and develop personal professional action plans to maintain and enhance their osteopathic capability.” (General Osteopathic Council 1998).

“Osteopaths must be sensitive to the concerns of the patient and be able to identify the needs of a patient by the elicitation of a comprehensive and relevant case history and to record the key findings accurately with appropriate detail.”  (General Osteopathic Council 1998).

“Osteopaths must be able to formulate a justifiable osteopathic treatment plan or an alternative course of action including referral to an appropriate health care professional if considered necessary. This will be based upon the professional judgement of the osteopath informed by a critical consideration of all of the facts and findings derived from the case history, clinical examination and other relevant information including tests from external sources when applicable. Differential thinking and clinical reasoning informed by the application of osteopathic principles will guide this judgement." (General Osteopathic Council 1998).

"Osteopaths must be committed to continuous self-evaluation of their professional actions and activities. This is especially relevant to their assessment of the health status of a patient following a planned osteopathic intervention. Osteopaths need to maintain an honest and thoroughly accountable approach to the evaluation of the level of outcome experienced by the patient. This must include the accurate recording of factual evidence derived from evaluation of the patient." (General Osteopathic Council 2000).

At the REHA MED practice in Andelsbuch, Austria, quality assessment is done according to these guidelines on a yearly basis. The results of the quality assessment period in 2005 suggested a significant difference in treatment results for patients who combined the osteopathic treatment with a sensory motor training, compared to patients who have received osteopathic treatment only.

This is why in 2006 the quality assessment procedure has been set up to find evidence for the benefit of sensory motor training in combination with osteopathic treatment. This procedure included re-assessment of patients suffering from low back pain (LBP) after a period of 6 weeks from the discharge date. Inclusion criteria were:

- Low back pain
- Initial positive standing flexion test (SFT), also false-positive tests
- Negative SFT at discharge
- VRS ≤ 3/10

The quality standards appointment (QS) took 15 minutes at average. Patients who fulfilled the inclusion criteria from a period of 3 months have been contacted by the practice clerk and an appointment has been arranged.

A total of 25 patients have attended the quality standards appointment. At the appointment, patients were asked to report about their progress over the last 6 weeks. Individual key tests have been repeated to correlate them with the patient's report. A Standing Flexion Test (SFT) has been performed to assess general pelvic mechanics, and the patient self-evaluated his/her present well-being (pain, stiffness) by means of the verbal rating scale (VRS), where 0 represents absence of any symptoms and 10 represents the maximum intensity of the symptoms experienced (Reading 1989, Littman 1985).

## 3.2 Subjects

### 3.2.1 Osteopathic groups

25 patients who fulfilled the inclusion criteria have been re-assessed for quality control. Twelve patients received the osteopathic treatment with a sensory motor training by means of an unstable shoe construction (USC) during the period of treatment and during the 6 weeks after discharge. These 12 patients have been defined as group 2 (Osteopathic group with sensory motor intervention). The other 13 patients have not received the standard sensory motor training at any time during the defined period and have been defined as group 1.

| Group | Number of subjects (n) | Mean age | Standard deviation (SD) |
|---|---|---|---|
| Group 1 (sensory motor control) | 13 | 50.2 | 11.4 |
| Group 2 (sensory motor intervention) | 12 | 40.7 | 13.8 |

Table 1: Osteopathic groups.

The two groups are very similar in number, age and standard deviation of age. However, there were significant differences in the outcome of the Standing Flexion Test (SFT) and the symptoms defined in the verbal rating scale (VRS).

Analysis of the QS results pointed out two critical facts:

- The two groups assessed were relatively small (group 1: n=13, group 2: n=12),
- and the amount of variables needed to be reduced, because the osteopathic treatment varied throughout the two groups. Thus, the SFT needed to be assessed in isolation to be able to evaluate the effect of the standard sensory motor training only.

### 3.2.2 Normal groups

Consequently, a group of normal subjects without any symptoms was recruited. A total of 41 subjects were divided randomly into two groups. The intervention group 4 (n=20) followed the same defined sensory motor training with the unstable shoe construction (USC), as did the osteopathic intervention group. The normal control group 3 (n=21) did not receive any intervention at all.

| Group | Number of subjects (n) | Mean age | Standard deviation (SD) |
|---|---|---|---|
| Group 3 (normal control) | 21 | 32.4 | 9.9 |
| Group 4 (normal intervention) | 20 | 36.1 | 11.9 |

Table 2: Normal groups.

The groups are very similar in number, age and standard deviation. However, analysis of the outcome data showed distinct differences between the two groups after a 6 weeks period. To support the thesis and to give further insight into the results, a third pool of subjects was included in the study. For this third pool of subjects a patient group with known sensory motor deficits were recruited to see if sensory motor training may improve pelvic function even in sensory motor impaired subjects.

### 3.2.2 Diabetic groups

People with diabetes are at risk of developing complications in the lower extremities such as neuropathies, foot ulcers, infections, and vascular insufficiency, which may finally lead to amputation (Cavanagh 2001). Reinhard (1983) found that neuropathy can be found in diabetic patients in up to 90%. Abnormalities in peripheral nerve function are present early in diabetes, before signs or symptoms develop (Polydefkis 2004). Subjective feelings of instability and an increased incidence of fall-related injuries have been reported. This appears to be due to a general loss of peripheral sensory receptor function in the lower leg, including the muscle spindles, and loss of plantar cutaneus sensation (van Deursen 1999).

In diabetic mellitus, neuropathy can appear as a sensory, autonomic, and motor disorder (Kwon 2003). For diabetic polyneuropathy, two mechanisms need to be considered. The first assumes that hyperglycemia induces metabolic derangements that directly affect Schwann cells, nodes of Ranvier, or axons. The second assumes that hyperglycemia and metabolic derangement affect the structure and function of endoneurinal micro-vessels, which then induce fibre changes by altering the blood-nerve barrier, inducing hypoxia or ischemia, or by unknown mechanisms. In proximal diabetic neuropathy, there is increasing evidence that the characteristic lesion is an inflammatory (immune) vasculitis that induces ischaemic nerve fibre degeneration (Dyck 1996). Fibre loss in the human sural nerve, for example, is multifocal, suggesting ischaemia. (Tesfaye 1995).

Reduced rates of nerve regeneration were found in people with diabetes without evidence of neuropathy and indicate that abnormalities in peripheral nerve function are present early in diabetes, before signs or symptoms develop (Polidefkis 2004). Zangger (1993) reports that destruction of an estimated 95% of all sensitive afferences from the foot may occur undetected by the individual suffering from polyneuropathy. The most important and most common neuropathy is the symmetrical peripheral sensory motor polyneuropathy (Boulton 1991).

One third of all diabetic neuropathies affect the autonomous nervous system. Most common complaints are dizziness, constipation, and erectile dysfunction (Haslbeck 2000). Clinical symptoms of neuropathy affecting the autonomous nervous system are dry and chapped skin, loss of the ability to sweat and pain at rest (Meusburger 2005, Conti 1995).

Sensory neuropathy contains the highest danger for the diabetic foot. It starts symmetrically at the tip of the big toe and progresses proximally as sensory function of the foot gradually disappears (Risse 2004). Impaired sensory awareness may lead to injuries as a result of tight footwear or hot water, and overloading of the foot (Apelquist 1990). Excessive mechanical loading is also responsible for callus production (hyperceratosis) on the foot, which in turn creates increased pressure areas (Risse 2004). In some cases there are dyskinetic symptoms like pins and needles, burning sensation on the sole of the foot, or tingling at rest (restless leg syndrome). Other clinical symptoms are reduced temperature sensation and numbness (Meusburger 2005).

In motor neuropathy there is atrophy of the intrinsic foot muscles through mal-innervation, leading to consecutive claw foot and shifting of pressure peaks to the metatarsal heads (Risse 2004, Conti 1995). Timing of the activity of some of the muscles of the lower leg controlling foot function is delayed, especially peak activity of the anterior tibial muscle, leading to foot slap and increased forefoot loading (Abboud 2000). Strength loss in the leg, especially dorsiflexor strength (-21%) and plantiflexor strength (also -21%), has been well documented by Andersen (1996). Gefen (2001) finds that it is the weakness of the tibialis anterior muscle that dramatically decreases foot stability. Gutierrez (2001) states that diabetic neuropathy leads to a decrease in rapidly available ankle strength, which impairs balance recovery. While Eils (1994) found that reduction of plantar sensory input impairs balance with an increase of postural sway in single limb stance of more than 50% in both, anterio-posterior and medio-lateral direction in healthy subjects.

A total of 46 diabetic patients with known mild to moderate neuropathy have been recruited through the diabetic outpatient department of the University Teaching Hospital Feldkirch, Austria. Subjects have randomly been appointed to one of two groups: a diabetic intervention group 6 (n=24) which followed the 6 weeks standardised sensory motor training, and a diabietic control group 5 (n=22) which did not have any intervention during the 6 weeks study period.

| Group | Number of subjects (n) | Mean age | Standard deviation (SD) |
|---|---|---|---|
| Group 5 (diabetic control) | 22 | 62.7 | 6.9 |
| Group 6 (diabetic intervention) | 24 | 61.3 | 11.2 |

Table 3: Diabetic groups.

The two groups were very similar in number, age and standard deviation of age.

### 3.3 Data collection

A standard form was used to collect name, age, stance leg side, and dexterity. For subjects from the osteopathic treatment groups 1 and 2 symptoms have been objectified by means of a verbal rating scale (VRS) and values noted. For diabetic patients duration of illness has also been noted. Then the standing flexion test (SFT) was performed and results noted.

Palpation of bony landmarks has recognised limitations. Reliability may be reduced by anatomical variation of bony prominences from left to right, lower limb inequality, and obesity of patient (Peace 2004). Palpation of the posterior superior iliac spines (PSIS) has to go through the layers of skin, subcutaneous soft tissue, and the fascias of the major and medium gluteus muscle, as well as the thoraco-lumbar fascia and fascia of the erector trunci muscles (Winkel 1992). The distance between the skin surface and the sacroiliac joint is 5 cm at the cranial pole of the joint and 2 cm at the caudal pole (Winkel 1992).

Palpation and evaluation of the Standing Flexion Test may not be easy, however, to the experienced Osteopath it seems to be a valuable and reliable test. The test was performed with the patient standing in front of the Osteopath. After palpation of the distal margins of the posterior superior iliac spines (PSIS) patients have been instructed to bend forward at the hip to reach the floor with their hands. During forward bending, the osteopath assessed symmetry of PSIS movement and surrounding myofascial tension. This procedure was repeated three times (Egan 1996). The test was noted as positive, if mobility asymmetry was detected at least on two of the three repetitions and the positive side was defined (the side of the forward travelling PSIS) (Egan 1996, Dreyfuss 1994).

Figure 13: Standing Flexion Test (STF).

### 3.4 Ethical committee approval

Standards of ethics for research with human subjects summarise several ideals. These include high quality of informed consent, confidentiality, truthfulness, social sensitivity and minimisation of harm (Good 2001).

For the normal and diabetic subjects recruited through the University Teaching Hospital Feldkirch a standard procedure for ethical approval was followed and all necessary forms provided. The Ethical Committee gave full approval to the study.

### 3.5 Study Design

Controlled clinical tests are especially useful to evaluate the effectiveness of a treatment (Toumilehto 2006). The study design of this project followed the design criteria of a single blinded randomised controlled trial (RCT) (Donald 1999, Greenhalgh 2001, Schumacher 2002). Randomised controlled trials (RCTs), are known to be the most reliable kind of research (with the exception of systemic reviews (SRs), which look at RCTs and try to find a synthesis (Greenhalgh 2001). To avoid bias, it is necessary to develop a blinded study design. However, a double-blinded study design would be even better (Donald 1999). Blinded means, that the researcher does not know, which group the subject belongs to, the intervention group or the control group. Double blinded means, that neither the researcher nor the subjects know, which group the subject belongs to (Greenhalgh 2001, Donald 1999). However, since the intervention group cannot be blinded, the RCT can only be single blinded. Single blinding of the researcher was assured through transfer of the whole intervention procedure to an externally acting MBT Instructor.

Randomisation is important to avoid bias during the selection phase of the subjects (Greenhalgh 2001), i.e. the subjects are put into one of the two groups at random. One group will receive an intervention the other group will serve as a control group.

Randomisation took place after the first measurement session. This way, the researcher did not know, which group the subject belonged to. For randomisation each subject drew a letter with further instructions. The letter has only been opened, once the subject has left the gait laboratory. Two different forms have been developed for randomisation.

### 3.6 Sample size

Sample size is a very important factor in statistics to be able to conclude from a small sample of subjects to the whole population. Therefore, the higher the sample size the more representative the outcomes of a study are.

Sample size for the groups generated from the osteopathic quality standards (QS) assessment was clearly too small to conclude to the whole population. This is why two groups of over 20 normal subjects have been recruited, which is a generally accepted sample size. Also, a difference of over 30% between the groups with osteopathic treatment suggested a highly significant effect of the standard sensory motor training, which allows smaller sample sizes to be representative.

Other projects have shown that recruitment of diabetic patients is a difficult task, even more so for a longitudinal study. Therefore, for the diabetic groups the aim was to simply recruit as many participants as possible. In this light, the final outcome of 24 and 22 participants respectively for the diabetic groups was highly appreciated.

### 3.7 Organisation of intervention setup

For those subjects who have randomly been appointed to the intervention groups, intervention procedure has been organised at a nearby orthopaedic shoemaker, Johannes Vogelsberger. A MBT test contingent of 50 MBTs has been ordered from AUSTRO MASAI Vertriebs GmbH. Thus, after the first measurement and following randomisation, the subjects of the intervention group would be fitted an MBT without the knowledge of the researcher.

The local MBT instructor and physiotherapist, Christof Pichorner, has been informed about the project, procedures, and necessities. A schedule for group instructions according to the MBT guidelines has been set up which was coordinated with the study appointments of the diabetic subjects.

### 3.8 Statistical Methods

The presented study operated with a positive/negative function. Results have been noted as 1 for positive and 0 for negative in an EXCEL spread sheet. Data has then been transferred to the SPSS 13.0 (SPSS Inc., Chicago) software for descriptive analysis. The sum of positive test results after 6 weeks has been expressed as the percentage of the total number of subjects per group. The expressed percentage has then been compared between the two subgroups (1 compared to 2, 3 compared to 4, 5 compared to 6) and between intervention groups and controls. A Pearson Chi-square analysis has been performed to calculate statistical significance.

Repeated analysis of variance was applied to investigate differences between VRS values and the number of positive SFT before and after 6 weeks in the osteopathic treatment groups. These were Within-Subjects Factors in the analyses. Groups have been compared through analysis of the Between-Subject Effect. The Bonferonni correction for multiple comparisons was applied to means *post hoc* and the Huynh-Feldt adjustment for non-sphericity made.

# CHAPTER IV - Results

## 4.1 Osteopathic treatment groups 1 and 2

Comparison of symptom-related treatment results by means of the verbal rating scale (VRS) before and after 6 weeks suggests that symptoms in subjects of group 1 with a mean VRS of 2.2/10 did not change, while in group 2 there is a significant further improvement of symptoms (p=0,021) over the 6 weeks training period following discharge from VRS 1.2/10 to VRS 0.4/10.

**Estimates(a)**

Measure: vrs

| factor1 | Mean | Std. Error | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|
| 1 | 2.231 | .323 | 1.526 | 2.935 |
| 2 | 2.231 | .611 | .899 | 3.563 |

a group = 1

**Estimates(a)**

Measure: vrs

| factor1 | Mean | Std. Error | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|
| 1 | 1.167 | .386 | .317 | 2.016 |
| 2 | .417 | .193 | -.008 | .841 |

a group = 2

Table 4: Estimate VRS values.

While the mean VRS value did not change for group 1, the standard error value and the 95% confidence interval actually increased, suggesting reduced homogeneity of group 1 after 6 weeks. Obviously some patients had experienced more symptoms, while others experienced a reduction of symptoms.

In group 2 values for standard error and the 95% confidence interval decreased, suggesting an increased homogeneity of the group after 6 weeks. This supports the view that in group 2 most of the subjects experienced further improvement of symptoms after the 6 weeks period of sensory motor training.

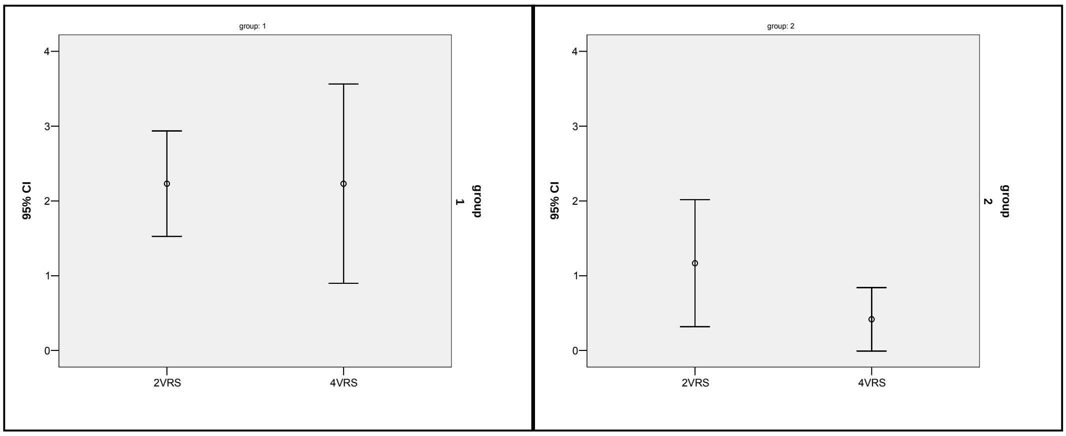


Figure 14: VRS histogram.

At submission, all the patients included in this study presented with a positive SFT. At discharge all of those patients who received osteopathic treatment showed a negative SFT. Re-assessment after 6 weeks has shown re-occurrence of a positive SFT in some cases.

| Group | n of initially positive SFT | n of pos SFT post 6 weeks | Improve-ment [%] | Signifi-cance |
|---|---|---|---|---|
| Group 1 (sensory motor control) | 13 | 7 | 46.15 | p=0.008 |
| Group 2 (sensory motor intervention) | 12 | 2 | 83.33 | p<0.001 |

Table 5: Improvement of osteopathic treatment groups.

While 46% of the osteopathic group without sensory motor intervention showed an overall improvement of the SFT after 6 weeks (p=0.008), 83% improvement of the SFT for the sensory motor intervention group 2 (p<0.001) suggests that pelvic suspensory function benefits from a combination of both, osteopathic treatment and additional sensory motor training with an unstable shoe construction. The Between-Subject Effect of group 1 and 2 shows close significance with p=0.053. The bar chart below shows the number of still positive (1) and improved SFTs (0) for the two groups after osteopathic intervention and a 6 weeks intervention/control period.

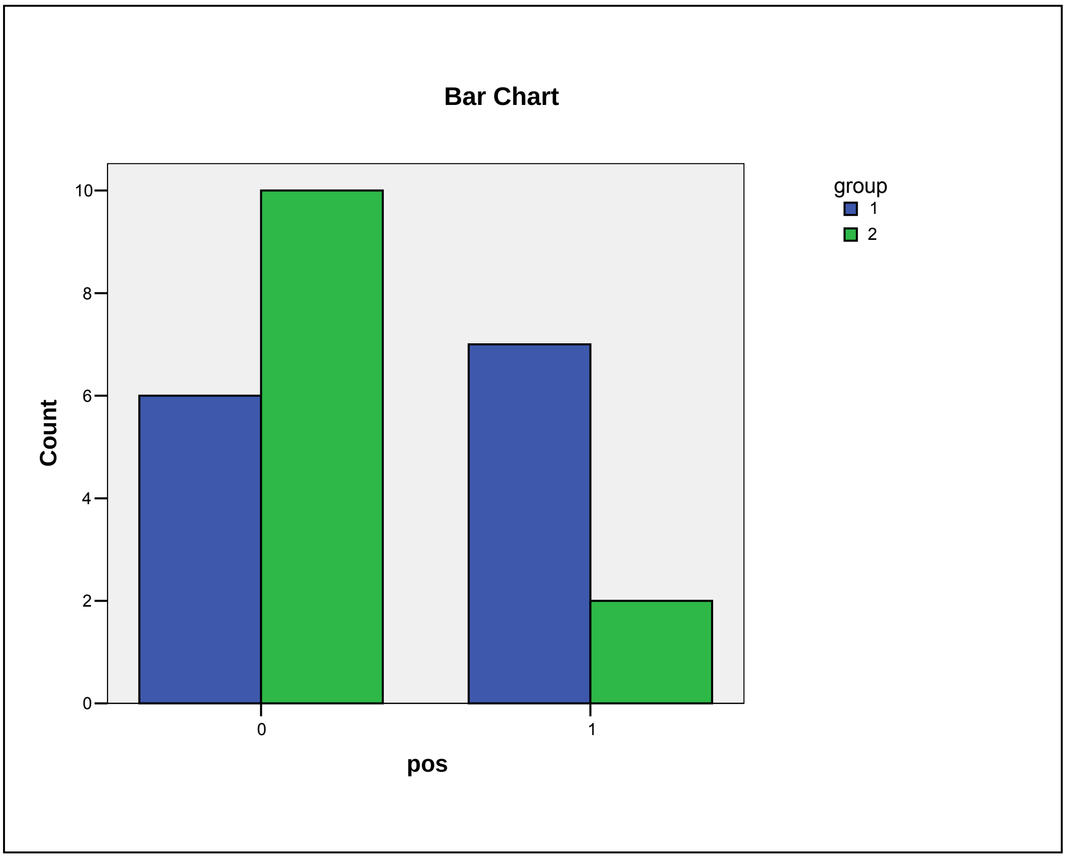


Figure 15: Comparison of osteopathic groups 1 and 2.

There is only poor correlation between the improvement of the Standing flexion test (STF) and the improvement of symptoms (VRS) in patients suffering from LBP. For the osteopathic treatment group 1 with no sensory motor intervention improvement of the SFT correlates in 30.77% with the improvement of the VRS. For the osteopathic treatment group 2 with sensory motor intervention improvements correlate in 66.67 % .

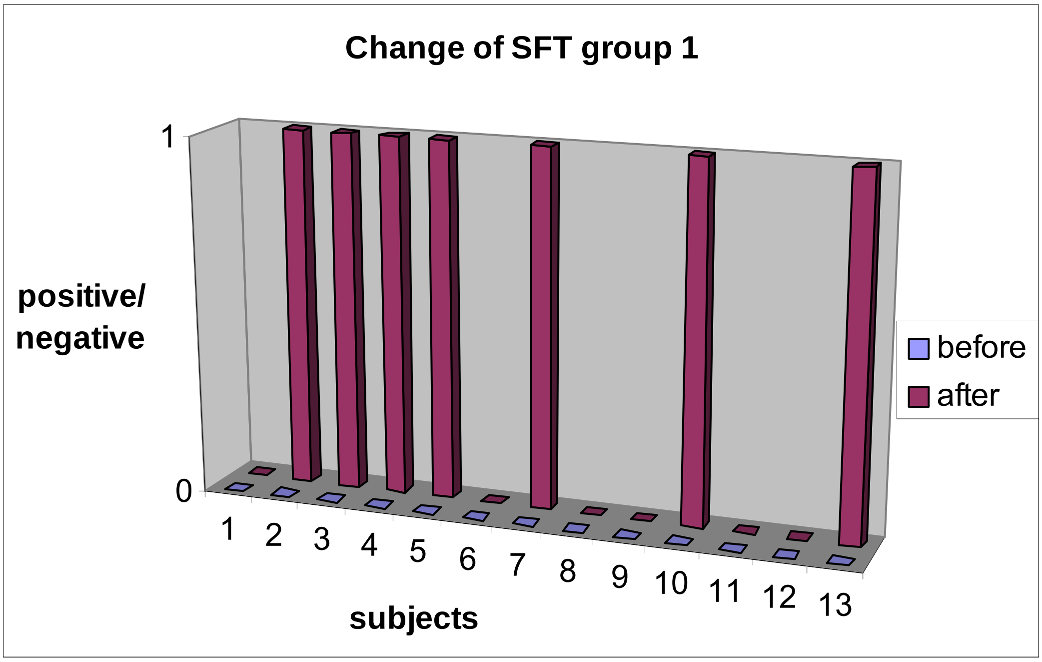


Figure 16: Change of SFT in group 1.

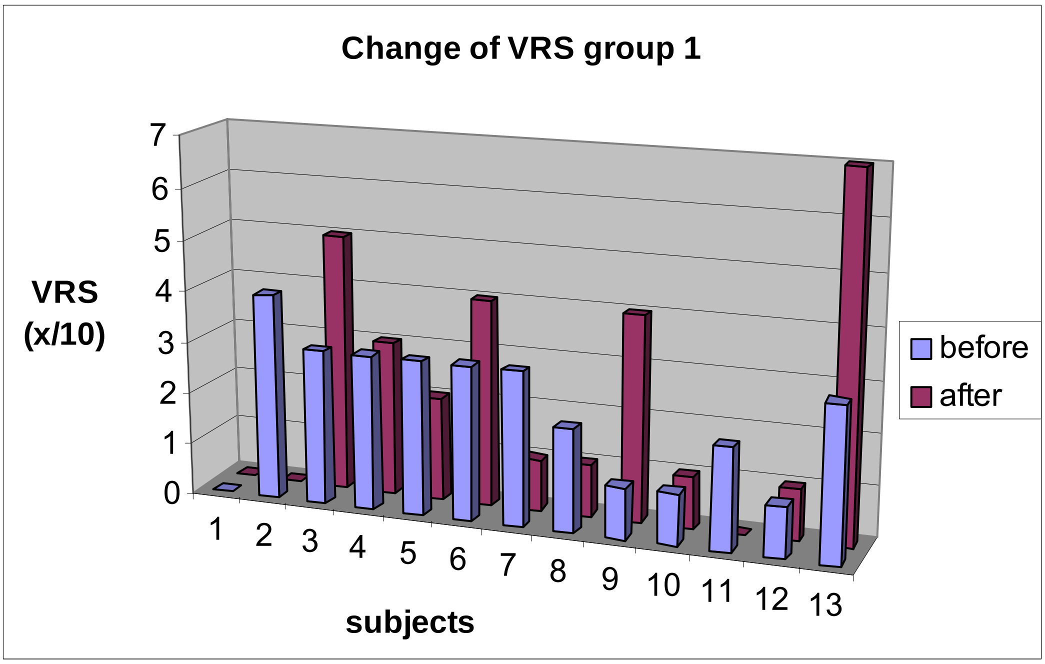


Figure 17: Change of VRS in group 1.

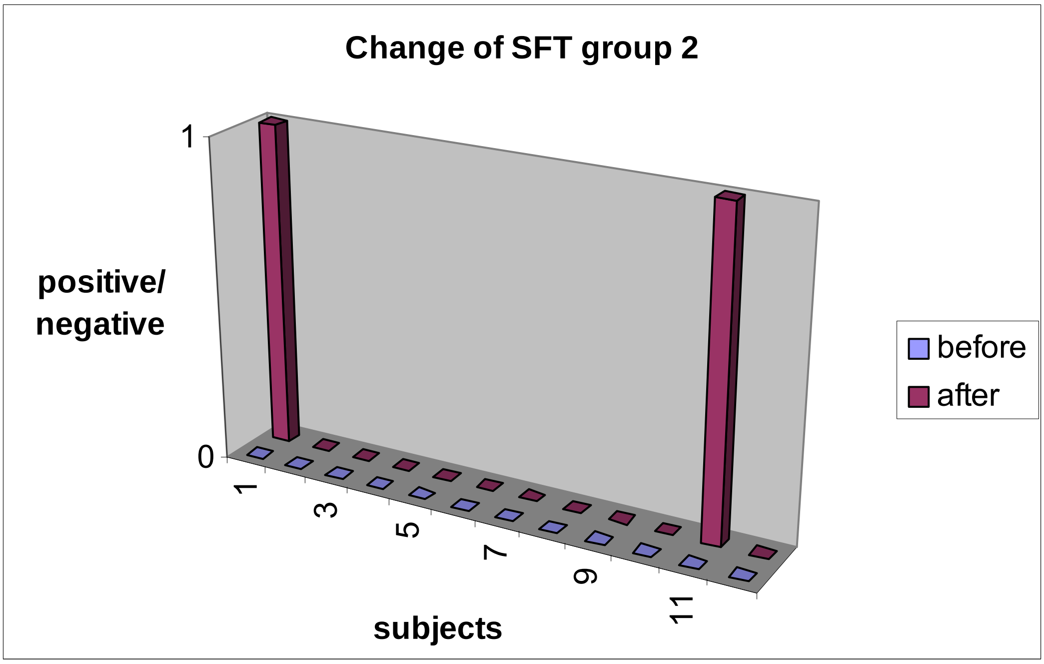


Figure 18: Change of SFT in group 2.

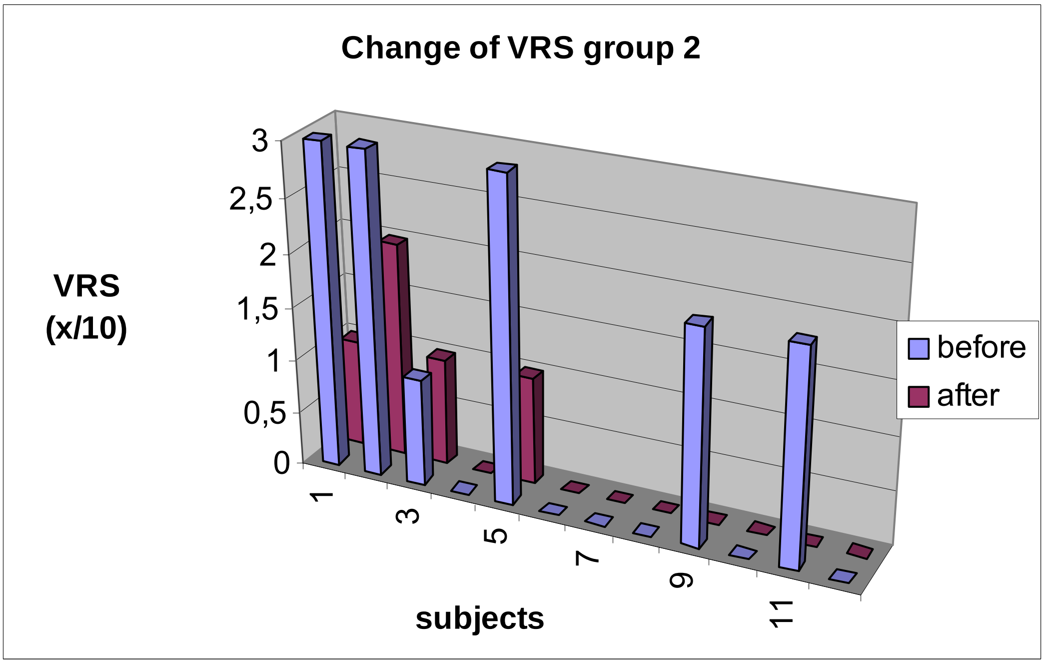


Figure 19: Change of VRS group 2.

### 4.2 Normal subjects groups 3 and 4

Results for the normal control group 3 show minimal changes with changes for only one subject of this group. This subject has initially shown a positive SFT, which has improved during the 6 weeks to be negative.

| Group | n of initially positive SFT | n of pos SFT post 6 weeks | Improvement [%] | Significance |
|---|---|---|---|---|
| Group 3 (normal control) | 21 | 20 | 4.76 | p=0.162 |
| Group 4 (normal intervention) | 20 | 10 | 50.00 | p<0.001 |

Table 6: Improvement percentage of normal subject groups.

In the normal intervention group 4, however, half of all subjects have improved their positive SFT (p<0,001) after 6 weeks sensory motor training with the un-stable shoe construction.

The Between-Subjects Effect analysis shows that the difference between the two groups is significant with p=0.003. The bar chart shows the number of still positive (1) and improved SFTs (1) for the two groups after the 6 weeks intervention/control period.

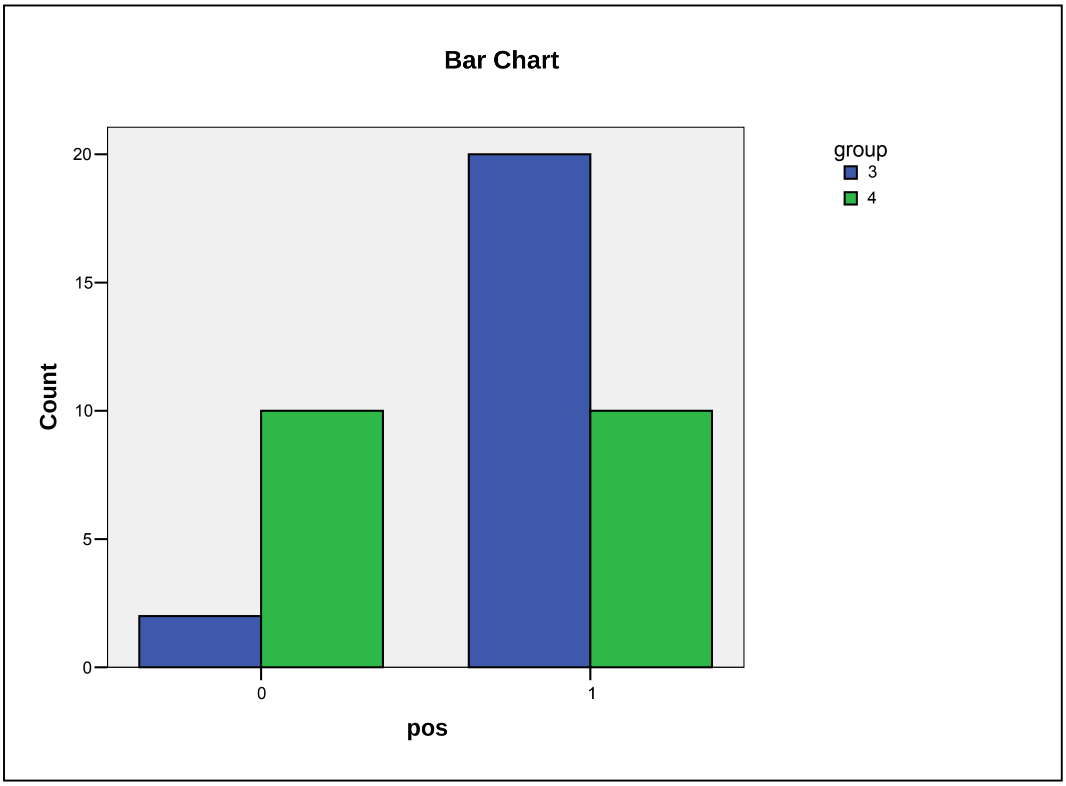


Figure 20: Comparison of normal groups 3 and 4.

### 4.3 Diabetic subjects groups 5 and 6

These two groups with a mean duration of illness of 7.1 (± 5,6) years (group 6) and 9.9 (± 9,2) years (group 5) showed very similar results compared to the normal subjects groups. While there was only minimal improvement in group 5 (9% or 2 subjects, p=0.162), the diabetic intervention group 6 improved by 62% (p<0.001).

| Group | n of initially positive SFT | n of pos SFT post 6 weeks | Improve-ment [%] | Signifi-cance |
|---|---|---|---|---|
| Group 5 (diabetic control) | 22 | 20 | 9.09 | p=0.162 |
| Group 6 (diabetic intervention) | 24 | 9 | 62.50 | p<0.001 |

Table 7: Improvement of diabetic subjects.

Between-Subject Effect analysis of these two groups shows a significant difference after 6 weeks of $p<0.001$. The bar chart below shows the number of still positive (1) and improved SFTs (0) for the two groups after an intervention/control period of 6 weeks.

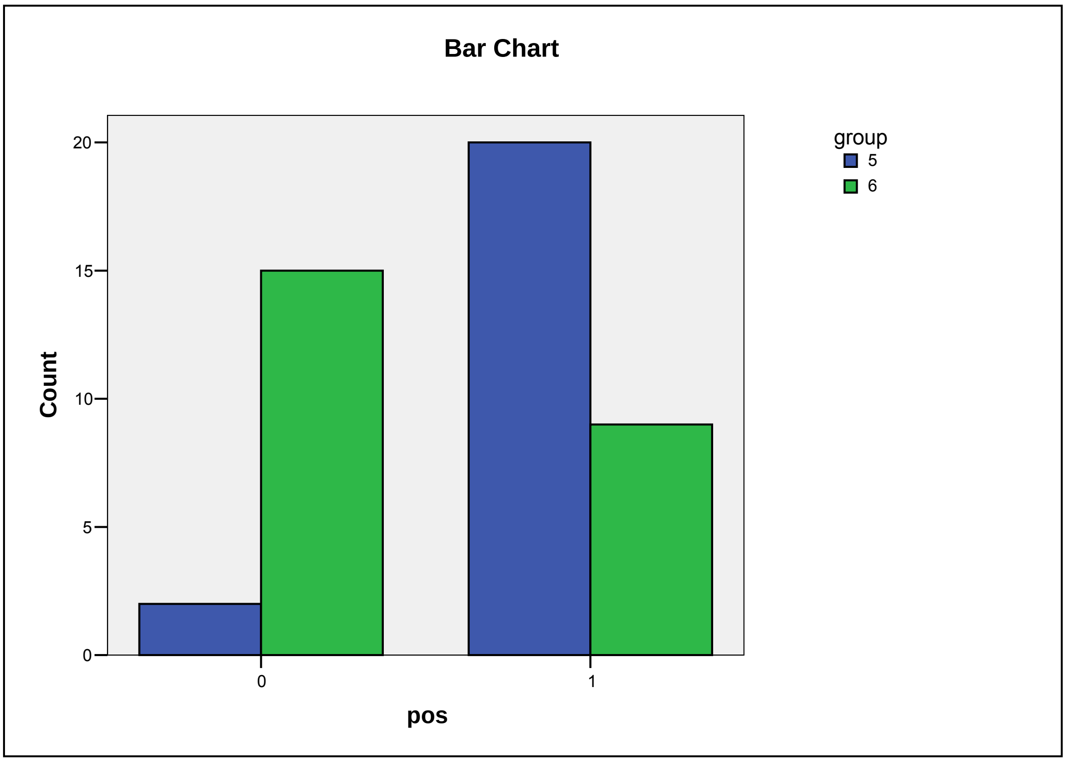


Figure 21: Comparison of diabetic groups 4 and 5.

### 4.4 Result summary

While in the two control groups 3 and 5 of this study (normal and diabetic) the SFT did not really improve, osteopathic treatment and isolated sensory motor training showed a similar significant improvement over a 6 weeks period. Improvement values lied around 50%.

Maximum improvement was found in group 2, the osteopathic treatment with intervention group. This group improved for over 80%. At the same time, this group also further improved their subjective symptoms.

94.6% of all initially positive tested SFT occurred on the right side. After 6 weeks 92.6% were on the right. At the same time, 63.4% of all subjects presented with a left stance leg, and 87.5% with right dexterity.

Comparison of all USC intervention groups to all control groups shows an improvement of 77.8% versus 22.2% (p<0.001) for the SFT after 6 weeks.

**pos * group Crosstabulation**

| | | | group | | Total |
|---|---|---|---|---|---|
| | | | control | USC intervention | |
| pos | 0 | Count | 10 | 35 | 45 |
| | | % within pos | 22.2% | 77.8% | 100.0% |
| | | % within group | 17.5% | 62.5% | 39.8% |
| | | % of Total | 8.8% | 31.0% | 39.8% |
| | 1 | Count | 47 | 21 | 68 |
| | | % within pos | 69.1% | 30.9% | 100.0% |
| | | % within group | 82.5% | 37.5% | 60.2% |
| | | % of Total | 41.6% | 18.6% | 60.2% |
| Total | | Count | 57 | 56 | 113 |
| | | % within pos | 50.4% | 49.6% | 100.0% |
| | | % within group | 100.0% | 100.0% | 100.0% |
| | | % of Total | 50.4% | 49.6% | 100.0% |

Table 8: Percentage of positive SFT in intervention and control groups.

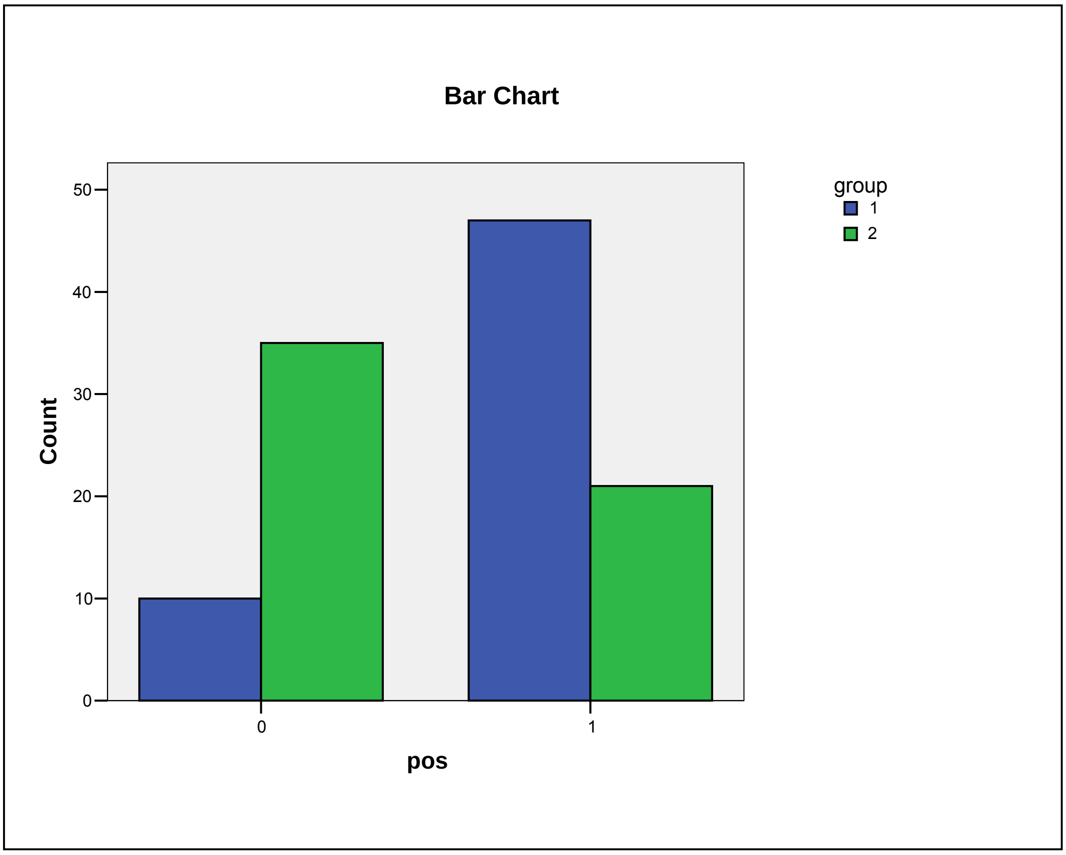


Figure 22: Comparison of intervention and control groups.

| Group | n of initially positive SFT | n of positive SFT post interv. | Improvement [%] |
|---|---|---|---|
| Group 3 (normal control) | 21 | 20 | 4.76 |
| Group 5 (diabetic control) | 22 | 20 | 9.09 |
| Group 1 (sensory motor control) | 13 | 7 | 46.15 |
| Group 4 (normal intervention) | 20 | 10 | 50.00 |
| Group 6 (diabetic intervention) | 24 | 9 | 62.50 |
| Group 2 (sensory motor intervent.) | 12 | 2 | 83.33 |

Table 9: Ranking of improvement.

There is a striking correlation between right hand dominance and the positive SFT on the right. Also, the percentage for the stance leg is higher for the left side. This could be evidence for a general myofascial compensatory pattern: Stance leg side left, positive SFT right and dominant hand right as suggested by some osteopaths (Dreyfuss 1994).

| Group | Positive SFT right | Positive SFT left | Stance leg right | Stance leg left | Dominant hand right | Dominant hand left |
|---|---|---|---|---|---|---|
| Group 1 (sensory motor control) | 13 | 0 | 4 | 9 | 13 | 0 |
| Group 2 (sensory motor intervention) | 12 | 0 | 4 | 8 | 10 | 2 |
| Group 3 (normal control) | 19 | 1 | 6 | 14 | 18 | 2 |
| Group 4 (normal intervention) | 21 | 0 | 11 | 10 | 17 | 4 |
| Group 5 (diabetic control) | 19 | 3 | 8 | 14 | 19 | 3 |
| Group 6 (diabetic intervention) | 22 | 2 | 8 | 16 | 21 | 3 |
| Total | 106 | 6 | 41 | 71 | 98 | 14 |

Table 10: Overview right-left dominance.

Fifty-three % of all tested subjects follow the pattern of left stance leg with a right positive SFT and right dexterity ($p<0.001$), while 28% follow the pattern of right stance leg and right positive SFT and right dexterity.

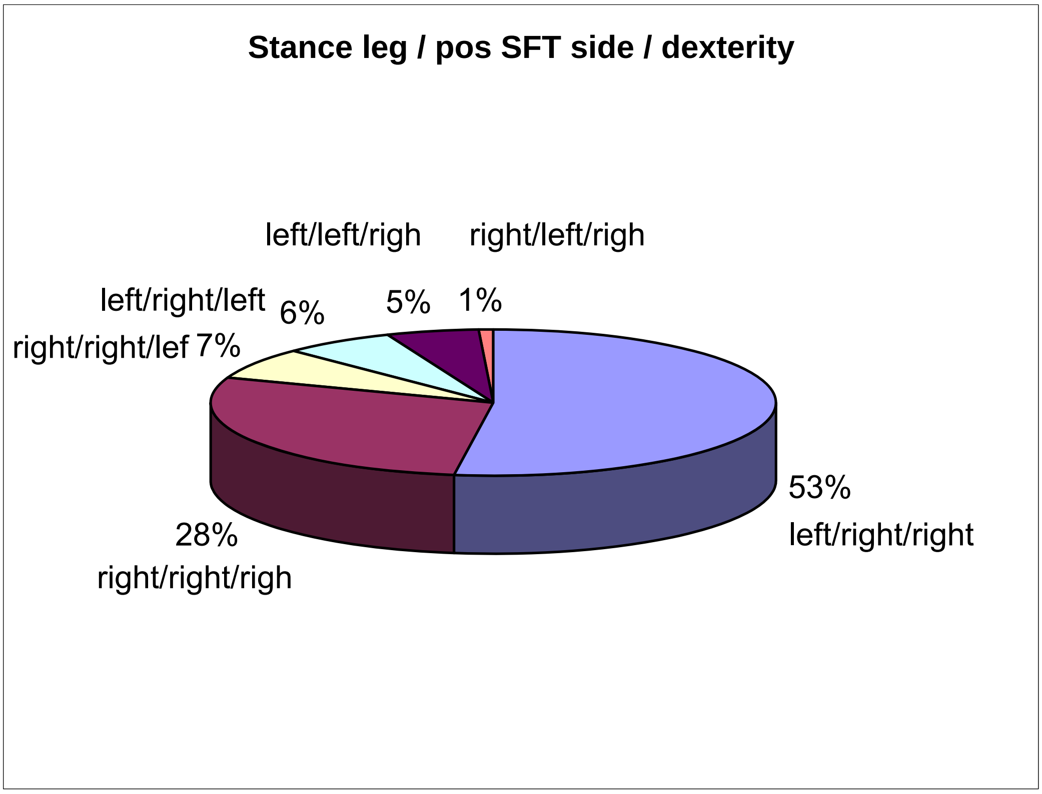


Figure 23: Percentage of different sensory motor patterns.

Correlation between stance leg side and positive SFT side is high ($p<0.001$) if analysed in isolation. 58% of all subjects with a left stance leg side showed a right positive SFT, while only 5% with a left stance leg side showed a left positive SFT.

Subjects with a right stance leg side showed a right positive SFT in 36% of the cases, while only 1 % showed a left positive SFT.

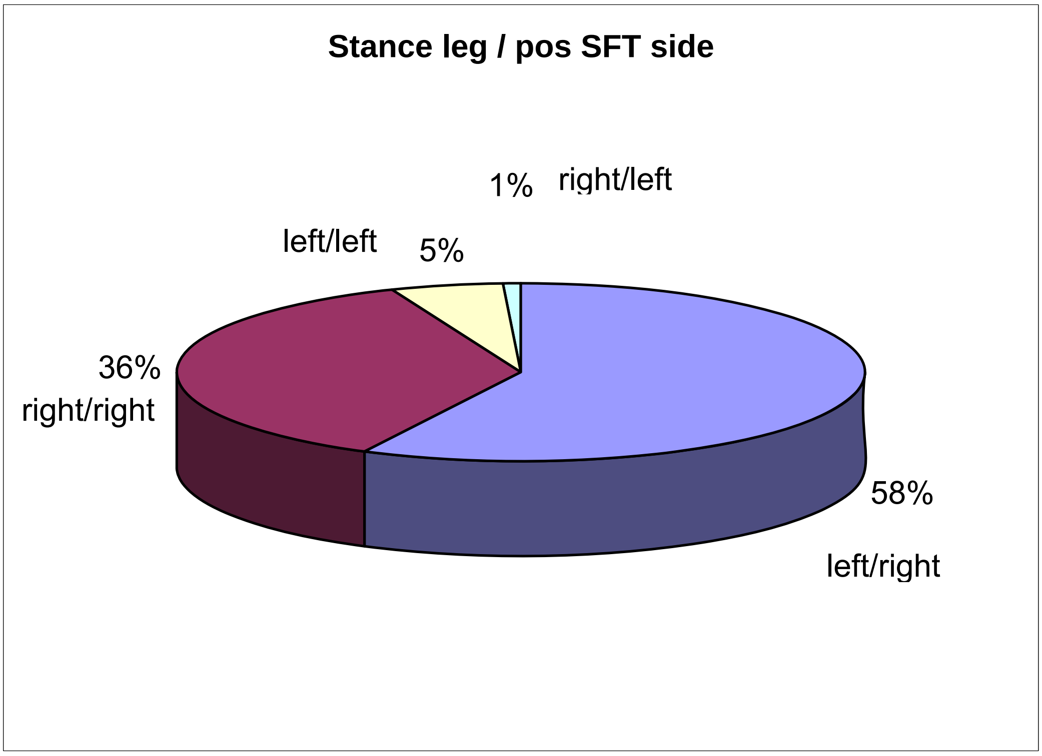


Figure 24: Percentage of different stance leg / pos SFT side patterns.

The positive SFT side is highly correlated to dexterity ($p<0.001$). 81% of all subjects tested showed a right positive SFT with right dexterity, while only 13% showed a right positive SFT with left dexterity.

Right dextrous subjects showed a left positive SFT in 6% only. No left handed subject presented with a left positive SFT in this study.

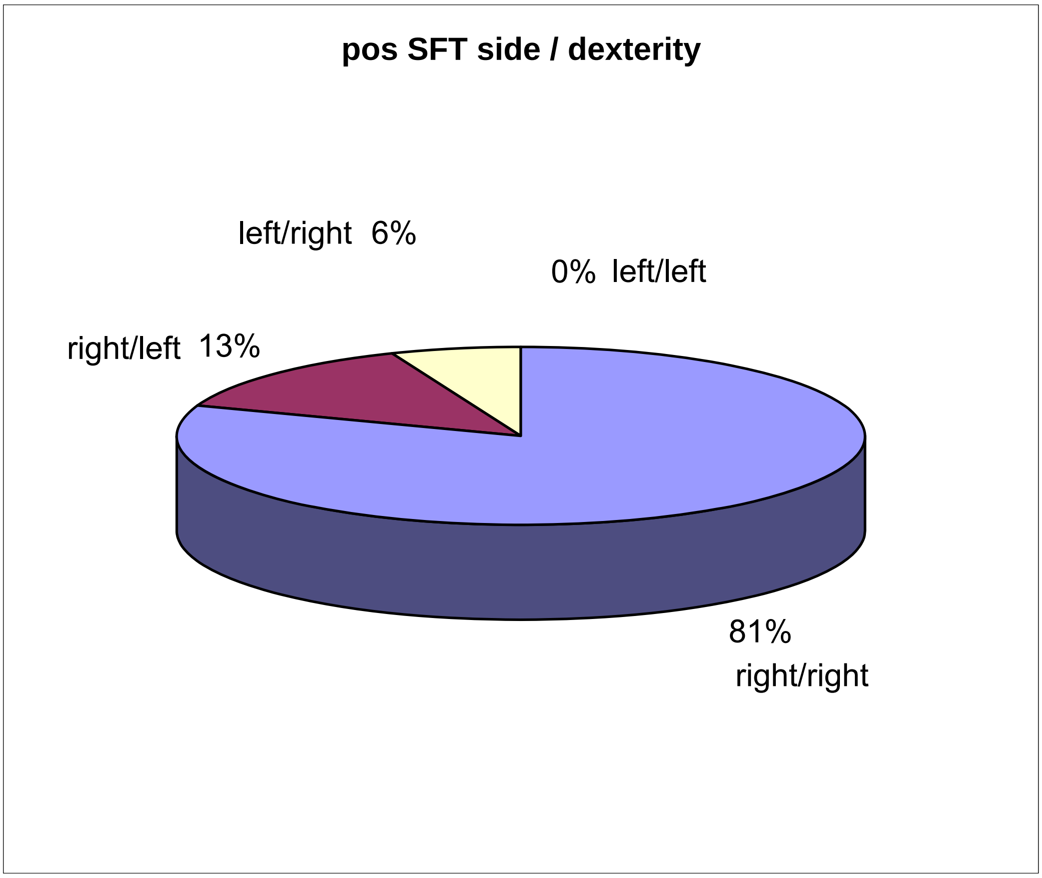


Figure 25: Percentage of different positive SFT side / dexterity patterns.

## CHAPTER V - Discussion

So far no study has been published regarding changes in pelvic function through the use of an unstable shoe construction. This study is the first single blinded randomised RCT to investigate the effect of a 6-week sensory motor training with an unstable shoe construction on a positive Standing Flexion Test (SFT).

Palpation and evaluation of the Standing Flexion Test may not be easy, however, for the experienced osteopath it seems to be a valuable and reliable test and is used in routine clinical practice.

There is no correlation between a positive SFT and Low Back Pain (VRS values). Also, there is no correlation between the change of a positive SFT and the change in VRS values over a time of 6 weeks. A positive SFT does not seem to be directly related to the symptoms a subject experiences.

However, there is very strong correlation of the side of the positive SFT with the stance leg side and dexterity. This suggests, that  the sacro-iliac joint functions as part of a musculo-skeletal chain which is dependent on dominant sensory motor patterns. This also supports the view, that the SFT is a test for musculo-skeletal function rather than sacroiliac joint mobility.

Osteopathic treatment has a positive effect on the SFT. As a short term result, 100% of the initially positive Standing Flexion Tests tested negative, while after 6 weeks only 46% still tested negative.

Sensory motor training with an USC has shown to have a positive effect on the SFT. 50% of the normal subjects and 62% of the diabetic subjects tested negative after a 6 weeks period of training with an USC.

Combination of osteopathic treatment and sensory motor training proved to have the most effect on the positive SFT. 80% of all initially positive Standing Flexion Tests tested negative after treatment and a 6 weeks intervention with sensory motor training.

The results of this study suggest that symmetry of the SFT and stability of pelvic function respectively is partially dependent on sensory motor function of the loco motor system and can be influenced by sensory motor training with an unstable shoe construction.

Sensory motor training has therefore shown that it has an effect on the continuity of pelvic integrity and may be important to ensure long-term benefit of the osteopathic treatment for pelvic integrity in some patients.

## CHAPTER VI - Conclusion

Osteopathic treatment is an effective way to improve symptoms in patients suffering from LBP.

The findings of this study also suggest, that patients suffering with low back pain treated with osteopathy benefit from additional sensory motor training with an unstable shoe construction.

The results of this single blinded RCT suggest that sensory motor training improves pelvic integrity and the suspensory function of the pelvic clutch in normal subjects as well as in patients suffering from mild diabetic neuropathy. This supports the findings of the quality standards assessment procedure.

Combination of osteopathic treatment and sensory motor training with an unstable shoe construction seems to improve the long-term results for the Standing Flexion Test (SFT) for over 30%.

Consequently, passive treatment may not be enough for patients suffering from pelvic dysfunction, and additional active sensory motor training should be considered for these patients by the conscious osteopath.

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# APPENDIX

## List of Abbriviations

| | |
|---|---|
| ADL | Activity of daily living |
| COE | Continuing Osteopathic Education |
| CPD | Continuing Professional Development |
| LBP | Low Back Pain |
| LKHF | University Teaching Hospital Feldkirch |
| LKHR | University Teaching Hospital Rankweil |
| MBT | Masai Barefoot Technology |
| OEGO | Austrian Osteopathic Association |
| PSIS | Posterior superior iliac spine |
| PU | Poly-Urethane |
| QS | Quality Standards |
| RCT | Randomised Controlled Trial |
| SD | Standard Deviation |
| SFT | Standing Flexion Test |
| SR | Systematic Review |
| USC | Un-stable shoe construction |
| VRS | Verbal Rating Scale |

## Standard Assessment Form

Patientenblatt Osteopathie

Name: ______________________________

d.o.b.: ____________________ Sozialer Hintergrund

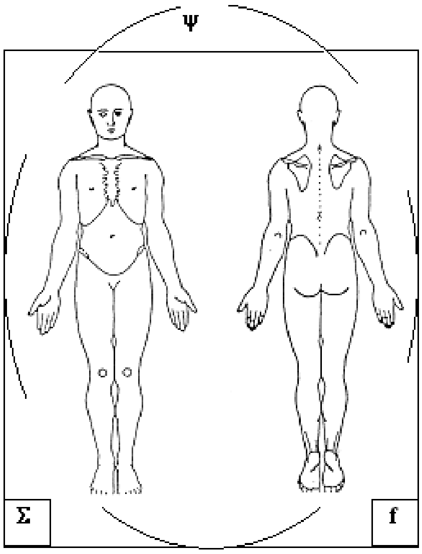
Adresse: ____________________ Allgemeine Gesundheit

Wohnort: ____________________ Medikation

Telefon: ____________________ HF ___ S/min li/re

Zuweiser: ____________________ RR li: ___ / ___ re: ___ /

Diagnose: ____________________ SR magen/darm/leber/galle




herz/ks

urogenital

neuro

atemtrackt

schilddrüse

blutwerte

zähne

OP

traumata

allergien

psi

diabetes

menses

qualität: röntgen

Analyse 1. Aanalyse 2. Aanalyse 3.

Vorgeschichte

0

10

20

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gelbe Fahne

„Sensory motor training for active completion of the osteopathic treatment“

Marcel Maetzler, MSc Thesis, Donau-Universitaet Krems, 2006.