The effects of the craniosacral work on the notochord on the right – left strain and the forefeet – heel strain in an upright position

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The Grand Architect of the Universe builds without the sound of hammers.

Nature is silent in her work. (A.T. Still)

1 Dedication

for Werner

in love and gratitude

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3 Abstract

The techniques of the Craniosacral Osteopathy are still difficult to verify. This paper shall serve as a contribution to prove the positive effects of the craniosacral therapy on the patients' health.

As the notochord is the first structural median line in our body (Upledger. 2003), I would like to question if the craniosacral work can change the right – left and forefoot – heel strain to such an extent that it becomes measurable by means of a force plate. My hypothesis is that the 'centre of pressure of the test persons moves towards the crossing of x and y axis of the pressure measuring plate (symmetry) and that the balance (postural stability) improves.

Methodology:
All the test persons are competitive athletes from the field of cross-country skiing, alpine skiing and snowboarding. With bandaged eyes they are placed three times for 20 seconds on the SP Sport force plate (Pernitsch Österreich) of the commercial ski school Schladming. On this occasion the forefoot strain in relation to the heel strain and the strain of the right foot in relation to the left foot are measured. After that the test persons lie down on a treatment couch and here the craniosacral technique on the notochord takes place. Immediately after the treatment the test persons are placed with the same foot position another three times for 20 seconds on the force plate.

If this technique has positive influences on symmetry and balance when standing upright the effect of this craniosacral technique on our body can confirmed. This would be a possibility to bring about performance enhancements in competitive sports.

Hypothesis:
I proceed on the assumption that the craniosacral technique used in this trial leads to an improvement of symmetry, measured throw the standard deviation by the force plate and the equilibrium, measured throw the deviation by the force plate.

4 Preface

In our days competitive sports is so highly developed that it becomes an always greater challenge to achieve advantages regarding the competitive success by means of new techniques, training contents, sports equipments etc. The fields of sports medicine, efficiency diagnosis, training – science etc have reached a point when it becomes always more difficult to achieve further performance enhancements. Enhancements will be indeed always possible but the temporal and financial expenses will be that high in the future that only large nations and federations will be able to afford them. Small nations will be successful in the future only if they work creatively, if they see sports from another angle, if they accept also those fields that have nothing to do with sports at a first glance.
Osteopathy is probably such a field by means of which efficiency can be influenced positively. The potential of an athlete is no longer determined by training only but also by his or her psyche and, to a certain extent, also by his or her inner equilibrium, his or her mental and corporal equilibrium.
The craniosacral osteopathy, normally applied in treatment, might be a form of treatment or rather an instrument to increase efficiency. The craniosacral treatment of the notochord is one example. It is possible that the equilibrium improves by means of such a treatment and subsequently the efficiency increases, especially in sports where the equilibrium is an efficiency determining factor.
I am glad that so many different persons from so many different fields attend to sports and particularly to the problem of a permanent performance enhancement in sports. Only in this way sports can develop further, especially on a level that is affordable for the athletes. However this trials ends, it is an important step into the right direction and I wish Claudia Neubauer all the best and success with this treatment.

Mag. Bernd Kindermann

5 Introduction

For ’non – osteopaths’ it might be elusive that craniosacral techniques can have effects. When watching craniosacral treatments one can only observe how the osteopaths hold different parts of the patient’s body. The improvement of the pain situation would be one possible evidence for the effect of the treatment. The sensation of pain, however, is subjective.

My motivation to conduct this trial is to prove the effect of one single craniosacral technique with the aid of a technical instrument. After due consideration which osteopathic technique could influence the statics of the whole body, I decided on the treatment of the midline. J. Jealous defines the midline as a primary line of orientation for the spatial organisation in the organism. (zit. Jealous, in Liem. 2006). The notochord is the guideline for the nervous system during the embryonic development (Drews. 1993). For the human being it is a functional (or energetic) median line. At best it is located as an imagined line between the coccygeal bone and the sphenoid body (Nusselein. 2001).

The notochord is the earliest structural median line and I would like to question if the craniosacral treatment of this median line can change the right – left and the forefoot – heel strain in such a way that it becomes measurable via a force plate. My hypothesis is that the “centre of pressure” moves towards the crosspoint of the x and y axis of the pressure measuring plate and thus the postural stability improves.

At the beginning of the eighties force plates were increasingly used in order to objectify the measurement results of the equilibrium (Bös 2001). By means of the computer programme of the SP Sport force plate (Pernitsch, Österreich) it is possible to conduct on the one hand measurements of the equilibrium (postural stability) and on the other hand measurements of the symmetry of the body. The software for the static measurements was developed especially for this test series.

If this technique improves symmetry and equilibrium in an upright position, the positive effect of these craniosacral techniques on our body can be verified.
This test series is also useful to find out about the balanced strain of the legs and the pelvis. If the ‘centre of gravity’ is central the right and the left leg would have to carry 50% of the

bodyweight each. Thereby we can counteract against an asymmetric strain of muscles and joints.

The ability for equilibrium is on the one hand precondition and on the other hand target for sportive activities (Bös. 2001). A good equilibrium and an equal strain of the right and the left leg positively affect the techniques in competitive skiing, cross-country skiing and snowboarding.

So far no study about this topic has been published. And also in osteopathic literature there is no study on the notochord. On the basis of studies about the measurements by means of force plates and with the aid of literature (Bös. 2001) I developed the methodology.

In the chapters on anatomy and biomechanics I give an overview of the notochord and the foot. Furthermore the terms 'body balance point' and 'equilibrium' are defined. In the methodology section the background of the choice of method as well as the force plate, the test persons and the study itself are highlighted. Finally the results are presented and discussed.

6 Anatomy of the notochord

6.1 What is the notochord (chorda dorsalis)

The chorda dorsalis serves the embryonic development of the nervous system like a primitive axial rod. It does not develop into an embryonic organ. Rests of the chorda dorsalis can be found in the gelatinous nucleus (Rohen. 2004), in the intervertebral disk and in the apical dental ligament (Nusselein. 2001).

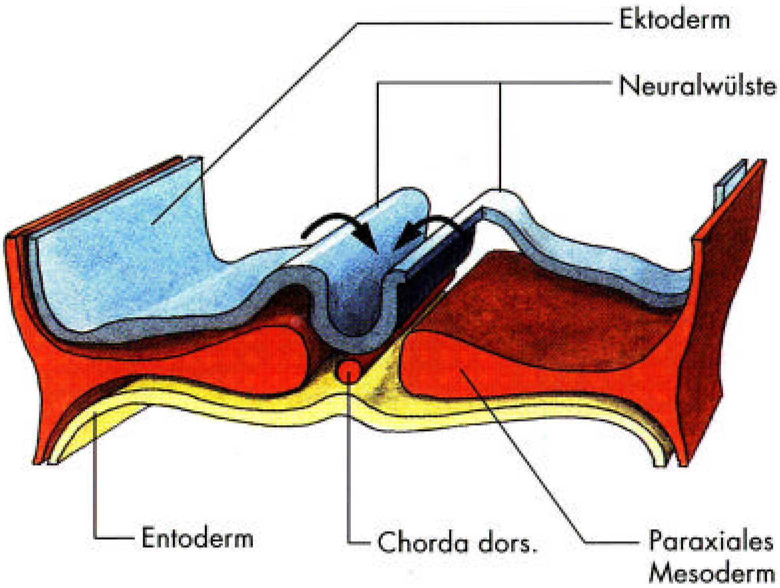

Fig. 1: chorda dorsalis between ectoderm and entoderm (according to Rohen p. 37. 2004. Schattauer. Stuttgart)

6.2 The embryonic development of the notochord

Around the 14th day of pregnancy the primitive streak develops on the germinal disk. The fast dividing cells of the streak contribute to the mesoderm. At the head end of the germinal disk the prechordal plate develops. It prevents the mesoderm cells of the primitive streak from penetrating into the head. Near to the anterior end of the primitive streak the Hensen’s node develops in the ectoderm layer. From these Hensen’s node a cell cord grows between the ectoderm and the entoderm layer towards the anterior end of the primitive streak to the prechordal plate. These cells are called chorda process and act as the body axis of the embryo.

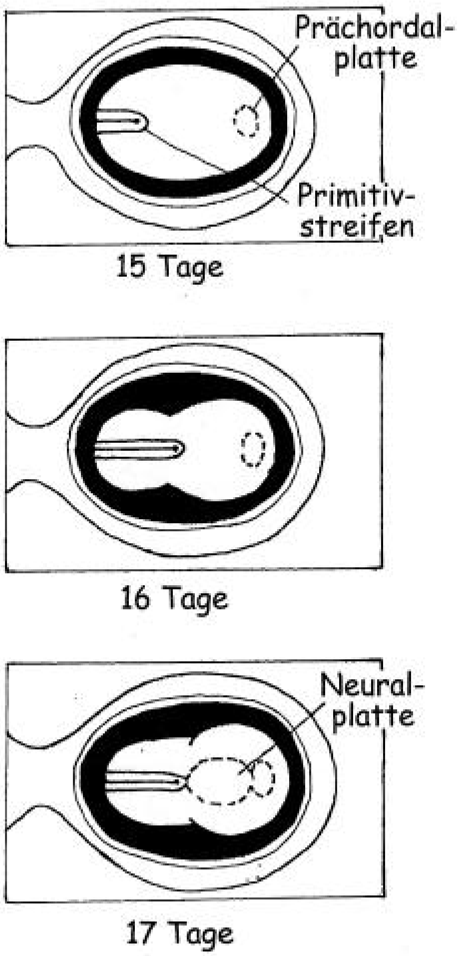

Fig. 2: Development of the primitive streak on the germinal disk (according to Upledger. p.35. 2003. Haug. Stuttgart)

Because of the further process of growth the chorda process develops into a chorda canal. At the same time at the bottom of the canal an aperture to the yolk sac develops. Via this aperture nourishment is brought to the cells until the placenta takes over this task via venes and arteries. After that the chorda canal fills up and develops into the chorda dorsalis. It lies between the ectoderm and the entoderm and is composed of mesoderm. The chorda dorsalis stimulates the development of the nervous system, the vertebral column with its muscles and the cranial base. After that it disappears (Upledger. 2003).

6.3 The meaning of the notochord or midline in osteopathy

The notochord is also called the “Primal Midline”; that means as the first (earliest) median line in the human body. The nervous system and the spinal column orient themselves on the notochord during their process of growth. Upleger speculates if a twist of the notochord can later lead to stellt auch Vermutungen an, ob eine Verdrehung der Notochord später zu Skoliosen der Wirbelsäule führen könnte (Upleger. 2003)

J. Jealous defines the midline as a bioelectric line that developed at the formation of the chorda dorsalis, a primary line of orientation for the spatial organisation in the organism (cited Jealous, in Liem. 2006). If in succession of a treatment dysfunctional tensions dissolve the orientation of the midline arranges itself spontaneously (Liem. 2006).

Moreover James Jealous describes the midline as follows:

- A bioelectric potency to which structure and function orient and re-orient after distortion or insult has been corrected
- Point of organization of Tide before it is dispersed into bodily functions
- Point of orientation for all suspended automatically shifting fulcrums
- Bioelectric potentials in C.N.S. are sustained by the midline ventricles
- The anterior midline is an extension o the posterior notochord midline
- Spatial fulcrum for osseous motion, C.S.F. and R.T.M. function
- There are multiple midlines of varying intensity. One in the notochord that extends anteriorly. One in the fluid of the ventricular system; these are the primary ones to become familiar with.
- The navel and midline are linked, especially at birth
- C7 and S2 are related via function to a series of forces anterior to midline in the viscera that function as a unit, not as separate “places”. (Jealous. 1998).

Van den Heede describes three midlines (Van den Heede. 2002), a dorsal midline (neural tube), a central midline (chorda dorsalis to the sphenoid and the ethmoidal cells) and a anterior midline. To him the nasion and the sacrum are basing points for the development of the central midline (Liem. 2006)

According to Hanneke Nusselein the notochord is the axis of self correcting mechanisms (Nusselein. 2005).

Every part of the body has its own median line around which it organises and develops itself. Jeder Teil im Körper hat eine eigene Mittellinie um die er sich organisiert und entwickelt. At the same time every structure orientates itself around a primary midline (Liem. 2006).

6.3.1 Which advantages do competitive athletes have from an improved equilibrium?

By the work with competitive athletes I learned that it is important for skiers, cross-country skiiers and snowboarders to have a good equilibrium.

The ability for equilibrium is on the one hand a precondition and on the other hand a target for sportive activities. The equilibrium is the ability to maintain an upright postion against the influences of the gravity and other impacts while standing (static equilibrium) and during movement (dynamic equilibrium) (Bös. 2001).

Bernd Kindermann: „*Leistungssportler brauchen im Bereich Schi Alpin ein gutes Gleichgewicht, um nach ungewolltem Abweichen von der Ideallinie beim Rennlauf, so schnell wie möglich wieder zur richtigen Linie und Technik zurückzufinden.*"
[Competitive skiing athletes do need a good equilibrium in order to find the right line and technique again after an unintentional department from the ideal line during a race.]

Roland Diethart: „*Im Langlauf, ist ein gutes Gleichgewicht eine wichtige Voraussetzung für das Lernen und Verändern der Technik. Durch ein gutes Gleichgewicht kann der Leistungssportler schneller die Technik verbessern. Weiters reduziert ein gutes Gleichgewicht die Verletzungsanfälligkeit beim Training.*"
[In cross-country skiing a good equilibrium is an important precondition for learning and changing the technique. By means of a good equilibrium the competitive athletes can improve their technique faster. Furthermore a good equilibrium reduces the risk of injury during the training.]

Werner Madlencnik: „*Beim Snowboard Race ist das dynamische Gleichgewicht leistungsbestimmender Faktor. Beim Snowboarden fährt man nur auf einer Kante und es gibt keine Möglichkeit die Unterstützungsfläche zu vergrößern. (im Unterschied zum Schifahren über eine Verbreiterung der Schiführung). Die Möglichkeit seine Muskelkraft einzusetzen ist immer abhängig vom optimalen dynamischen Gleichgewicht.*"
[During a snowboard race the dynamic equilibrium is an effort determining factor. Snowbording means to ride on an edge and there is no possibility to enlarge the support plain (in contrast to skiing where a broadening of the ski guidance). The possibility of using one's muscular strength always depends on an optimal dynamic equilibrium.]

7 What is craniosacral osteopathy

Osteopathy is a holistic form of treatment. During exmination and treatment osteopaths mainly use their hands.

The following three subareas are the base of the osteopathic therapy:

- the craniosacral therapy (head-sacrum)
- the visceral therapy (inner organs)
- the structural therapy

Craniosacral osteopathy

Cranium and sacrum are connected via the dura mater. Movements that emerge in the skull are conveyed via the dura mater from the skull to the sacrum. Thes flexions- / lateral rotation- / internal rotation- and extension- movements are palpable in the whole body and in every cell. Sutherland, who is the founder of the craniosacral osteopathy, mentioned no frequency. Becker describes a rhythm of 6-10 times per minute, Liem 6-14 times per minute (Liem. 1998).

This craniosacral rhythm is the starting point for diagnosis and therapy.

Craniosacral techniques in the osteopathy

The precondition for the execution of techniques is a good palpation. The hands that act as sense organs for the different modes of touching, such as pressure or vibration, should be able to think and see at the same time. This special skill is necessary to evaluate the quality of the movements. It is the aim of a technique or a treatment, respectively, to achieve equilibrium at a fluid-, neuro-, energy-, and biomechanics-level by means of the reconstitution of the flexibility in the different structures of the body. (Liem. 1998).

With the aid of the following techniques the craniosacral mobility can be improved:
Point of Balance, exaggeration, direct techniques, disengagement, compression / decompression, reverse physiological movement, molding, recoil techniques, multipe hand technique (Liem. 1998).

In this study I treated the notochord by means of a ‘point of balance’ technique. At this one goes with the lesion until it comes to a point of balance. This position lies between the normal scope of movement in one direction and the blocked flexibility in the other direction (Liem. 1998). Subsequently a stillpoint emerges. After a phase of reorganisation of the body the movement of the craniosacral rhythm starts again. (Nusselein. 2001).

7.1 The craniosacral technique on the notochord

Torsten Liem describes a midline technique from the vertex to the apex of the coccygeal bone as follows. Index finger and middle finger of the caudal hand clasp the coccygeal bone, the patient is in a supine position. Midline, the space around the midline and the potency are perceived. In the connection of the vertex and the coccygeal bone a ‘point of balance’emerges (Liem. 2006).

Hanneke Nusselein, who taught me at the Wiener Schule für Osteopathie (Vienna School of Osteopathy) starts with the visualization of the notochord from the apex of the coccygeal bone to the sphenoid body (between the anterior and the posterior part). The palpable connecting line is the primal midline, an energetic median line. It can be assessed concerning form, position and potency. By means of a ‘point of balance’ technique she achieves an alignment of the median (Nusselein. 2005).

Sills describes a very similar technique. He visualizes a connecting line between coccygeal bone and sphenoid body as well, but expands this mental picture to the ethmoid (Sills. 2004).

8 Anatomy of the foot

8.1 Osseous structures

The pedal skeleton is subdivided into the tarsus (root of foot), the metatarsus (midfoot) and the toes. The tarsus consists of the calcaneus (heel bone), the navicular bone, the cuboid bone and the cuneiform bones. The metatarsus contains five metatarsal bones and the toes are built by phalanges (Platzer. 1991).

8.2 Cartilage

The articular surfaces of the bones are covered by hyaline cartilage (Platzer. 1991).

8.3 Ligaments

Because of the large number of single bones there are many ligaments that span the joints. In the upper ankle joint, which is formed by the tibia (shinbone), the fibula and the talus (ankle bone) is on the medial side the deltoid ligament. Lateral there are the anterior talofibular ligament, the posterior talofibular ligament and the calcaneofibular ligament.

The joint partners of the lower ankle joint are the talus and the calcaneus. The medial and lateral strengthen the thin articular capsule

The talus is connected to the other tarsal bones via the talonavicular ligament, the interosseous talocalcaneal ligament, the lateral and medial talocalcaneal ligament and the posterior talocalcaneal ligament.

Dorsal of the foot there are the bifurcate ligament (consisting of the calcaneonavicular ligament and the calcaneocuboid ligament), the dorsal intercuneiform ligaments, the dorsal cuneocuboid ligament, the dorsal cuboideonavicular ligament and the dorsal calcaneocuboid ligaments.

On the plantar side of the foot there are the long plantar ligament, the plantar calcaneonavicular ligament, the plantar cuneonavicular ligament, the plantar cuboideonavicular ligament, the plantar intercuneiform ligaments, the interosseous cuneocuboid ligament and the interosseous intercuneiform ligaments.

Between the tarsus and the metatarsus there are the dorsal and plantar tarsometatarsal ligaments and the interosseous cuneometatarsal ligaments.

The ligaments between the metatarsal bones are called the dorsal and plantar interosseous metatarsal ligaments (Platzer. 1991).

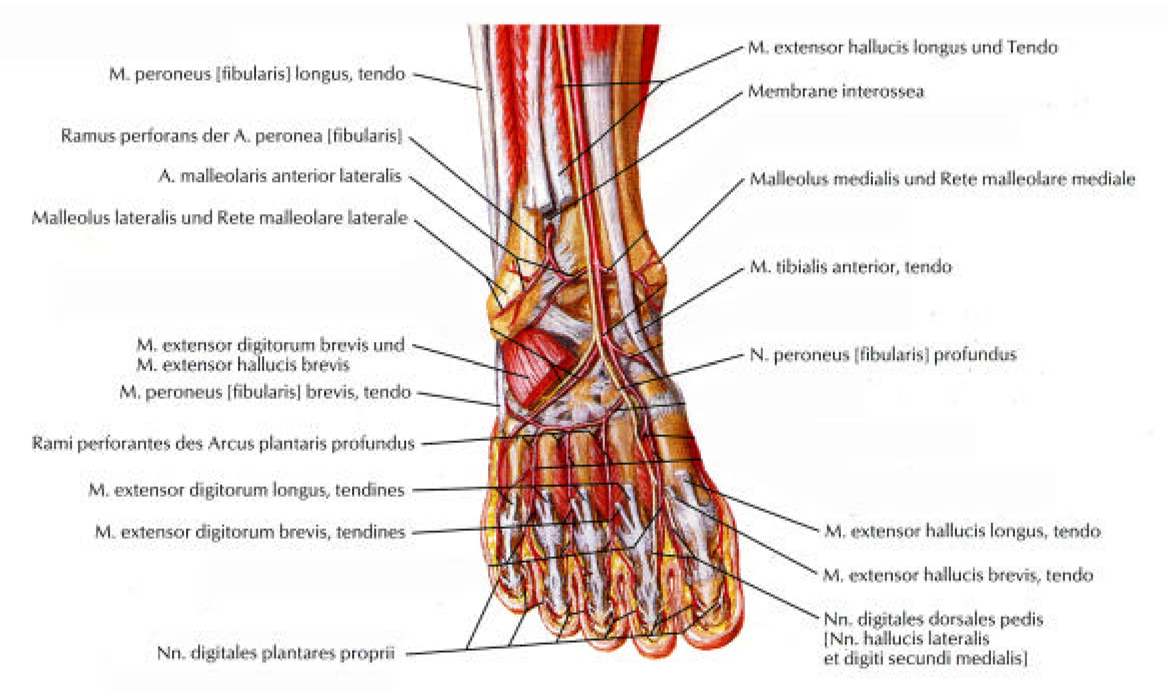

Fig. 3: Front view of the foot (according to Netter. table 485. 2000. Thieme. Stuttgart)

8.4 Muscles

All muscles of the lower leg originate at the pedal skeleton. The popliteal muscle that also originates at the lower leg counts among the muscles of the thigh. The muscles of the lower are subdivided into the anterior and the posterior main group. The tibialis anterior muscle, the extensor digitorum longus muscle and extensor hallucis longus muscle are part of the anterior muscules of the lower leg. These are also called the extensor group. Furthermore the peroneal group, consisting of the peronaeus longus muscle and the peronaeus brevis muscle is part of the musculature of the lower leg (Platzer. 1991).

The triceps surae muscle (gastrocnemius medial and lateral muscle and the soleus muscle) and the plantaris muscle, which are located on the surface, belong to the posterior muscles of the lower leg. The tibalis posterior muscle, the flexor hallucis longus muscle and the flexor digitorum longus muscles are located in the lower layers. The peroneus quadratus muscle rarely exists (Platzer. 1991).

The extensor digitorum brevis muscle, the extensor hallucis brevis muscle and the interossei dorsales muscles are part of the short pedal muscles. These lie on the dorsal side of the foot. On the plantar side there are the abductor hallucis muscles, the flexor hallucis brevis muscle, the adductor hallucis muscle, the opponens digiti minimi muscles, the flexor digiti minimi muscle, abductor digiti minimi muscle and the quadratus plantae muscle. Plantar there are furthermore the lumbrical muscles, the. interossei plantar muscles and the flexor digitorum brevis muscle (Platzer. 1991).

8.5 Nervs

The nervous supply of the foot comes from the sacral plexus. The ischiadic nerve is divided into the common fibular nerve and the tibial nerve. Above the popliteal cavity the common fibular nerve runs towards ventral to the head of fibula, the tibial nerve protracts under the gastrocnemius muscle to the medial malleolus and there divides itself into the medial plantar nerve and the lateral plantar nerve. The common fibular nerve divides itself further into the superficial fibular nerve, a predominantly sensitive nerve, and the deep fibular nerve, a predominantly motorial nerve (Kahle. 2001).

9 Biomechanics

9.1 *Specific biomechanics focused on the pilot batches*

9.1.1 Joints

Biomechanically the joints of the foot are composed of the talocrural joint between tibia, fibula and talus and the subtalar joint between talus and calcaneus. The transverse tarsal joint (Chopart's joint) embraces the talocalcaneonavicularis joints and the calcaneocuboid joints to the transverse tarsal joint. The tars metatarsal joints are also called Lisfranc's joint and connects the metatarsus with the tarsal plate. The joints between the navicular bone and the cuboid bone as well as the cuneiform bones are amphiarthrosis. (Kapandji. 1992).

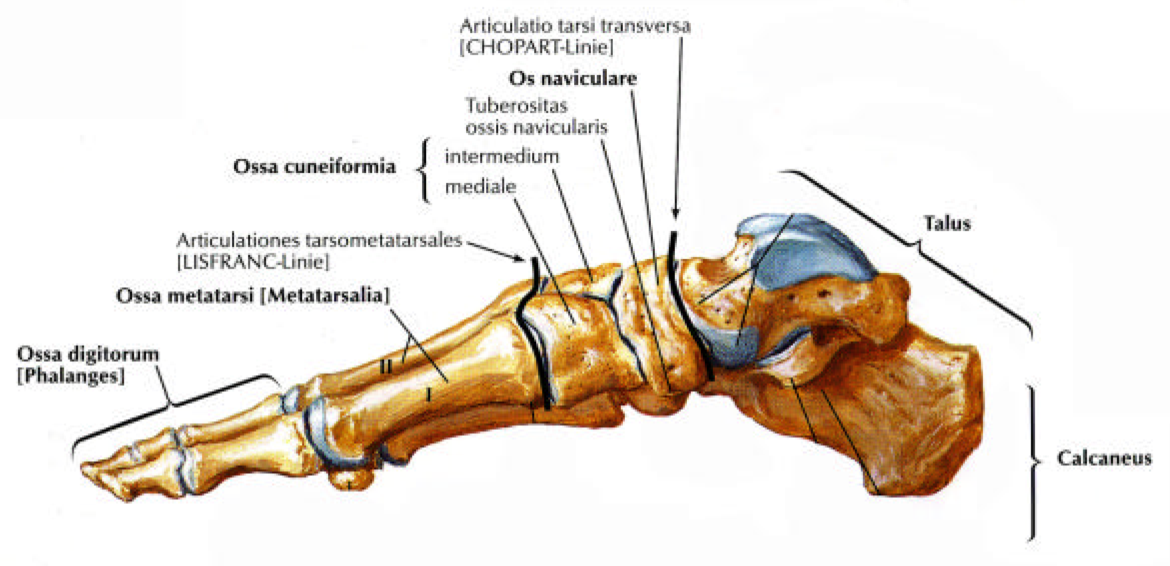

Fig. 4: Side view from inside (according to Netter. table 489. 2000. Thieme. Stuttgart)

The function of the joint is the accommodation of the foot to the inclination of the underground and to the unevenness of the ground. The arches of foot function as buffer. (Kapandji. 1992).

9.1.2 Movements

In the ankle joint the dorsiflexion and the plantar flexion take place. Furthermore the foot can move around the vertical crural axis and the horizontal longitudinal axis of the foot. Around the vertical crural axis the foot moves in a transverse plane in an abduction and an adduction. The horizontal longitudinal axis of the foot allows supination and pronation. The abduction, adduction, pronation and supination appear in their pure form only in theory. In fact they are combined movements. This means an adduction is accompanied by a supination and a slight plantar flexion, on the other side an abduction is attended by a pronation and a little dorsiflexion. (Kapandji. 1991).

While standing upright the body is in the sagittal plane always in motion. In the ankle joint the motion deflection amounts two degree in anterior and posterior direction. (Klein P. 2000)

9.1.3 Axis

The anatomical longitudinal axis of the foot goes from the rear medial heel through the metacarpophalangeal joint of the third toe. This axis forms an angle of eleven degree to the functional longitudinal axis of the foot. The functional longitudinal axis of the foot goes from the lateral calcaneal tubercle to the middle metacarpophalangeal joint of the big toe. While walking normally and standing upright this axis is adjusted to the front into the direction of the locomotion. (Klein-Vogelbach. 1993).

9.2 The strain load on the foot in a both-legged position

The sole of foot can be compared to a truss with two columns of a truss and a clamping piece which avoids at its basis the sprawling out of the construction. Particularly considered it a truss with a main and two minor clamping pieces. Three contact points make contact to the base, the head of the first metatarsal bone, the head of the fifth metatarsal bone, the medial process of calcaneal tuberosity and the lateral process of calcaneal tuberosity. (Kapandji. 1992).

According to Seitz (Seitz 1901) the load of the body disseminates on three support points: the head of the first metatarsal, the head of the fifth metatarsal and the calcaneus. When a weight of six kilogram affects the talus one kilogram accounts to anterolateral part, two kilogram account to the anteromedial part and three kilogram account to the posterior part. While standing upright the heel takes on the half of the weight that has to be carried (Kapandji. 1192).

The median of the body at the foot lies anterior the upper ankle joint. Because of the oscillation no exact point can be figured out (Sommerfeld. 2006).

9.3 Definition body balance point and „centre of gravity“

The balance point of a body is the point of origin of results of all of its parts of the weight force. Information to the balance points of the human body are always approximated values. They are subject to the individual variations which also depend on every situation (Klein. 1997).

The ‘centre of gravity’ (COG) is the projection of the body balance point (BBP) to the ground. The COG can be detected via force plates by measuring the ground reaction force. The midpoint of pressure is the ‘centre of pressure’ (COP). In literature there is no well-defined limit between COG and COP (Bös. 2001). The ’centre of gravity’ can be calculated from „centre of pressure“ (Winter. 1995).

You talk about symmetry if you measure the distribution of the body mass on both legs (Bös. 2001).

9.4 Influences on the ‘centre of gravity” in a both-legged position

Influences in the sagittal plane

Position types according to Little John (Molinari. 2002):

Little John describes a vertical line at the upright position which begins dorsal of the foramen magnum and leads through the middle of the hip joint, the knee joint and the ankle joint. At anterior position types this line goes anterior of the hip joint, the knee joint and the ankle joint, at posterior position types it goes posterior of the hip joint, the knee joint and the ankle joint (Molinari. 2002).

Influences on the frontal plane

As scoliosis mostly come along with pelvic torsion (Weiß. Rigo. 2001), this can lead to a functional difference in the length of leg (Ligner. 1997). Functional and real differences in the length of leg change the position of the pelvis in the frontal plane. Like that the COG can shift to the frontal plane (Ligner. 1998). Furthermore muscular or fascial disbalances inside the body and postural defects lead to asymmetrical strains in the leg what can lead to a change of the COGs in the frontal plane.

9.5 Definition balance

The equilibrium is the ability to maintain an upright position against the influences of gravity and other impacts while standing (static equilibrium) and during movement (dynamic equilibrium) (Bös. 2001).

Physiological condition for the sensomotorial equilibrium are a good function internal ear, the proprioreceptors of muscles and joints and the eyes (Van den Berg. 2000).

The centre of equilibrium of the internal ear lies in the labyrinth. It is connected very closely with the hearing organ (Van den Berg. 2000).

Receptors are sensorial “organs” inside the body that measure different states of stress and pressure and transmit it to the nervous system. With help of this information the nervous system can carry out the adequate “answer” of the muscle (Van den Berg. 2000).

The picture seen attains through the cornea, the lens and the vitreous body (bulbus) to the retina. Thence it is transferred to the information processing to the lateral geniculate body, the primary visual cortex, the pretectal area and the superior colliculi (Van den Berg. 2000).

Traditionally the equilibrium has been checked according to Romberg’s test (1853 described by Romberg). Thereby the test person had the task stand as still as possible with their feet put together, closed eyes and reached out arms. The evaluation was only made subjectively. Another possibility to test the equilibrium is to stand on one leg but this is subjective too and therefore it is only utile for an inexplicit screening. That is why force plates were used more often at the beginning of the eighties to get more objective measurement results (Bös 2001).

You talk about postural stability if you measure the ability of the body to stay as still as possible (Bös.2001).

9.6 The equilibrium while standing both-legged

Physiological it comes to an oscillation of about two degree in the upper ankle joint in the sagittal plane. Because of this oscillations the body is in anterior and posterior direction always in movement (Klein P. 2000).

The lateral stability depends on the track width of the position of the foot. The broader the position of the foot the bigger the supporting area and the stability (Klein-Vogelbach. 1993).

9.7 Influences on the equilibrium while standing both-legged

As the conditions for postural stability are that the eyes, the internal ear and the musculoskeletal system are well-functioning, every limitation of these sense organs has a negative influence on the equilibrium. The equilibrium also depends on the nervous transmission of information and the processing in the central nervous system (Van den Berg. 2000).

10 Methodology

10.1 Collective of the probands

The probands of this study are competitive athletes from the field of cross-country skiing, alpine skiing and snowboard race. The average age of the probands was 18.4 years ± 4.7 years. The average age of the female probands was 16.1 years ± 3.4 years. The average size was 166.4 cm ± 5.8 cm and the average weight was 60.8 kg ± 4.8 kg. The average age of the male probands was 15.5 years ± 4.9 years. The average size was 180.1 cm ± 6.5 cm, the average weight was about 73.1 kg ± 7.6 kg. The probands were divided into two groups by the principle of contingency, a research group and a comparison group.

In the research group there were twelve probands, three of them female and nine of them male. The average age of the female probands was 14.3 years ± 0.6 years, the average weight was 58.7 kg ± 5.8 kg, the average size was 165.3 cm ± 8.5 com. The average age of the male probands in the research group was 20.7 years ± 6.4 years, the average weight was 74.3 kg ± 8.2 kg and the average size amounted 179.6 cm ± 7 cm.

The comparison group consists of five female and seven male probands. The average age of the female probands was 17.2 years ± 4.1 years. The average weight was 62.1 kg ± 4.2 kg and the average size was 167 cm ± 4.6 cm. The average age of the male probands was 17.8 years ± 1.9 years, the average weight was 71.4 kg ± 7.1 kg and the average size was 180.7 cm ± 6.1 cm.

The following criterions for expulsion have been controlled:

- Alcohol within the last 48 hours
- Nicotine and coffee within the last 24 hours
- drugs
- medicaments that influence the vestibular system
- recent injuries, psychic diseases
- orthopaedical, neurological and vestibular diseases
- diseases like flu, strong fatigue
- intensive training within the last twelve hours
- visual diseases (exception eye correction)

10.2 Study implementation

Comparison group

Twelve probands from the comparison group were put on the SP sport force plate (Pernitsch, Österreich) so that the medial joint cavity of the Chopart joint was placed on the horizontal (x) axis. The feet were arranged in a distance of 26 centimetre (on the x-axis) and an angle of eleven degrees. Afterwards the probands were blindfolded and they received the task to look straight ahead, to dangle the arms and to stand upright and as still as possible. The symmetry and the postural stability have been measured over a period of 20 seconds. After a break of 30 seconds they measured a second and a third time. It was indicated at a research of Hagemann et al. (1995) or Collins & DeLuca (1993) that the averaging of data of several measurements leads to a better reproducibility (Bös. 2001). Furthermore Mittermaier C., et al. (2003) carried out in their research three measurements for 20 seconds of 105 probands, as well as Guadagnoli and Mark who carried out three measurements for 15 second. Stock and David (1999) had a duration of measurement of 30 seconds. To avoid error in measurement caused by symptoms of fatigue we used 20 seconds in this study.

Therefore the probands of the comparison group laid themselves on a treatment couch. One person who was not an osteopath held her hands to the head of the proband for eight minutes. The probands did not know that she was no osteopath and that they did not receive a treatment. Following the probands of the comparison group posed themselves in the same position as before on the SP sport force plates. The symmetry and the postural stability have been measured again for three times over a period of time of 20 seconds.

Research group

Also twelve probands from the research group were put on the SP sport force plates (Pernitsch, Österreich), so that the medial joint cavity of the Chopart joint was placed on the horizontal (x) axis. The feet were arranged in a distance of 26 centimetre (on the x-axis) and an angle of eleven degrees. Afterwards the probands were blindfolded and they received the task to look straight ahead, to dangle the arms and to stand upright and as still as possible. The symmetry and the postural stability have been measured over a period of 20 seconds. After a break of 30 seconds they measured a second and a third time.

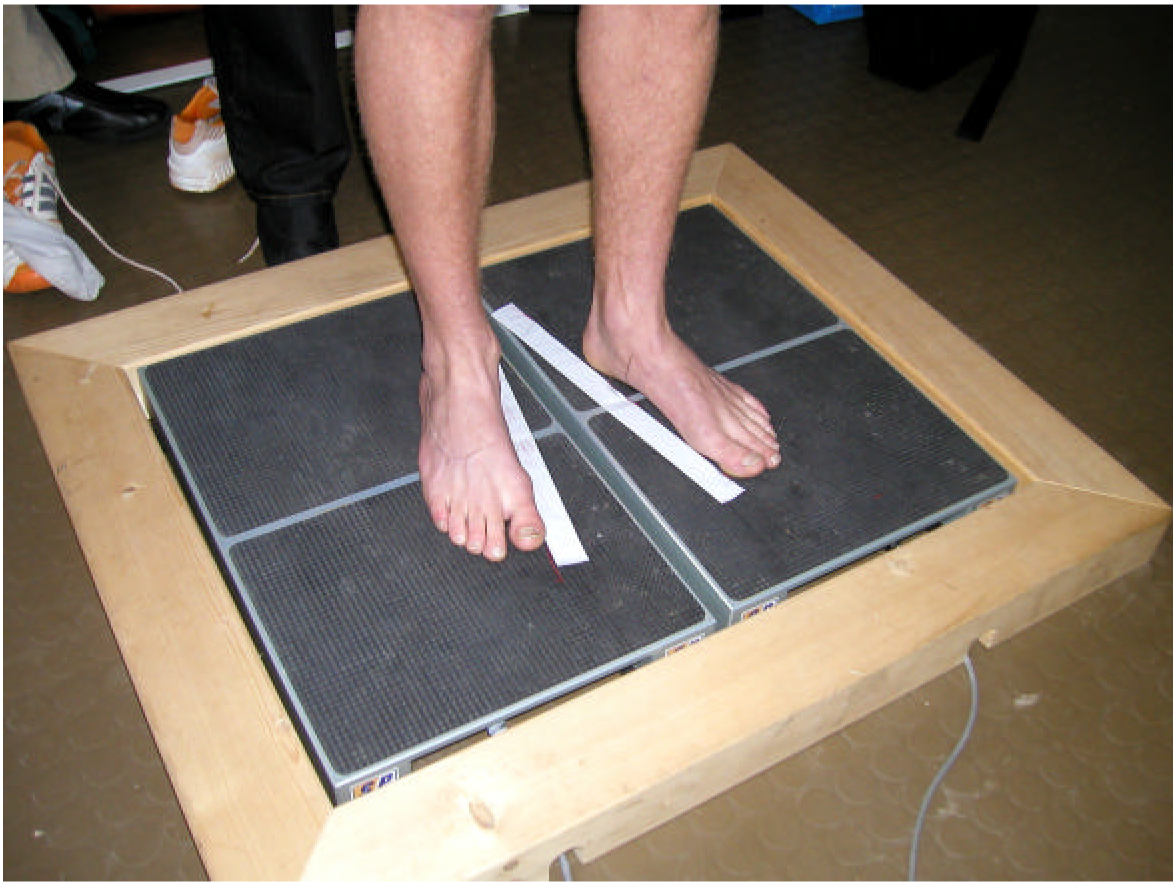

Fig. 5: SP Sport force plate with proband

Afterwards the probands laid themselves on a treatment couch where the craniosacral technique was carried out by a hand position on the head on the notochord (according to Nusselein. 2005). The realisation of this technique has been elaborated together with Hanneke Nusselein as there was no corresponding literature available at the date of execution.

Following the probands of the comparison group posed themselves in the same position as before on the SP sport force plates. The symmetry and the postural stability have been measured again for three times over a period of time of 20 seconds.

10.3 Measuring data

The standard deviation has been measured as value for the distance of the ‘centre of pressure” from the cross-over point of the x- and y-axis whereby the symmetry can be judged.

Furthermore the deviation has been measured as a value for the postural stability (balance).

The standard deviation as well as the deviation have been measured over a period of 20 seconds. At the same time every third of those 20 seconds has been calculated at the measurements of the standard deviation and the deviation.

11 Result

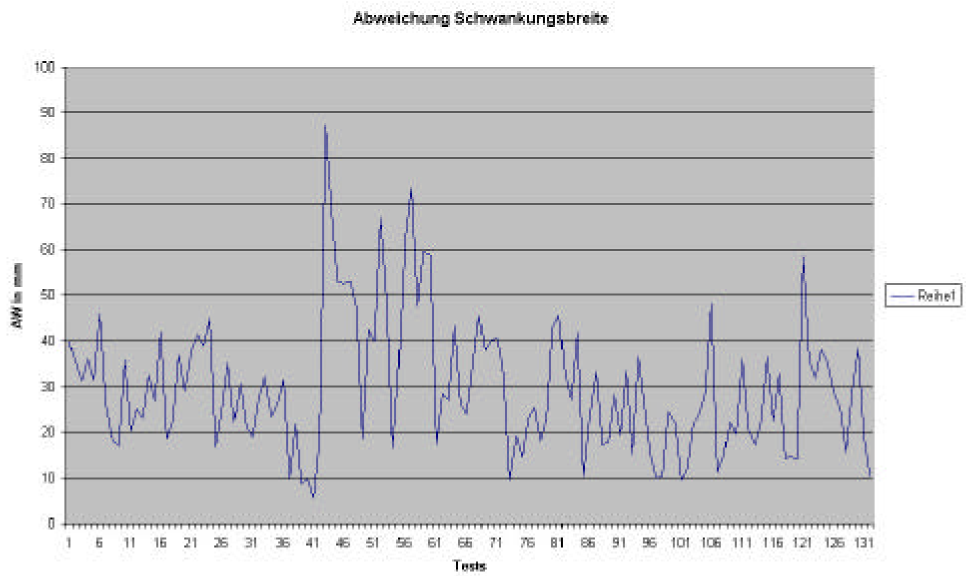

Table 1: Margin of deviation of all measured de viations over a period of 20 seconds

The average value at the deviation over a period of 20 seconds amounts 29.9 mm ± 14.63 mm.

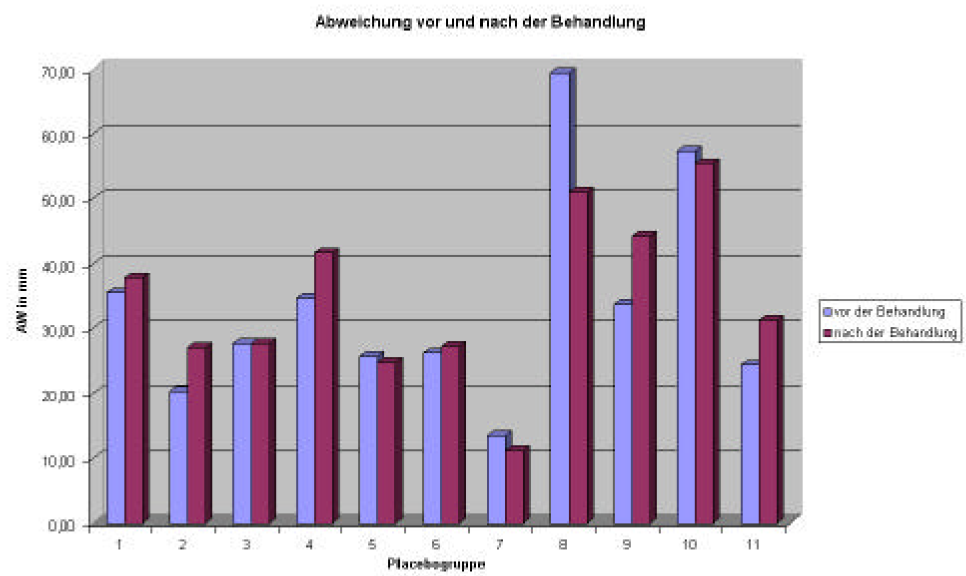

Table 2: Deviation of the placebo group before and after the pseudo treatment measured over a period of 20 seconds

The average value at deviation before the treatment was 33.44 mm ± 16.35 mm and after the treatment 34.45 mm ± 12.94 mm.

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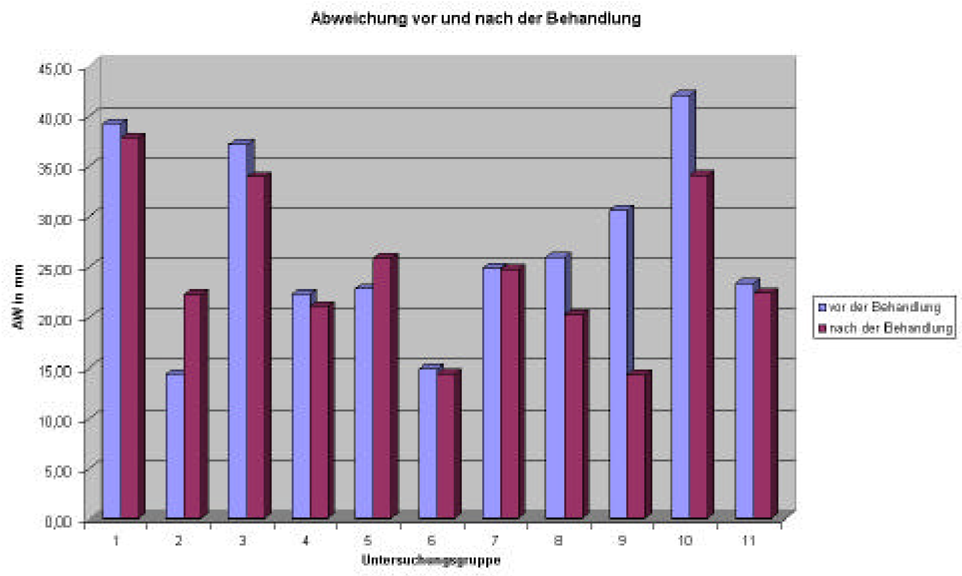

Table 3: Deviations of the research group before and after the treatment measured over a period of 20 seconds

The average value at deviation before the treatment was 27.05 mm ± 9.26 mm and after the treatment 24.65 mm ± 7.77 mm.

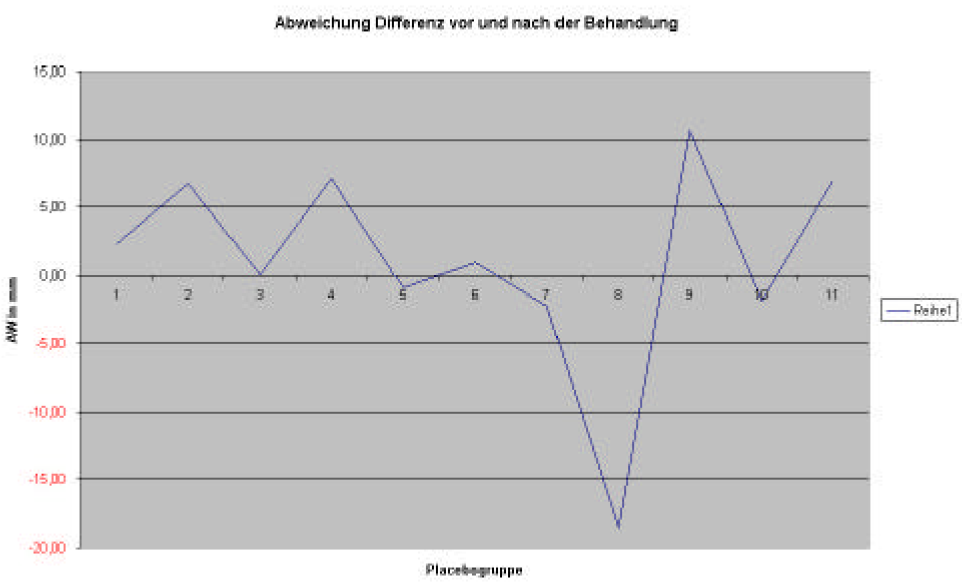

Table 4: Difference of the deviation of the placebo group measured over a period of 20 seconds before and after the pseudo treatment

The average value of the difference of the deviation at the placebo group was 1.01 mm ± 7.76 mm.

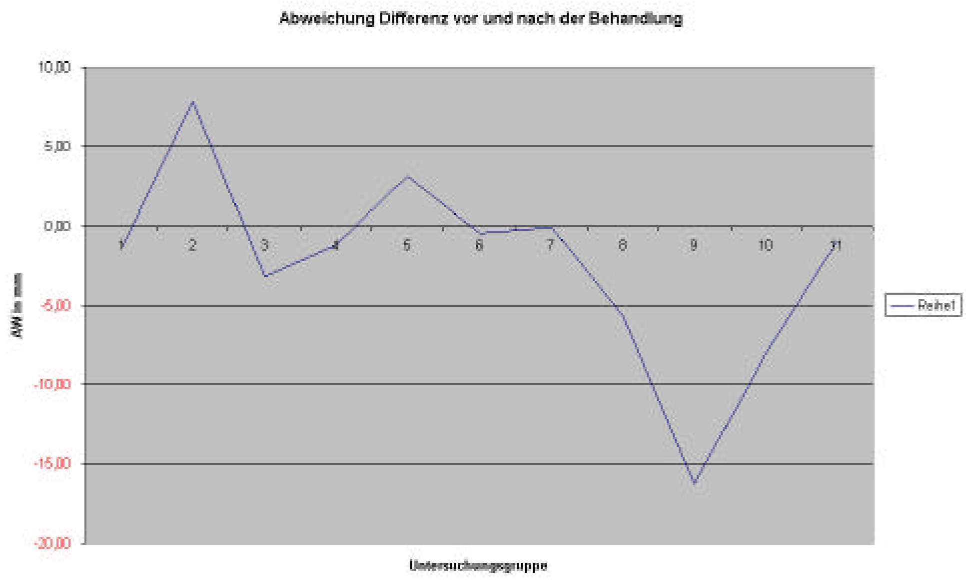

Table 5: Difference of the deviation of the research group measured over a period of 20 seconds before and after the treatment

The average value of the differenz of the deviation was 2.4 mm ± 6.19 mm

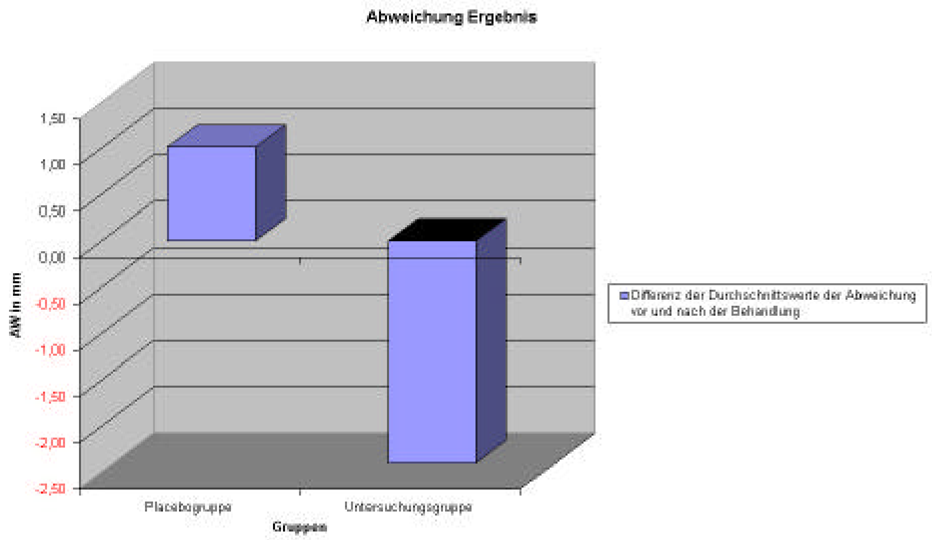

Table 6: Result of the deviation of the placebo group compared to the research group measured over a period of 20 seconds

The average value of the results of the pacebo group and the research group was –0.69 mm ± 2.41 mm.

The statistics has been carried out with eleven probands in the placebo group and eleven probands in the research group as one measurement in the placebo group and in the research group was not valid due to error in measurement.

The deviation is the value for the measurement of the postural stability (balance). The balance is gauged from the beginning of the measurement. Out of three measurements before and after the treatment an average value is amounted. The difference has been calculated out of the value before and after the treatment. Out of these differences in the placebo group and in the research group an average value has been calculated again and this one represents the result of the study. At the placebo group the value of the deviation measured over a period of 20 seconds was 1.01 mm, at the research group –2.40 mm. This makes a difference between placebo group and research group of –3.41 mm. This means an improvement of the research group opposite to the placebo group of 3.41 mm.

To find out if there are strong fluctuations of the deviation from the beginning to the end of this 20 second measurement, a third of these 20 seconds has been gauged separately. The results have been calculated in the same way as already described and mentioned above and for every third of the 20 seconds. The deviation of the first third at the placebo group amounted 0.60 mm and at the research group –2.29 mm which makes a difference of –2.88 mm.

The deviation of the second third at the placebo group amounted 1.19 mm and at the research group –2.89 mm. The difference between the placebo and the research group in the second third is –4.08 mm.

In the third third of measuring the deviation the value of the placebo group was 1.01 mm, the value of the research group was –2.01 mm. This makes a difference of –3.02 mm.

While the postural stability of the placebo group got worse after the pseudo treatment, the postural stability improved after the treatment, during the whole 20 seconds as well as in every third.

In the middle third the value of the improvement of the postural stability reached its peak. The tables of the measurements about the thirds are attached in the appendix.

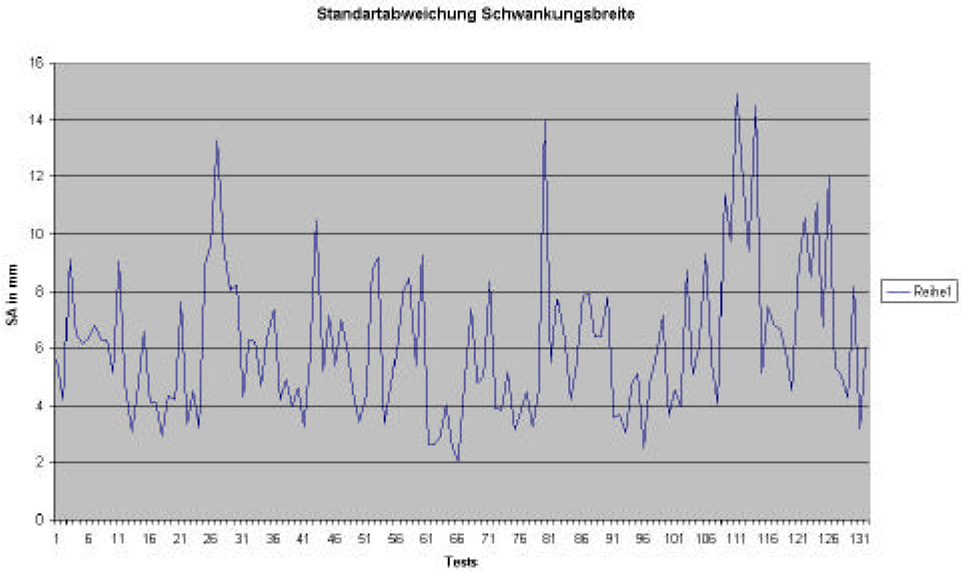

Table 7: Margin of deviation of all measured standard deviations over a period of 20 seconds

The average value of the standard deviation over 20 seconds amounted 6.16 mm ± 2.62 mm.

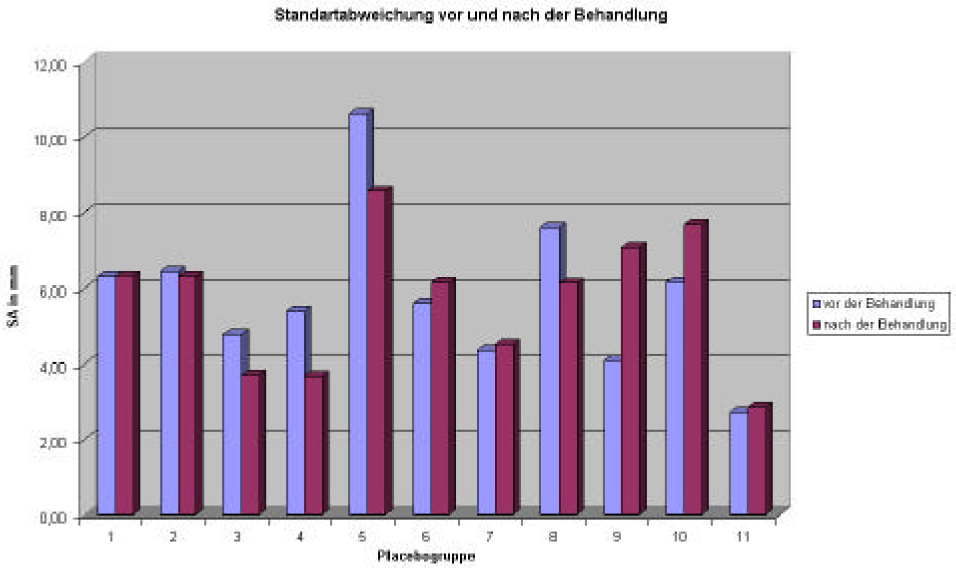

Table 8: Standard deviation of the placebo group before and after the treatment before and after the pseudo treatment measured over a period of 20 seconds

The average value of the standard deviation before the treatment was 5.83 mm ± 2.08 mm and after the treatment 5.73 mm ± 1.80 mm.

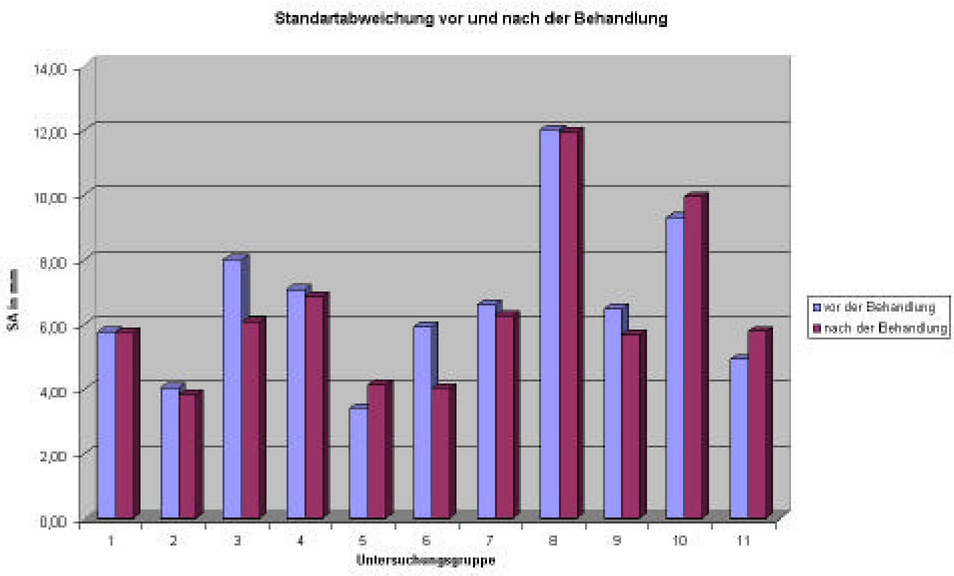

Table 9: Standard deviation of the research group before and after the treatment measured over a period of 20 seconds

The average value of the standard deviation before the treatment was 6.69 mm ± 2.44 mm and after the treatment 6.39 mm ± 2.49 mm.

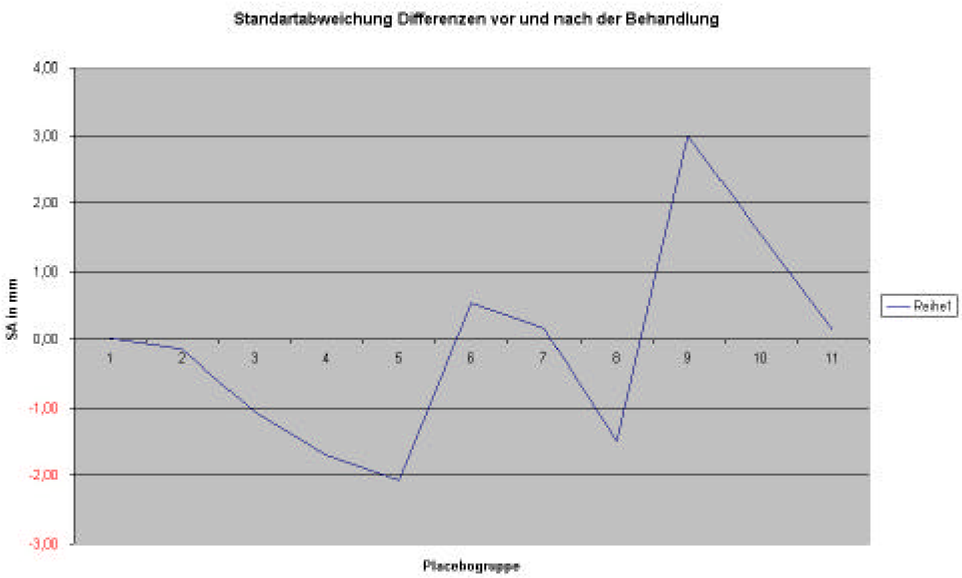

Table 10: Difference of the standard deviation of the placebo group measured over a period of 20 seconds before and after the pseudo treatment

The average value of the differences of the standard deviation of the placebo group was 0.10 mm ± 1.49 mm.

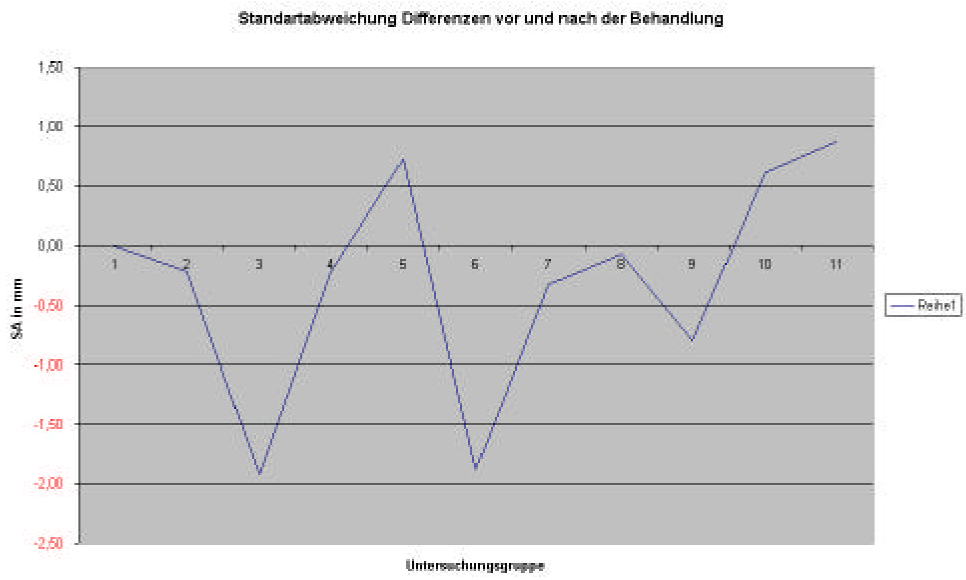

Table 11: Difference of the standard deviation of the research group measured over a period of 20 seconds before and after the pseudo treatment

The average value of the differences of the standard deviation of the research group was 2.29 mm ± 0.93 mm.

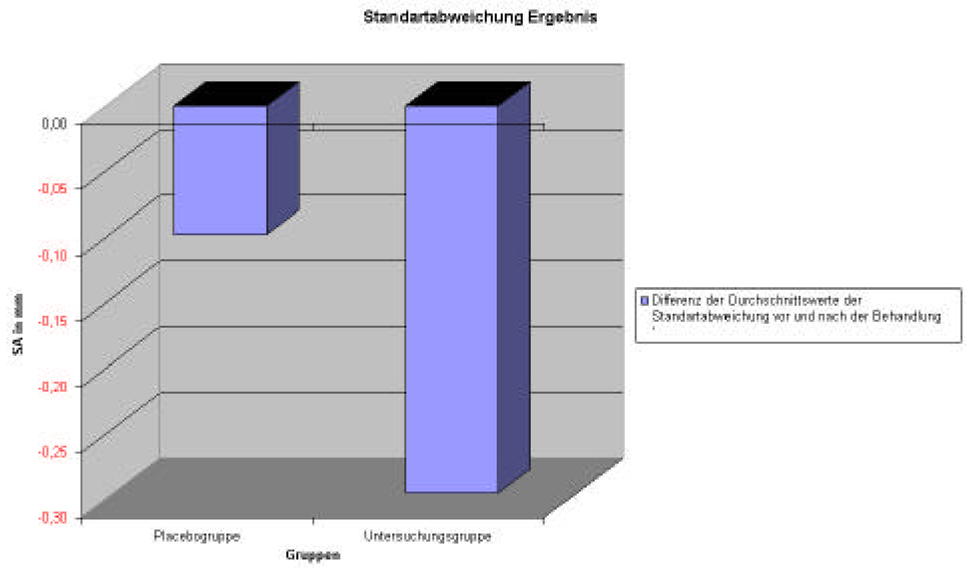

Table 12: Result of the standard deviation of the placebo group compared to the research group measured over a period of 20 seconds

The average value of the results of the placebo group and the research group was –0.20 mm ± 0.14 mm.

The standard deviation is the value for the measurement of symmetry, gauged from the cross-over point of the x-axis and the y-axis of the force plate. It shows how far the ‘centre of pressure’ is away from the middle of the crossing. For the person who stands on the force plate the x-axis lies in the frontal plane and the y-axis lies in the sagittal plane. Like at the measurements of the deviation, at the standard deviation an average value has been calculated out of three measurements before and after the treatment. Out of those average values before and after treatment a difference has been figured out. An average value has been calculated out of the differences of the placebo group and of the research group that presents the result of the study. At the placebo group the value of the standard deviation was –0.10 mm measured over a period of 20 seconds, at the research group it was –0.30 mm. That makes a difference of –0.20 mm between those two groups. That means an improvement of the research group of 2.20 mm compared to the placebo group.

Furthermore the results of every third of the 20 seconds has been appraised. The results have been calculated in the same way as already mentioned and for every third of those 20 seconds. The standard deviation of the first third of the placebo group amounted 0.35 mm and the one of the research group was –0.82 mm, which makes a difference of –1.17 mm.

The standard deviation of the second third of the placebo group was –0.13 mm and of the research group it was –0.78 mm. The difference between those two groups is –0.65 in the second third.

In the third third of the measurement of standard deviation the value of the placebo group was 0.20 mm, the value of the research group was 0.48mm. The difference amounts 0.68 mm.

The symmetry of the research group has improved within those 20 seconds about –0.20 mm compared to the placebo group. If you compare the thirds among themselves you can state that the improvement of symmetry reaches its peak in the first third, decreases in the second one and even deteriorate in the third third compared to the placebo group.

The tables of the thirds over the period of 20 seconds are attached in the appendix.
To calculate the significance a t-test for impartial samples has been generated. The quantile of the maximum allowable appreciated probability of error is set a priori and is often

denominated as α (greek: alpha), or example α=0.05 for five per cent maximum allowable probability of error. The smaller this is the higher is the quality of information. The statistical significance describes the amount of information of an event or a measurement (Wikipedia).

For a better statically consideration the variables are renamed:

AV before = the average value of all deviations (that means RG and CG) at the point of time t1 (before the intervention)
SD before = the average value of all standard deviations (that means RG and CG) at the point of time t1 (before the intervention)
AV after = the average value of all measurements of deviations (that means RG and CG) at the point of time t2 (after the intervention)
SD after = the average of all standard deviations measurements (that means RG and CG) at the point of time t2 (after the intervention)

		AV before	SD before	AV after	SD after
N		22	22	22	22
Parameter of the normal distribution	**Average value**	30,2455	6,2577	29,5523	6,0614
	Standard deviation	13,37298	2,25243	11,55766	2,1482
Kolmogorov-Smirnov-Z		0,797	0,783	0,735	0,841
Asymptotoc significance (two-sided)		0,549	0,572	0,653	0,479

Table 13: Adaption test on normal distribution based on Kolmogorov-Smirnov

The test of goodness of fit on the normal distribution of the values according to Kolmogorov-Smirnov showed that none of this values lies below 0.05. The convincing values are the two-sided asymptotic values of significance. That is why you can state that neither of these characteristics differ significant from a normal distribution.

	1,2	N	Average value	Standard deviation	Standard error of the average value
AV before	Research group	11	27,0518	9,25757	2,79126
	Placebo group	11	33,4391	16,35285	4,93057
AV after	Research group	11	24,6545	7,76801	2,34214
	Placebo group	11	34,45	12,9384	3,90107
SD before	Research group	11	6,6855	2,43671	0,7347
	Placebo group	11	5,83	2,07705	0,62625
SD after	Research group	11	6,3909	2,4889	0,75043
	Placebo group	11	5,7318	1,80486	0,54419

Table 14: Group statistic

		T-Test for the equality of the average value						
		T	df	Sig. (two-sided)	Middle difference	Standard error of the difference	95% confidence interval of the difference	
							lower	Upper
AV before	Variances are homogeneous	-1,127	20	0,273	-6,38727	5,66583	-18,20599	5,43145
AV after	Variances are homogeneous	-2,153	20	0,044*	-9,79545	4,55017	-19,28694	-0,30397
SD before	Variances are homogeneous	0,886	20	0,386	0,85545	0,96539	-1,15831	2,86922
SD after	Variances are homogeneous	0,711	20	0,485	0,65909	0,92698	-1,27455	2,59273

* sig. auf dem 5% Niveau

Table 15: t-test for independent samples on crude data

The essential values are hereby the two-sided significances of the t-values. We can observe very well at the average value that the research group and the placebo group do not differ significantly from each other before the intervention (0.273 ≥ 0.05) but after the intervention they do (0.044 ≥ 0.05). At the characteristics of the standard deviation this improvement is not obvious: (0.386 = 0.05) as well as (0.485 = 0.05).

For examination you do the same with the difference values. First the test on normal distribution of the difference according to Kolmogorov-Smirnov.

The asymptotic significance values lie again above the critical value of 0.05, that means the differences are normally distributed.

Kolmogorov-Smirnov-adaption test

		Diff Placebo group	Diff research group
N		11	11
Parameter of the normal distribution (a,b)	Average value	-1,0109	2,3973
	Standard deviation	7,7585	6,19334
Most extreme differences	Absolute	0,246	0,199
	Positive	0,246	0,199
	Negative	-0,127	-0,174
Kolmogorov-Smirnov-Z		0,815	0,66
Asymptotic significance (two-sided)		0,52	0,776

Table 16: Adaption test on normal distribution based on Kolmogorov-Smirnov-

	Group (1=RG;2=CG)	N	Average value	Standard deviation	Standard error of the average value
Differences	1	11	-26,0518	9,25757	2,79126
	2	11	-1,0109	7,7585	2,33928

Table 17: Group statistic

Test for independent samples

		T-test for the equality of the average value						
		T	df	Sig. (two-sided)	Middle difference	Standard error of the difference	95%confidence interval of the difference	
							lower	upper
Differences	Variances are homogeneous	-6,876	20	0**	-25,04091	3,64189	-32,63776	-17,44406

** sig. auf dem 1% Niveau

Table 18: t-test for independent samples on the differences

The essential value is the two-sided significance of the t-value of 0.00 which means that the difference values of the research group (RG) and the placebo group (CG) is significant.

12 Discussion

If you compare the results of the placebo group with the results of the research group you can state that the symmetry (distance of the crossover of the x-axis and the y-axis) as well as the postural stability (equilibrium) has improved at the research group. The hypothesis of my master thesis that the craniosacral technique on the notochord can improve the parameters mentioned above has proved true.

The improvement of the postural stability has proved at the t-test for independent samples to be significant, the symmetry as not significant. The small number of probands might be responsible for this fact. At a lager group you could question also the measurement values that diverge from the norm and take them out of the statistics. For example at the measurement of the deviation over a period of 20 seconds proband number eight of the placebo group or proband number nine of the research group. These measurement values show that the proband was very unsettled for a short time. To reach a better significance you could take out the data that diverges from the norm and recalculate the result. As there were only eleven probands the number of test persons would reduced again and so the study had less significance. The result of the same study with a larger number of probands would be very interesting.

As already mentioned in the introduction there is no study about the notochord (midline). In autumn 2006 the book of Liem was published which contains a chapter about the 'importance of the midline in osteopathy'. I used this topical piece of literature amongst others for my master thesis.

For the period of the measurements there are different instructions in the citations. The measurement period ranges from 15 seconds (Guadagnoli, Mark. 2004) to 20 seconds (Culham, Elsie. 2000) up to 30 seconds (Stock und David.1999). Le Clair und Riach (1996) showed that the optimum test-retest-reliability for measurements of the postural structures via force plates lie between 20 and 30 seconds (Eklund, Robert. 2003). To avoid error in measurement because of the fatigue of the proband I decided to use a test period of 20 seconds. What is more, already Mittermaier C. et al. (2003) carried out the study by using measurements over the time of 20 seconds.

The measurements have been carried out three times and an average value has been calculated from it. According to Hagemann et al. (2003) or Collins and DeLuca (1993) it showed that by averaging the data you get a better reproducibility (Bös. 2001).

The measurements have been carried out blindfolded. At other studies the measurements have been carried out with opened or closed eyes (Culham, Elsie. 2000, Stock, David. 1999). As the eyes are apart of the equilibrium organ it is expectable that the measurement values are very low while standing both-legged and with open eyes and the analysis is not very significant. Furthermore it is not possible to determine the same point to look at while standing upright for a person who is 160 cm tall as for someone who is 189 cm tall. That is why I decided to blindfold the probands in my study. This also excludes opening the eyes only for a short time during the test.

To achieve the same condition for position of the feet the Chopart's joint has been stetted with a line and has been set on the x-axis on the plate. For the distance between the legs and the external rotation of eleven degree an adhesive tape was affixed at the plate and it was not varied during all measurements.

As my hypothesis proved true it would be interesting to carry out another study with a larger number of probands. Furthermore you could consider which further impacts "only" one treatment on the notochord or the midline have except the improvement of the postural stability and the symmetry.

Since the improvement of the equilibrium would be significant you could consider which positive influence this might have on the competitive sports and on persons with disturbances of equilibrium.

13 Summary

For an osteopath the effect of craniosacral techniques is very understandable and clear. If, however, one talks to persons who know only a little bit about osteopathy, it i soften hard for them to imagine how one can feel out and treat different structures via sensibility. This study shall show that there a possibilities to measure the effect of one single craniosacral technique by means of a technical instrument.

In this study I measured, with the aid of a force plate, how the craniosacral work on the notochord affects the right-left strain and the forefoot-heel strain in an upright position. The notochord is the first (earliest) median line at the embryonic development of a human being. After it initiated the growth of the nervous system and of the spinal column it disappears. Rests of this notochord are to be found in the gelatinous nucleus (= nucleus of the intervetebral disk) and in the apical dental ligament. In osteopathy the techinque on the notochord is also called midline or primal midline. Jealous describes it also as a bioelectric line that developed at the formation of the chorda dorsalis, a primary line of orientation for the spatial organisation in the organism (Liem.2006).

The standard deviation, as the value for symmetry and the deviation, as the value for the postural stability (equilibrium) were evaluated.

A proband group of 24 competitive skiing, cross-country skiing and snowboarding athletes were divided according to the principle of contingency into a placebo group and a research group. I decided to choose competitive athletes because their ability of equilibrium is on the one hand precondition and on the other hand target for their sportive activities (Bös. 2001). With bandaged eyes the test persons were placed in an upright position three times for 20 seconds on the SP Sport force plate and measurements were conducted before the treatment / pseudo treatment. Subsequently another three measurements were made after the treatment / pseudo treatment. At the measurements before and after the treatment / pseudo treatment an average value was generated and the results before and after the treatment were compared.

Unlike in the placebo group, in the research group the average value of these differences showed an improvement at the measurement of symmetry as well as at the measurement of

the equilibrium. Furthermore the improvement of the equilibrium at the t-test is significant for independent samples.

Thank you

Roland Diethart (Langlauftrainer NAZ Eisenerz)

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17 Appendix

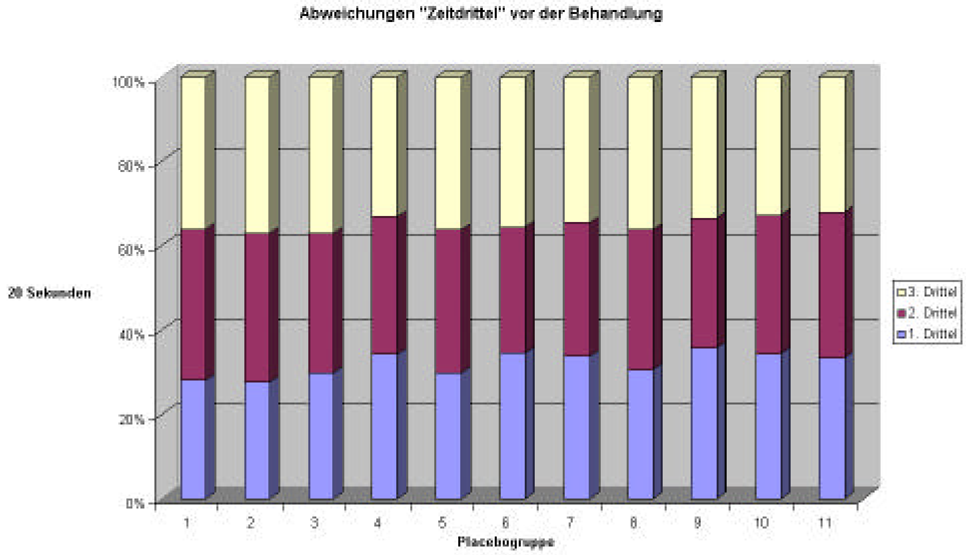

Table 19: Deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the placebo group before the pseudo treatment

The average value of the 'time-thirds' in the placebo group amounted 33,51 mm ± 16,02 before the pseudo treatment.

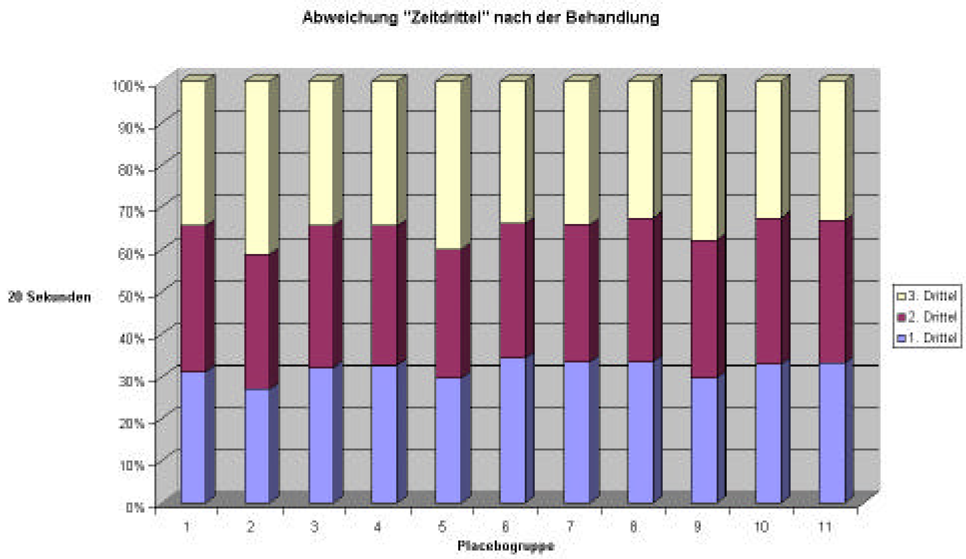

Table 20: Deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the placebo group after the pseudo treatment

The average value of the 'time-thirds' in the placebo group amounted 34,44 mm ± 17,75 after the pseudo treatment.

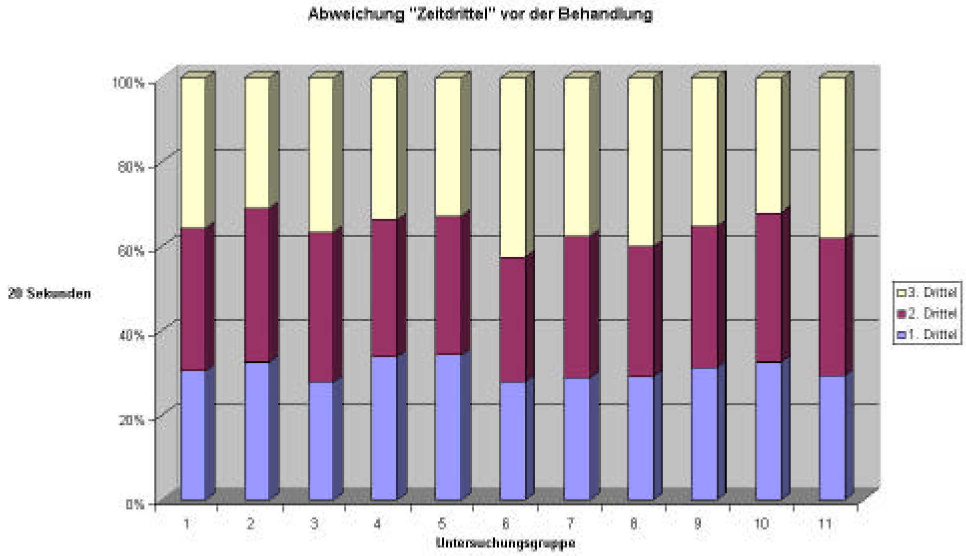

Table 21: Deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the research group before the treatment

The average value of the third of the examination interval among the examination group prior to the treatment was 20,04 mm ± 9,28

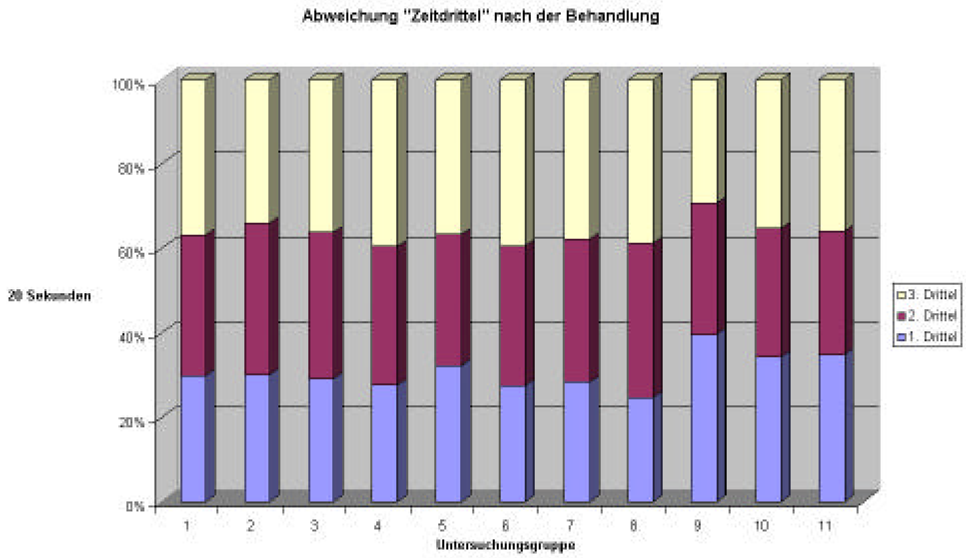

Table 22: Deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seonds of the research group after the treatment

The average value of the third of the examination interval among the examination group after the treatment was 24,65 mm ± 7,95

Significance 1. third: 0,69, 2. third: 0,40, 3. third: 0,79

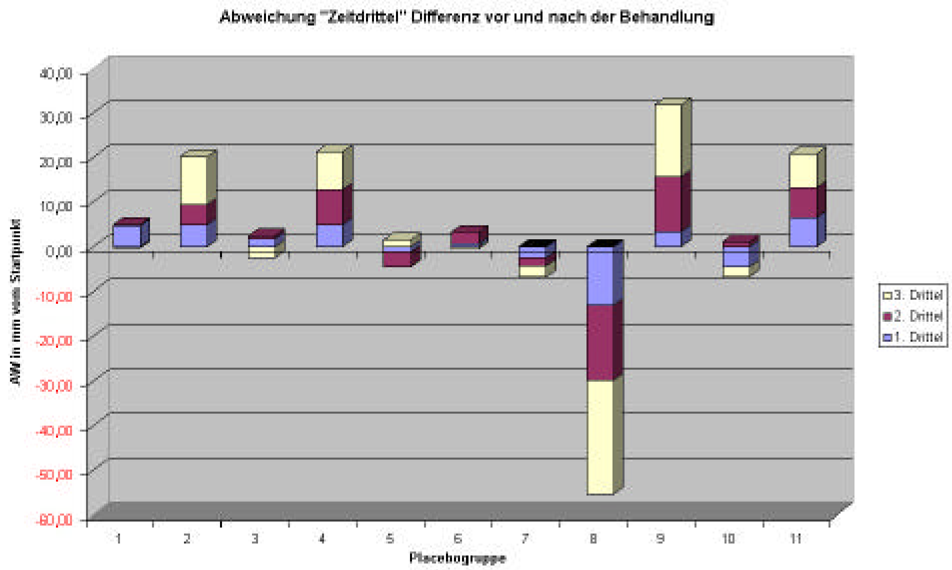

Table 23: Difference of the deviation before and after the pseudo treatment of the placebo group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the third of the examination interval of the differences of the allowances among the placebo-group was 0,93 mm ± 8,01 mm

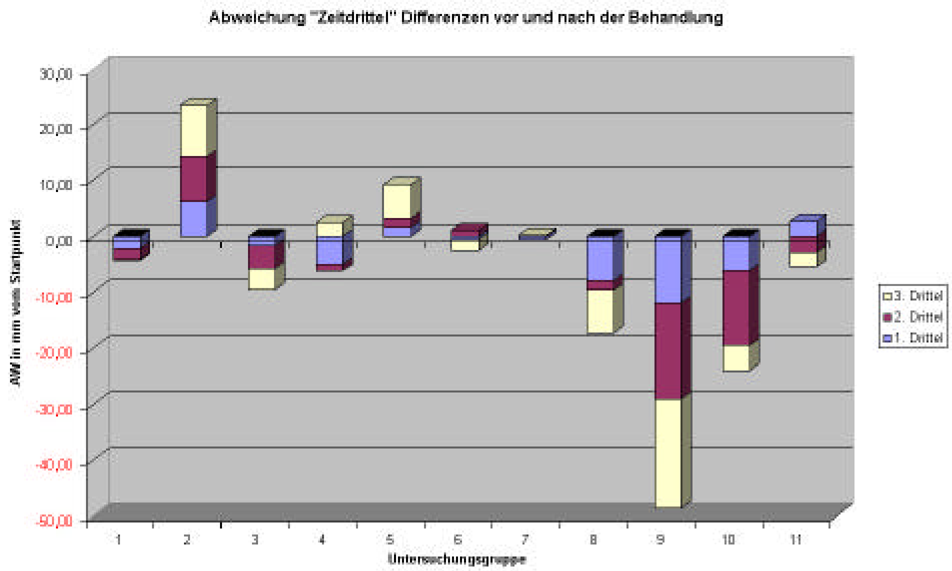

Table 24: Difference of the deviation before and after the treatment of the research group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the third of the examination interval of the differences of the allowances among the examination group was -2,4 mm ± 6,44 mm

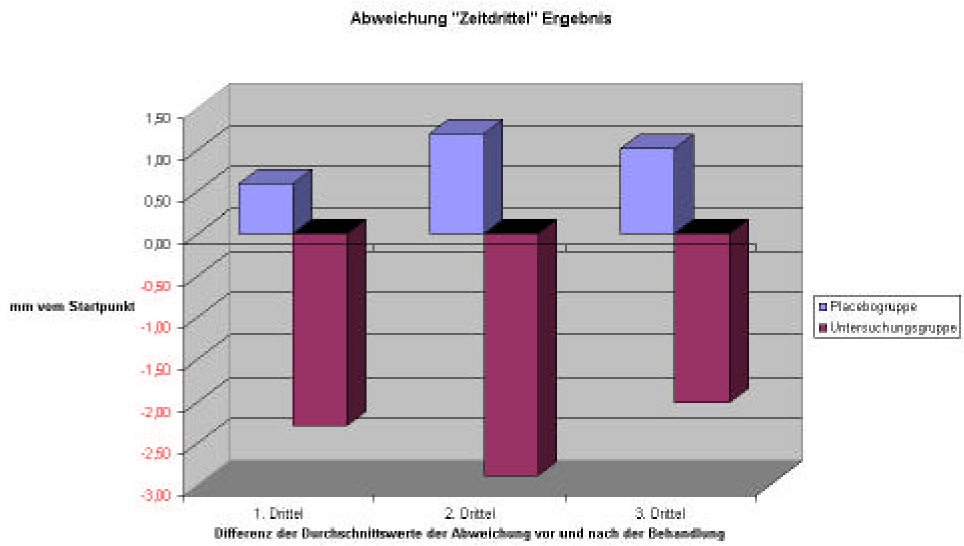

Table 25: Result of the deviation of the placebo group in comparison to the research group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the results of the third of the examination interval among the placebo- and examination group was -0,73 mm ± 1,85 mm

Significance: 1. third: 0,75, 2. third: 0,85, 3. third: 0,27

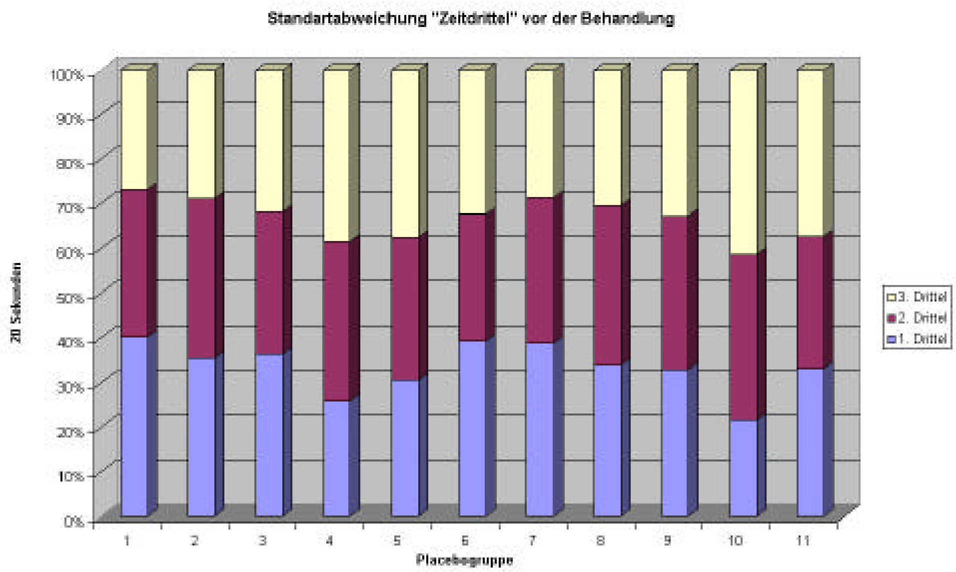

Table 26: Standard deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the placebo group before the pseudo treatment

The average value of the third of the examination interval among the placebo group prior to the treatment was 4,56 mm ± 1,63 mm

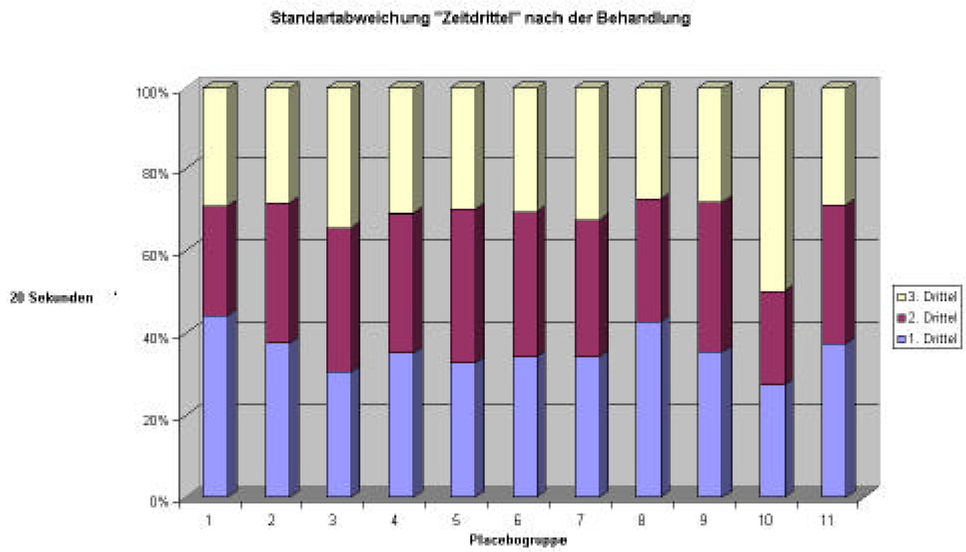

Table 27: Standard deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the placebo group after the pseudo treatment

The average value of the third of the examination interval among the placebo-group after the treatment was 4,57 mm ± 1,68 mm

Significance: 1. third: 0,77, 2. third: 0,94, 3. third: 0,99

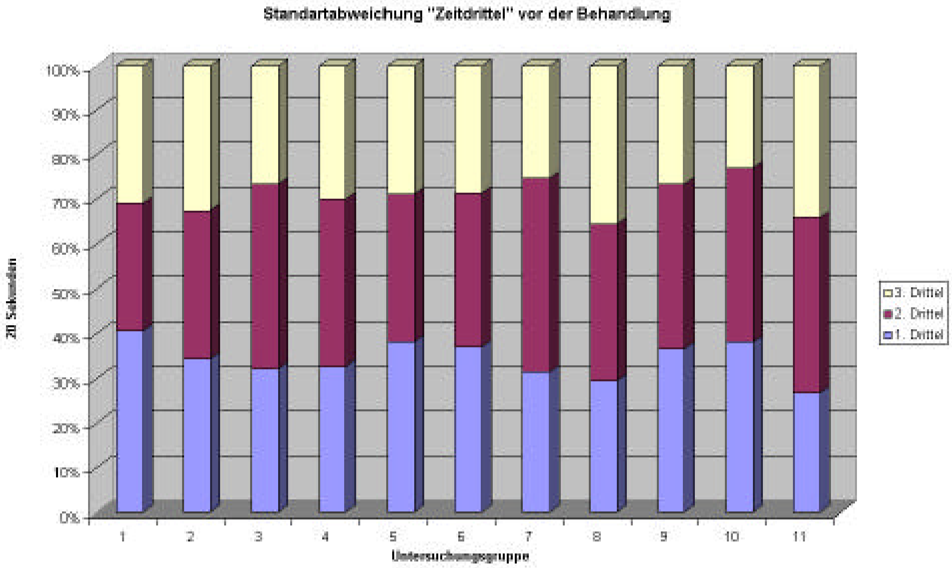

Table 28: Standard deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the research group before the treatment

The average value of the third of the examination interval among the examination group prior to the treatment was 5,46 mm ± 2,32 mm

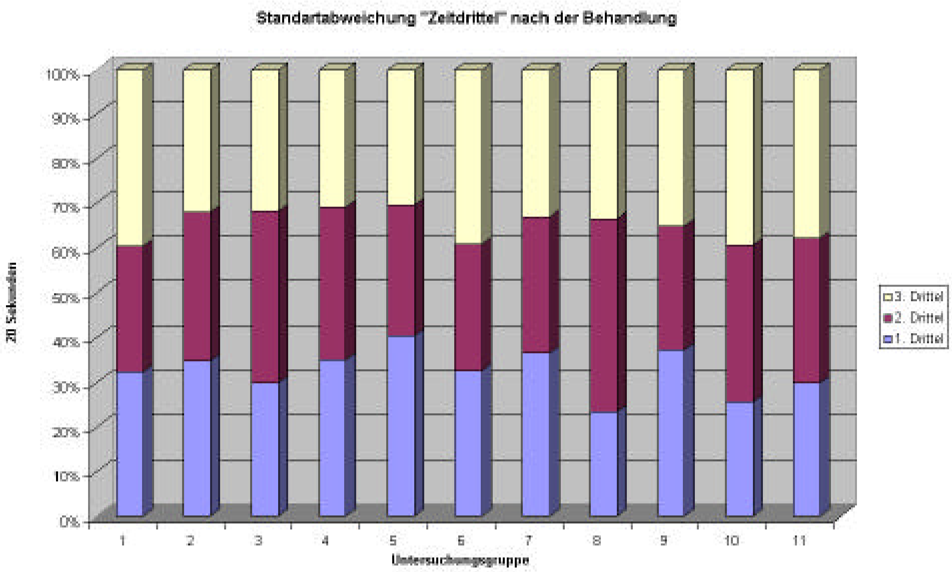

Table 29: Standard deviation of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds of the research group after the treatment

The average value of the third of the examination interval among the examination group after the treatment was 5,09 mm ± 2,39 mm

Significance 1. third: 0,29, 2. third: 0,50, 3. third: 0,98

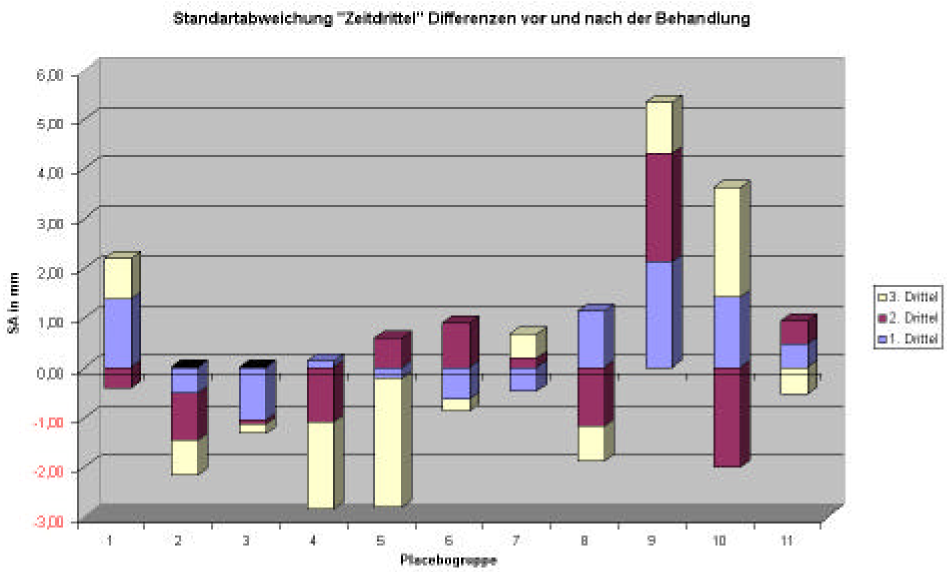

Table 30: Difference of the standard deviation before and after the pseudo treatment of the placebo group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the third of the examination interval of the differences to the standard deviation among the placebo-group was 0,01 mm ± 1,17 mm

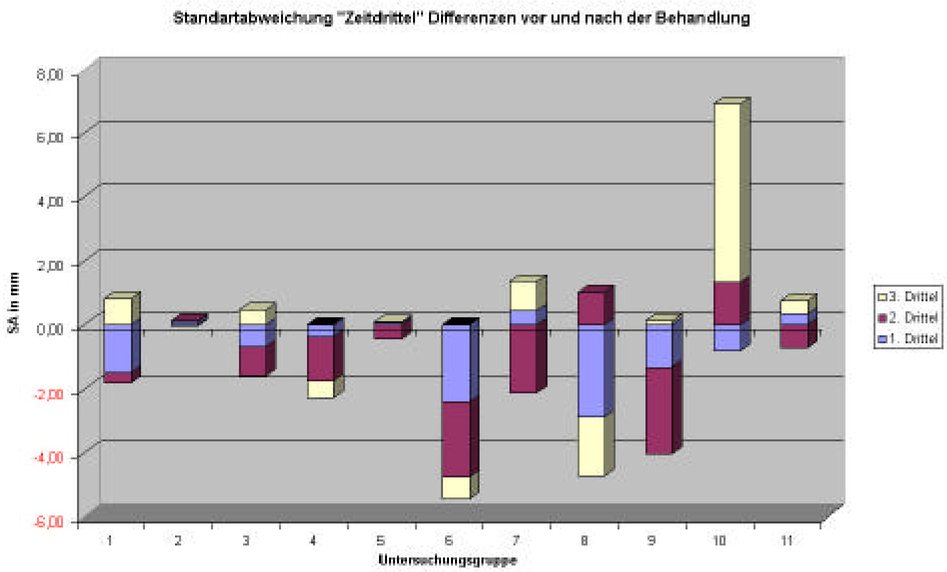

Table 31: Difference of the standard deviation before and after the treatment of the research group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the third of the examination interval of the difference to the standard deviation among the examination group was 0,37 mm ± 1,54 mm

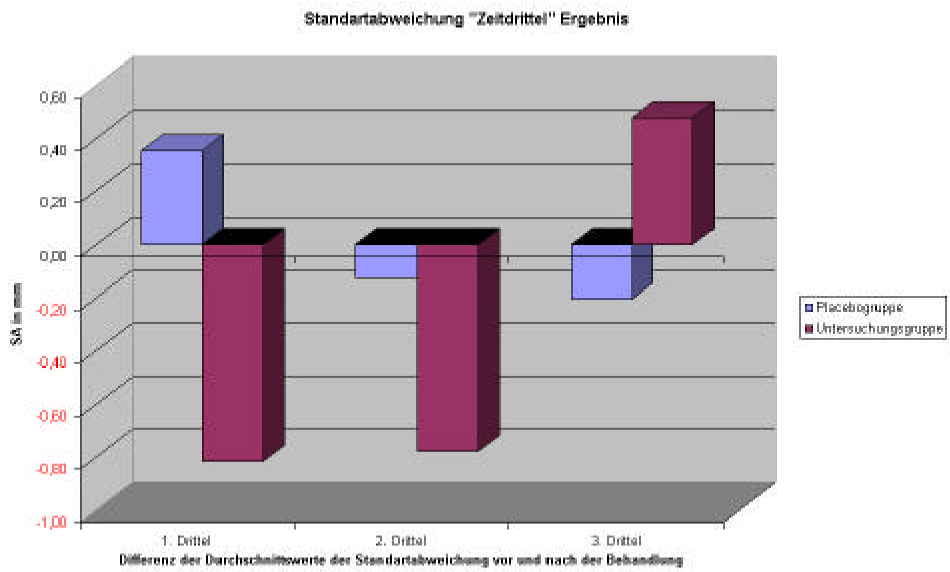

Table 32: Result of the standard deviation of the placebo group in comparison to the research group of the first 6,67 seconds, the second 6,67 seconds and the third 6,67 seconds

The average value of the result of the third of the examination interval among the placebo- and examination group was -0,18 mm ± 0,54 mm

Significance: 1. third: 0,85, 2. third: 0,73, 3. third: 0,30

17.1 *Data sheet*

ID Nr.:
Date of examination:
Hour:
Room temperature:
Humidity:
Group (K,T):
Name:
Date of birth:
Height (cm):
Weight (kg):
Sex:
Phone number:
Sport (1-6):
Years of training:
Amount of training in hours per week (hours):
Last meal (Hour):
Quantitiy of food (1-5):
Meal morning:
Meal in between:
Meal lunchtime:
Nutritious supplements (yes/no):
Coffee (yes/no):
Nicotine (yes/no):
Medication (yes/no):
Alcohol (yes/no):
Bed time (Hour):
Waking hour (Hour):
Do you feel physically and emotionally healthy? (yes/no):
Recent injuries? (yes/no):
Virus infections such as e.g. flu? (yes/no):
Orthopaedic, neurological, vestibular illnesses (yes/no):
Seeing aids? (yes/no):
Sight deficit left (-/+ dioptres):
Sight deficit right (-/+ dioptres):
Hour of end of last training:
Type of training (1-7):

Amount of training (length of training unit in minutes):
Subjective Intensity of training (1-5):
ID Nr.:
Type of posture anterior or posterior (1-3):
Endomorph or ectomporph body types (1-3):
Shorter leg left (yes/no):
Shorter leg right (yes/no):
Ilium right anterior (yes/no):
Ilium left anterior (yes/no):
Scoliosis (yes/no):
Shoe size (cm):
Splayfoot right (yes/no):
Splayfoot left (yes/no):
Fallen arches right (yes/no):
Fallen arches left (yes/no):
Flat foot right (yes/no):
Flat foot left (yes/no):

SSB Pattern:

Flex/Ext:

Vitality:

Base of the skull: Ethmoid, Sphenoid, Occiput, Temporalia,

17.2 Additional sheet

0 = no
1 = yes

Sports:
1 = Ski
2 = Cross country
3 = Snowboard Race
4 = Snowbord Freestyle
5 = Football
6 = else

Quantitaty of food:
1 = nothing
2 = little
3 = medium
4 = a lot
5 = very much

Type of training:
1 = No training
2 = Regeneration (going for a walk, massage, sauna, ...)
3 = Basic endurance (aerobic field)
4 = Intense endurance
5 = Coordination training (intermuscular coordination)
6 = Hypertrophy training (about. 60% of maximum strength, weight training)
7 = intramuscular coordination (springiness)

Subjective training intensity:
1 = no training
2 = light
3 = medium
4 = intense
5 = very intense

Type of posture:
1 = anterior
2 = centered
3 = posterior

Body type:
1 = endomorph
2 = mixed type
3 = ectomorph

17.3 Screenshot of the measurement

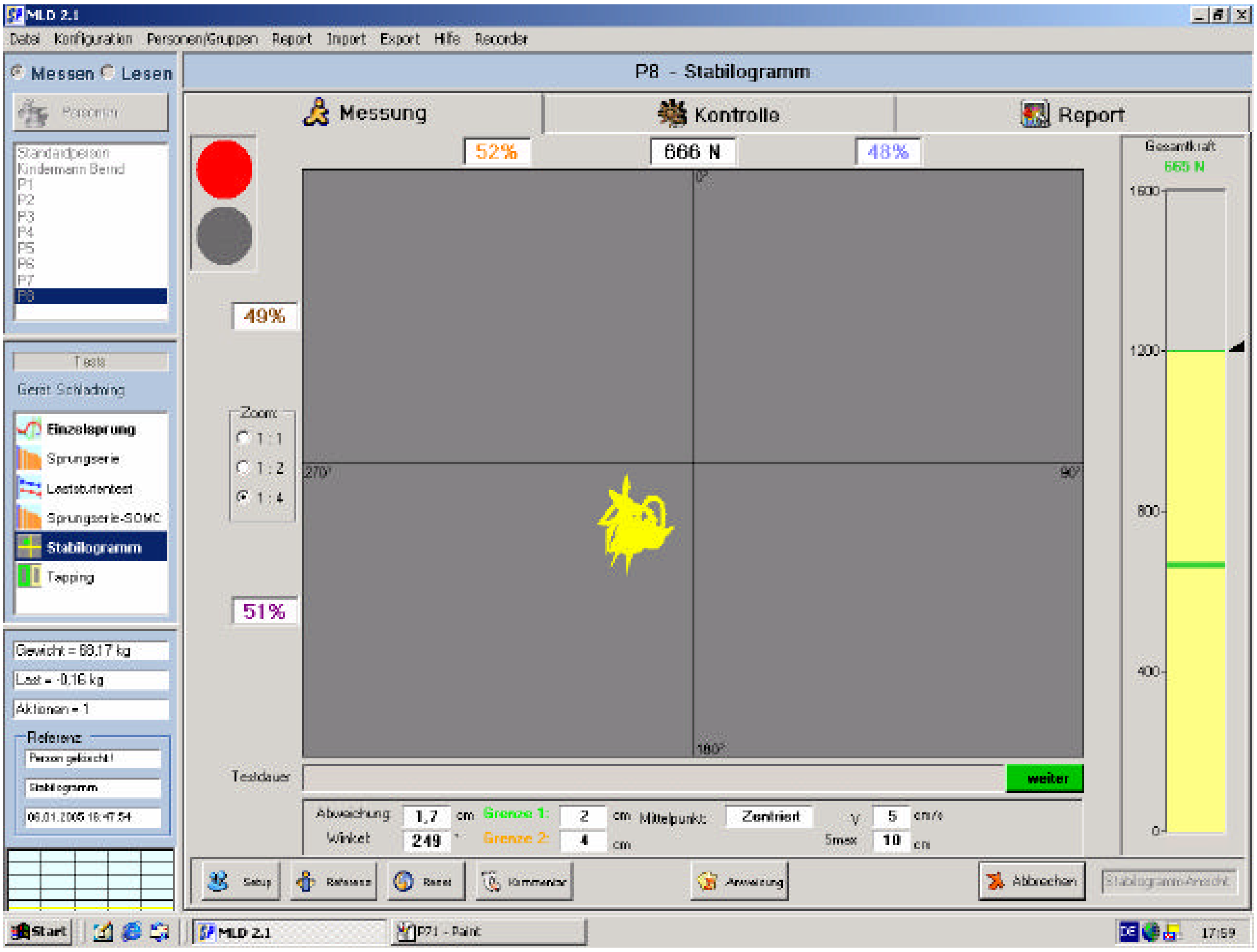

Fig. 6: Screenshot of the computer programme of the SP force plate

Placebo group

			MW Abw mm	MW Abw 1/3 mm	MW Abw 2/3 mm	MW Abw 3/3 mm	Std Abw mm	Std Abw 1/3 mm	Std Abw 2/3 mm	Std Abw 3/3 mm
1	P041	09.Mär	39,75	37,1	43,08	39,02	5,59	7,59	3,38	2,58
2	P042	09.Mär	35,21	33,21	40,68	39,29	4,22	4,32	3,59	4,1
3	P043	09.Mär	31,41	22,05	32,75	39,29	9,12	5,2	6,97	4,79
4	P044	09.Mär	35,98	32,36	36,44	39,09	6,47	6,38	4,02	6,78
5	P045	09.Mär	31,49	31,58	35,34	27,57	6,14	7,73	3,74	3,06
6	P046	09.Mär	45,99	42,47	45,43	50,01	6,36	7,18	4,99	4,07
7	P061	09.Mär	25,95	18,36	28,11	31,26	6,79	4,05	5,29	1,94
8	P062	09.Mär	18,07	22,34	16,21	15,74	6,3	5,71	5,38	5,55
9	P063	09.Mär	16,95	10,08	20,09	20,57	6,25	4,32	3,54	4,02
10	P064	09.Mär	35,68	32,58	32,83	41,58	5,15	3,22	1,97	3,57
11	P065	09.Mär	20,3	10,09	21,35	29,29	9,03	4,73	5,05	3,37
12	P066	09.Mär	25,08	23,05	23,38	28,78	4,72	4,62	4,34	2,44
13	P081	09.Mär	23,25	21,67	24,2	23,87	3,09	3,44	2,76	2,34
14	P082	09.Mär	32,58	31,57	31,9	34,25	4,66	4,95	3,83	4,67
15	P083	09.Mär	26,91	21,25	25,61	33,78	6,58	4,05	4,27	3,83
16	P084	09.Mär	41,85	40,92	43,69	40,93	4,13	3,37	4,41	3,88
17	P085	09.Mär	18,6	16,12	17,77	21,85	4,1	3,32	3,11	3,5
18	P086	09.Mär	22,47	23,21	22,24	21,97	2,92	2,6	3,08	2,91
19	P101	09.Mär	36,88	33,45	35,52	41,63	4,36	1,3	2,45	3,6
20	P102	09.Mär	29,09	29,02	29,4	28,85	4,19	3,52	2,16	5,95
21	P103	09.Mär	37,87	44,4	36,7	32,62	7,63	4,49	8,07	4,2
22	P104	09.Mär	41,34	41,94	42,4	39,7	3,35	3,68	2,19	3,34
23	P105	09.Mär	38,8	35,57	37,43	43,34	4,52	2,55	4,17	2,08
24	P106	09.Mär	44,88	44,65	44,69	45,31	3,2	3,49	3,04	3,03
25	p121	14.Mär	16,79	14,31	17,09	18,92	8,95	7,1	7,52	11,05
26	P122	14.Mär	24,94	32,36	23,94	18,64	9,67	10,48	6,79	5,48
27	P123	14.Mär	35,16	22,73	36,68	45,88	13,27	5,46	9,51	11,68
28	P124	14.Mär	22,27	20,38	19,2	27,18	9,41	9,82	9,84	5,97
29	P125	14.Mär	30,73	26,64	31,07	34,42	8,06	7,76	8,16	6,17
30	P126	14.Mär	21,11	19,14	17,3	26,86	8,21	4,88	7,63	8,24
31	P141	14.Mär	18,95	21,35	15,66	19,87	4,32	4,9	2,94	2,45
32	P142	14.Mär	27,37	33,02	22,64	26,55	6,3	5,15	4,03	4,66
33	P143	14.Mär	32,12	26,76	32,35	37,15	6,23	4,74	3,72	5,11
34	P144	14.Mär	23,33	27,28	22,98	19,81	4,71	5,04	3,19	1,82
35	P145	14.Mär	26,49	31,27	25,33	22,95	6,4	3,2	6,83	5,39
36	P146	14.Mär	31,51	25,01	29,81	39,6	7,35	4,68	3,37	4,27
37	P161	14.Mär	9,76	12,05	8,74	8,53	4,2	4,24	4,24	3,05
38	P162	14.Mär	21,85	21,08	20,04	24,42	4,91	6,1	2,63	4,25
39	P163	14.Mär	8,69	7,76	9,57	8,72	3,96	3,61	4,83	3,02
40	P164	14.Mär	9,76	11,22	7,53	10,54	4,61	4,72	2,4	5,31
41	P165	14.Mär	5,49	6,93	4,2	5,34	3,26	3,83	3,11	1,95
42	P166	14.Mär	18,27	15,49	21,01	18,27	5,7	4	6,77	4,5
43	P181	14.Mär	87,24	77,5	86,9	97,17	10,5	7,24	8,12	4,41
44	P182	14.Mär	68,25	65,26	70,51	68,94	5,22	4,08	4,63	5,4
45	P183	14.Mär	52,87	49,48	49,24	59,84	7,15	5,44	4,78	5,22
46	P184	14.Mär	52,62	48,84	53,39	55,57	5,4	4,88	5,35	3,42
47	P185	14.Mär	53,05	52,99	55,45	50,72	7	8,89	5,24	5,47
48	P186	14.Mär	47,21	51,6	47,37	42,72	6,01	6,45	3,41	4,02
49	P201	14.Mär	18,62	21,71	16,85	17,36	4,46	3,77	5,21	2,03

50	P202	14.Mär	42,33	44,98	40,61	41,46	3,44	3,09	2,9	2,63
51	P203	14.Mär	39,97	41,4	36,01	42,53	4,35	2,62	1,77	4,74
52	P204	14.Mär	66,83	61,57	64,14	74,7	8,69	9,18	4,86	4,75
53	P205	14.Mär	49,33	40,57	50,72	56,57	9,19	3,65	9,47	4,4
54	P206	14.Mär	16,64	16,39	14,63	18,89	3,37	3,08	2,04	3,35
55	P221	14.Mär	35,7	37,27	33,88	35,99	4,59	3,16	5,91	3,51
56	P222	14.Mär	62,78	64,89	63,23	60,24	5,92	3,84	7,11	5,34
57	P223	14.Mär	73,3	75,09	72,82	72,03	7,97	3,81	5,53	11,82
58	P224	14.Mär	47,78	42,51	48,44	52,33	8,44	4,74	4,48	11,04
59	P225	14.Mär	59,62	61,43	60,3	57,16	5,4	7,04	3,34	4,17
60	P226	14.Mär	58,76	59,81	64,39	52,08	9,25	3,32	4,74	12,02
61	P231	16.Mär	17,42	16,3	18,12	17,83	2,65	3,02	1,79	2,62
62	P232	16.Mär	28,43	28,27	29,56	27,45	2,63	2,16	2,38	2,84
63	P233	16.Mär	27,05	28,58	27,62	24,96	2,91	2,2	2,36	2,82
64	P234	16.Mär	43,29	42,39	44,92	42,56	4,03	3,31	4,99	2,97
65	P235	16.Mär	26,21	25,06	27,03	26,52	2,55	3,41	1,01	2,21
66	P236	16.Mär	24,11	25,26	23,32	23,78	2,03	2,07	1,92	1,53

Research group

		MW Abw mm	MW Abw 1/3 mm	MW Abw 2/3 mm	MW Abw 3/3 mm	Std Abw mm	Std Abw 1/3 mm	Std Abw 2/3 mm	Std Abw 3/3 mm
P011U	10.Mär	34,37	33,16	33,76	36,17	5,1	6,56	3,79	3,97
P012U	10.Mär	45,41	37,9	46,37	51,84	7,37	5,08	5,22	3,41
P013U	10.Mär	37,91	37,56	38,6	37,56	4,82	5,43	2,87	5,59
P014U	10.Mär	40,12	38,51	40,14	41,69	5,04	5,47	4,19	4,86
P015U	10.Mär	40,46	33,86	37,93	49,51	8,34	3,89	3,53	7,01
P016U	10.Mär	32,85	30,03	34,56	33,92	3,89	3,29	3,16	3,54
P051U	10.Mär	9,49	12,66	8,11	7,73	3,84	4,27	2,53	2,17
P052U	10.Mär	19,22	14,48	23,64	19,48	5,18	2,81	4,42	3,32
P053U	10.Mär	14,48	15,3	15,21	12,94	3,14	2,57	2,4	3,69
P054U	10.Mär	23,2	20,3	24	25,26	3,79	3,28	2,51	3,58
P055U	10.Mär	25,48	24,42	28,75	23,26	4,47	2,97	5,25	2,57
P056U	10.Mär	18,07	16,05	18,7	19,42	3,25	3,7	1,72	2,99
P071U	10.Mär	22,92	22,76	23,87	22,11	4,56	4,87	4,91	3,6
P072U	10.Mär	43,03	26,26	51,02	51,54	13,94	5,01	11,35	3,71
P073U	10.Mär	45,51	45,18	43,17	48,19	5,51	5,82	3,53	5,65
P074U	10.Mär	32,83	26,19	32,77	39,44	7,69	4,49	6,55	5,15
P075U	10.Mär	27,15	23,98	28,82	28,62	6,34	5,4	6,32	6,04
P076U	10.Mär	41,81	39,37	43,85	42,17	4,2	3,73	4,28	3,25
P091U	10.Mär	10,34	10,63	12,18	8,23	5,5	4,82	6,44	4,26
P092U	10.Mär	23,13	24,74	19,54	25,13	7,82	9,82	5,67	6,01
P093U	10.Mär	33,42	32,64	33,65	33,95	7,91	4,98	10,13	7,69
P094U	10.Mär	17,3	13,65	14,98	23,21	6,39	3,55	5,87	4,64
P095U	10.Mär	17,79	14,42	19,17	19,74	6,38	6,51	6,35	4,75
P096U	10.Mär	28,21	24,64	27,88	32,05	7,79	8,47	5,88	6,96
P111U	10.Mär	19,47	19,69	18,12	20,61	3,56	3,55	3,66	2,98
P112U	10.Mär	33,64	34,52	34,25	32,17	3,66	3,95	3,54	2,95
P113U	10.Mär	15,24	16,13	15,31	14,3	3,03	3,69	2,38	2,56
P114U	10.Mär	36,44	37,71	33,69	37,93	4,77	6,73	2,84	1,97
P115U	10.Mär	26,14	22,2	24,7	31,45	5,13	2,5	3,59	3,74
P116U	10.Mär	15,08	15,51	13,81	15,92	2,52	2,19	1,83	2,89
P131U	16.Mär	9,94	8,42	10,9	10,48	4,81	6,74	3,53	2,93
P132U	16.Mär	10,28	6,92	9,32	14,57	5,81	5,18	5,03	4,32
P133U	16.Mär	24,44	22,37	19,17	31,74	7,15	3,52	5,71	4,73
P134U	16.Mär	22,03	20,79	24,52	20,76	3,63	2,65	3,03	3,74
P135U	16.Mär	9,47	6,03	7,95	14,39	4,55	2,35	1,99	3,76
P136U	16.Mär	11,85	9,24	10,35	15,94	3,94	3,27	2,15	2,37
P151U	16.Mär	21,75	14,87	19,61	30,66	8,72	3,56	7,02	5,88
P152U	16.Mär	24,02	21,32	23,2	27,51	5,09	4,92	4,53	3,58
P153U	16.Mär	28,73	28,8	31,99	25,39	6	5,39	7,38	1,63
P154U	16.Mär	48,14	42,19	47,28	54,88	9,29	9,58	4,23	8,28
P155U	16.Mär	11,34	7,47	9,58	16,93	5,46	2,78	4,46	3,55
P156U	16.Mär	14,69	13,77	18,36	11,92	4,07	2,87	3,94	1,94
P171U	16.Mär	22,24	16,21	22,37	28,04	11,39	11	10,49	9,4
P172U	16.Mär	19,71	18,21	15,39	25,52	9,74	6,73	8,43	10,62
P173U	16.Mär	35,99	34,32	33,85	39,79	14,91	11,9	16,26	15,43
P174U	16.Mär	20,77	13,11	22,8	26,3	11,94	6,41	15,03	8,17
P175U	16.Mär	17,28	20,53	14,65	16,73	9,4	9,74	5,9	10,86
P176U	16.Mär	22,67	11,45	28,89	27,52	14,49	4,86	17,3	10,85
P191U	16.Mär	36,37	35,5	37,33	36,28	5,17	7,12	3,42	4,06
P192U	16.Mär	22,52	20,86	21,29	25,37	7,47	6,94	7,69	6,91

P193U	16.Mär	32,82	30,39	32,89	35,16	6,8	5,94	8,88	3,64
P194U	16.Mär	14,28	19,13	12,61	11,16	6,67	7,4	3,8	5,35
P195U	16.Mär	14,48	15,89	11,1	16,47	5,85	4,11	4,98	6,59
P196U	16.Mär	14,22	16,05	16,22	10,42	4,53	4,52	3,1	3,11
P211U	16.Mär	58,59	51,36	61,49	62,8	8,89	7,8	9,16	3,81
P212U	16.Mär	35,67	33,72	46,44	26,82	10,55	4,26	8,99	5,95
P213U	16.Mär	31,98	38,26	26,28	31,5	8,49	10,37	4,8	3,81
P214U	16.Mär	38,01	41,9	33,38	38,81	11,07	7,9	6,39	15,05
P215U	16.Mär	35,56	35,61	37,91	33,16	6,73	7,32	7,87	3,02
P216U	16.Mär	28,69	27,69	22,39	35,97	11,97	4,74	12,69	12,27
P251U	16.Mär	25,29	19,65	26,99	29,14	5,36	2,35	4,81	2,85
P252U	16.Mär	15,62	12,82	13,86	20,13	5,09	3,55	3,5	4,65
P253U	16.Mär	29,17	29,83	26,91	30,78	4,28	3,11	4,72	3,85
P254U	16.Mär	38,26	34,6	34,57	45,56	8,17	4,51	6,07	7,91
P255U	16.Mär	18,77	17,7	17,42	21,17	3,17	3,18	1,81	2,83
P256U	16.Mär	10,15	17,93	7	5,62	6	2,33	2,96	1,85

Evaluation of deviation

Name	*U-Dat*	*MW Abw mm*				*MW Abw 1/3 mm*				*MW Abw 2/3 mm*				*MW Abw 3/3 mm*			
P041	09.Mär	39,75				37,1				43,08				39,02			
P042	09.Mär	35,21				33,21				40,68				39,29			
P043	09.Mär	31,41	35,46			22,05	30,79			32,75	38,84			39,29	39,20		
P044	09.Mär	35,98				32,36				36,44				39,09			
P045	09.Mär	31,49				31,58				35,34				27,57			
P046	09.Mär	45,99	37,82	2,36		42,47	35,47	4,68		45,43	39,07	0,23		50,01	38,89	-0,31	
P061	09.Mär	25,95				18,36				28,11				31,26			
P062	09.Mär	18,07				22,34				16,21				15,74			
P063	09.Mär	16,95	20,32			10,08	16,93			20,09	21,47			20,57	22,52		
P064	09.Mär	35,68				32,58				32,83				41,58			
P065	09.Mär	20,3				10,09				21,35				29,29			
P066	09.Mär	25,08	27,02	6,70		23,05	21,91	4,98		23,38	25,85	4,38		28,78	33,22	10,69	
P081	09.Mär	23,25				21,67				24,2				23,87			
P082	09.Mär	32,58				31,57				31,9				34,25			
P083	09.Mär	26,91	27,58			21,25	24,83			25,61	27,24			33,78	30,63		
P084	09.Mär	41,85				40,92				43,69				40,93			
P085	09.Mär	18,6				16,12				17,77				21,85			
P086	09.Mär	22,47	27,64	0,06		23,21	26,75	1,92		22,24	27,90	0,66		21,97	28,25	-2,38	
P101	09.Mär	36,88				33,45				35,52				41,63			
P102	09.Mär	29,09				29,02				29,4				28,85			
P103	09.Mär	37,87	34,61			44,4	35,62			36,7	33,87			32,62	34,37		
P104	09.Mär	41,34				41,94				42,4				39,7			
P105	09.Mär	38,8				35,57				37,43				43,34			
P106	09.Mär	44,88	41,67	7,06		44,65	40,72	5,10		44,69	41,51	7,63		45,31	42,78	8,42	
p121	14.Mär	16,79				14,31				17,09				18,92			
P122	14.Mär	24,94				32,36				23,94				18,64			
P123	14.Mär	35,16	25,63			22,73	23,13			36,68	25,90			45,88	27,81		
P124	14.Mär	22,27				20,38				19,2				27,18			
P125	14.Mär	30,73				26,64				31,07				34,42			
P126	14.Mär	21,11	24,70	-0,93		19,14	22,05	-1,08		17,3	22,52	-3,38		26,86	29,49	1,67	
P141	14.Mär	18,95				21,35				15,66				19,87			
P142	14.Mär	27,37				33,02				22,64				26,55			
P143	14.Mär	32,12	26,15			26,76	27,04			32,35	23,55			37,15	27,86		
P144	14.Mär	23,33				27,28				22,98				19,81			
P145	14.Mär	26,49				31,27				25,33				22,95			
P146	14.Mär	31,51	27,11	0,96		25,01	27,85	0,81		29,81	26,04	2,49		39,6	27,45	-0,40	
P161	14.Mär	9,76				12,05				8,74				8,53			
P162	14.Mär	21,85				21,08				20,04				24,42			
P163	14.Mär	8,69	13,43			7,76	13,63			9,57	12,78			8,72	13,89		
P164	14.Mär	9,76				11,22				7,53				10,54			
P165	14.Mär	5,49				6,93				4,2				5,34			
P166	14.Mär	18,27	11,17	-2,26		15,49	11,21	-2,42		21,01	10,91	-1,87		18,27	11,38	-2,51	
P181	14.Mär	87,24				77,5				86,9				97,17			
P182	14.Mär	68,25				65,26				70,51				68,94			
P183	14.Mär	52,87	69,45			49,48	64,08			49,24	68,88			59,84	75,32		
P184	14.Mär	52,62				48,84				53,39				55,57			
P185	14.Mär	53,05				52,99				55,45				50,72			
P186	14.Mär	47,21	50,96	-18,49		51,6	51,14	-12,94		47,37	52,07	-16,81		42,72	49,67	-25,65	
P201	14.Mär	18,62				21,71				16,85				17,36			
P202	14.Mär	42,33				44,98				40,61				41,46			

P203	14.Mär	39,97	33,64			41,4	36,03			36,01	31,16			42,53	33,78		
P204	14.Mär	66,83				61,57				64,14				74,7			
P205	14.Mär	49,33				40,57				50,72				56,57			
P206	14.Mär	16,64	44,27	10,63		16,39	39,51	3,48		14,63	43,16	12,01		18,89	50,05	16,27	
P221	14.Mär	35,7				37,27				33,88				35,99			
P222	14.Mär	62,78				64,89				63,23				60,24			
P223	14.Mär	73,3	57,26			75,09	59,08			72,82	56,64			72,03	56,09		
P224	14.Mär	47,78				42,51				48,44				52,33			
P225	14.Mär	59,62				61,43				60,3				57,16			
P226	14.Mär	58,76	55,39	-1,87		59,81	54,58	-4,50		64,39	57,71	1,07		52,08	53,86	-2,23	
P231	16.Mär	17,42				16,3				18,12				17,83			
P232	16.Mär	28,43				28,27				29,56				27,45			
P233	16.Mär	27,05	24,30			28,58	24,38			27,62	25,10			24,96	23,41		
P234	16.Mär	43,29				42,39				44,92				42,56			
P235	16.Mär	26,21				25,06				27,03				26,52			
P236	16.Mär	24,11	31,20	6,90	1,01	25,26	30,90	6,52	0,60	23,32	31,76	6,66	1,19	23,78	30,95	7,54	1,01
U011	10.Mär	34,37				33,16				33,76				36,17			
U012	10.Mär	45,41				37,9				46,37				51,84			
U013	10.Mär	37,91	39,23			37,56	36,21			38,6	39,58			37,56	41,86		
U014	10.Mär	40,12				38,51				40,14				41,69			
U015	10.Mär	40,46				33,86				37,93				49,51			
U016	10.Mär	32,85	37,81	-1,42		30,03	34,13	-2,07		34,56	37,54	-2,03		33,92	41,71	-0,15	
U051	10.Mär	9,49				12,66				8,11				7,73			
U052	10.Mär	19,22				14,48				23,64				19,48			
U053	10.Mär	14,48	14,40			15,3	14,15			15,21	15,65			12,94	13,38		
U054	10.Mär	23,2				20,3				24				25,26			
U055	10.Mär	25,48				24,42				28,75				23,26			
U056	10.Mär	18,07	22,25	7,85		16,05	20,26	6,11		18,7	23,82	8,16		19,42	22,65	9,26	
U071	10.Mär	22,92				22,76				23,87				22,11			
U072	10.Mär	43,03				26,26				51,02				51,54			
U073	10.Mär	45,51	37,15			45,18	31,40			43,17	39,35			48,19	40,61		
U074	10.Mär	32,83				26,19				32,77				39,44			
U075	10.Mär	27,15				23,98				28,82				28,62			
U076	10.Mär	41,81	33,93	-3,22		39,37	29,85	-1,55		43,85	35,15	-4,21		42,17	36,74	-3,87	
U091	10.Mär	10,34				10,63				12,18				8,23			
U092	10.Mär	23,13				24,74				19,54				25,13			
U093	10.Mär	33,42	22,30			32,64	22,67			33,65	21,79			33,95	22,44		
U094	10.Mär	17,3				13,65				14,98				23,21			
U095	10.Mär	17,79				14,42				19,17				19,74			
U096	10.Mär	28,21	21,10	-1,20		24,64	17,57	-5,10		27,88	20,68	-1,11		32,05	25,00	2,56	
U111	10.Mär	19,47				19,69				18,12				20,61			
U112	10.Mär	33,64				34,52				34,25				32,17			
U113	10.Mär	15,24	22,78			16,13	23,45			15,31	22,56			14,3	22,36		
U114	10.Mär	36,44				37,71				33,69				37,93			
U115	10.Mär	26,14				22,2				24,7				31,45			
U116	10.Mär	15,08	25,89	3,10		15,51	25,14	1,69		13,81	24,07	1,51		15,92	28,43	6,07	
U131	16.Mär	9,94				8,42				10,9				10,48			
U132	16.Mär	10,28				6,92				9,32				14,57			
U133	16.Mär	24,44	14,89			22,37	12,57			19,17	13,13			31,74	18,93		
U134	16.Mär	22,03				20,79				24,52				20,76			
U135	16.Mär	9,47				6,03				7,95				14,39			
U136	16.Mär	11,85	14,45	-0,44		9,24	12,02	-0,55		10,35	14,27	1,14		15,94	17,03	-1,90	
U151	16.Mär	21,75				14,87				19,61				30,66			

U152	16.Mär	24,02				21,32				23,2				27,51			
U153	16.Mär	28,73	24,83			28,8	21,66			31,99	24,93			25,39	27,85		
U154	16.Mär	48,14				42,19				47,28				54,88			
U155	16.Mär	11,34				7,47				9,58				16,93			
U156	16.Mär	14,69	24,72	-0,11		13,77	21,14	-0,52		18,36	25,07	0,14		11,92	27,91	0,06	
U171	16.Mär	22,24				16,21				22,37				28,04			
U172	16.Mär	19,71				18,21				15,39				25,52			
U173	16.Mär	35,99	25,98			34,32	22,91			33,85	23,87			39,79	31,12		
U174	16.Mär	20,77				13,11				22,8				26,3			
U175	16.Mär	17,28				20,53				14,65				16,73			
U176	16.Mär	22,67	20,24	-5,74		11,45	15,03	-7,88		28,89	22,11	-1,76		27,52	23,52	-7,60	
U191	16.Mär	36,37				35,5				37,33				36,28			
U192	16.Mär	22,52				20,86				21,29				25,37			
U193	16.Mär	32,82	30,57			30,39	28,92			32,89	30,50			35,16	32,27		
U194	16.Mär	14,28				19,13				12,61				11,16			
U195	16.Mär	14,48				15,89				11,1				16,47			
U196	16.Mär	14,22	14,33	-16,24		16,05	17,02	-11,89		16,22	13,31	-17,19		10,42	12,68	-19,59	
U211	16.Mär	58,59				51,36				61,49				62,8			
U212	16.Mär	35,67				33,72				46,44				26,82			
U213	16.Mär	31,98	42,08			38,26	41,11			26,28	44,74			31,5	40,37		
U214	16.Mär	38,01				41,9				33,38				38,81			
U215	16.Mär	35,56				35,61				37,91				33,16			
U216	16.Mär	28,69	34,09	-7,99		27,69	35,07	-6,05		22,39	31,23	-13,51		35,97	35,98	-4,39	
U251	16.Mär	25,29				19,65				26,99				29,14			
U252	16.Mär	15,62				12,82				13,86				20,13			
U253	16.Mär	29,17	23,36			29,83	20,77			26,91	22,59			30,78	26,68		
U254	16.Mär	38,26				34,6				34,57				45,56			
U255	16.Mär	18,77				17,7				17,42				21,17			
U256	16.Mär	10,15	22,39	-0,97	-2,40	17,93	23,41	2,64	-2,29	7	19,66	-2,92	-2,89	5,62	24,12	-2,57	-2,01
					-3,41				**-2,88**				**-4,08**				**-3,02**

Evaluation of standard deviation

Name	U-Dat	Std Abw mm				Std Abw 1/3 mm				Std Abw 2/3 mm				Std Abw 3/3 mm			
P041	09.Mär	5,59				7,59				3,38				2,58			
P042	09.Mär	4,22				4,32				3,59				4,1			
P043	09.Mär	9,12	6,31			5,2	5,70			6,97	4,65			4,79	3,82		
P044	09.Mär	6,47				6,38				4,02				6,78			
P045	09.Mär	6,14				7,73				3,74				3,06			
P046	09.Mär	6,36	6,32	0,01		7,18	7,10	1,39		4,99	4,25	-0,40		4,07	4,64	0,81	
P061	09.Mär	6,79				4,05				5,29				1,94			
P062	09.Mär	6,3				5,71				5,38				5,55			
P063	09.Mär	6,25	6,45			4,32	4,69			3,54	4,74			4,02	3,84		
P064	09.Mär	5,15				3,22				1,97				3,57			
P065	09.Mär	9,03				4,73				5,05				3,37			
P066	09.Mär	4,72	6,30	-0,15		4,62	4,19	-0,50		4,34	3,79	-0,95		2,44	3,13	-0,71	
P081	09.Mär	3,09				3,44				2,76				2,34			
P082	09.Mär	4,66				4,95				3,83				4,67			
P083	09.Mär	6,58	4,78			4,05	4,15			4,27	3,62			3,83	3,61		
P084	09.Mär	4,13				3,37				4,41				3,88			
P085	09.Mär	4,1				3,32				3,11				3,5			
P086	09.Mär	2,92	3,72	-1,06		2,6	3,10	-1,05		3,08	3,53	-0,09		2,91	3,43	-0,18	
P101	09.Mär	4,36				1,3				2,45				3,6			
P102	09.Mär	4,19				3,52				2,16				5,95			
P103	09.Mär	7,63	5,39			4,49	3,10			8,07	4,23			4,2	4,58		
P104	09.Mär	3,35				3,68				2,19				3,34			
P105	09.Mär	4,52				2,55				4,17				2,08			
P106	09.Mär	3,2	3,69	-1,70		3,49	3,24	0,14		3,04	3,13	-1,09		3,03	2,82	-1,77	
p121	14.Mär	8,95				7,1				7,52				11,05			
P122	14.Mär	9,67				10,48				6,79				5,48			
P123	14.Mär	13,27	10,63			5,46	7,68			9,51	7,94			11,68	9,40		
P124	14.Mär	9,41				9,82				9,84				5,97			
P125	14.Mär	8,06				7,76				8,16				6,17			
P126	14.Mär	8,21	8,56	-2,07		4,88	7,49	-0,19		7,63	8,54	0,60		8,24	6,79	-2,61	
P141	14.Mär	4,32				4,9				2,94				2,45			
P142	14.Mär	6,3				5,15				4,03				4,66			
P143	14.Mär	6,23	5,62			4,74	4,93			3,72	3,56			5,11	4,07		
P144	14.Mär	4,71				5,04				3,19				1,82			
P145	14.Mär	6,4				3,2				6,83				5,39			
P146	14.Mär	7,35	6,15	0,54		4,68	4,31	-0,62		3,37	4,46	0,90		4,27	3,83	-0,25	
P161	14.Mär	4,2				4,24				4,24				3,05			
P162	14.Mär	4,91				6,1				2,63				4,25			
P163	14.Mär	3,96	4,36			3,61	4,65			4,83	3,90			3,02	3,44		
P164	14.Mär	4,61				4,72				2,4				5,31			
P165	14.Mär	3,26				3,83				3,11				1,95			
P166	14.Mär	5,7	4,52	0,17		4	4,18	-0,47		6,77	4,09	0,19		4,5	3,92	0,48	
P181	14.Mär	10,5				7,24				8,12				4,41			
P182	14.Mär	5,22				4,08				4,63				5,4			
P183	14.Mär	7,15	7,62			5,44	5,59			4,78	5,84			5,22	5,01		
P184	14.Mär	5,4				4,88				5,35				3,42			
P185	14.Mär	7				8,89				5,24				5,47			
P186	14.Mär	6,01	6,14	-1,49		6,45	6,74	1,15		3,41	4,67	-1,18		4,02	4,30	-0,71	
P201	14.Mär	4,46				3,77				5,21				2,03			
P202	14.Mär	3,44				3,09				2,9				2,63			

P203	14.Mär	4,35	4,08			2,62	3,16			1,77	3,29			4,74	3,13		
P204	14.Mär	8,69				9,18				4,86				4,75			
P205	14.Mär	9,19				3,65				9,47				4,4			
P206	14.Mär	3,37	7,08	3,00		3,08	5,30	2,14		2,04	5,46	2,16		3,35	4,17	1,03	
P221	14.Mär	4,59				3,16				5,91				3,51			
P222	14.Mär	5,92				3,84				7,11				5,34			
P223	14.Mär	7,97	6,16			3,81	3,60			5,53	6,18			11,82	6,89		
P224	14.Mär	8,44				4,74				4,48				11,04			
P225	14.Mär	5,4				7,04				3,34				4,17			
P226	14.Mär	9,25	7,70	1,54		3,32	5,03	1,43		4,74	4,19	-2,00		12,02	9,08	2,19	
P231	16.Mär	2,65				3,02				1,79				2,62			
P232	16.Mär	2,63				2,16				2,38				2,84			
P233	16.Mär	2,91	2,73			2,2	2,46			2,36	2,18			2,82	2,76		
P234	16.Mär	4,03				3,31				4,99				2,97			
P235	16.Mär	2,55				3,41				1,01				2,21			
P236	16.Mär	2,03	2,87	0,14	-0,10	2,07	2,93	0,47	0,35	1,92	2,64	0,46	-0,13	1,53	2,24	-0,52	-0,20
U011	10.Mär	5,1				6,56				3,79				3,97			
U012	10.Mär	7,37				5,08				5,22				3,41			
U013	10.Mär	4,82	5,76			5,43	5,69			2,87	3,96			5,59	4,32		
U014	10.Mär	5,04				5,47				4,19				4,86			
U015	10.Mär	8,34				3,89				3,53				7,01			
U016	10.Mär	3,89	5,76	-0,01		3,29	4,22	-1,47		3,16	3,63	-0,33		3,54	5,14	0,81	
U051	10.Mär	3,84				4,27				2,53				2,17			
U052	10.Mär	5,18				2,81				4,42				3,32			
U053	10.Mär	3,14	4,05			2,57	3,22			2,4	3,12			3,69	3,06		
U054	10.Mär	3,79				3,28				2,51				3,58			
U055	10.Mär	4,47				2,97				5,25				2,57			
U056	10.Mär	3,25	3,84	-0,22		3,7	3,32	0,10		1,72	3,16	0,04		2,99	3,05	-0,01	
U071	10.Mär	4,56				4,87				4,91				3,6			
U072	10.Mär	13,94				5,01				11,35				3,71			
U073	10.Mär	5,51	8,00			5,82	5,23			3,53	6,60			5,65	4,32		
U074	10.Mär	7,69				4,49				6,55				5,15			
U075	10.Mär	6,34				5,4				6,32				6,04			
U076	10.Mär	4,2	6,08	-1,93		3,73	4,54	-0,69		4,28	5,72	-0,88		3,25	4,81	0,49	
U091	10.Mär	5,5				4,82				6,44				4,26			
U092	10.Mär	7,82				9,82				5,67				6,01			
U093	10.Mär	7,91	7,08			4,98	6,54			10,13	7,41			7,69	5,99		
U094	10.Mär	6,39				3,55				5,87				4,64			
U095	10.Mär	6,38				6,51				6,35				4,75			
U096	10.Mär	7,79	6,85	-0,22		8,47	6,18	-0,36		5,88	6,03	-1,38		6,96	5,45	-0,54	
U111	10.Mär	3,56				3,55				3,66				2,98			
U112	10.Mär	3,66				3,95				3,54				2,95			
U113	10.Mär	3,03	3,42			3,69	3,73			2,38	3,19			2,56	2,83		
U114	10.Mär	4,77				6,73				2,84				1,97			
U115	10.Mär	5,13				2,5				3,59				3,74			
U116	10.Mär	2,52	4,14	0,72		2,19	3,81	0,08		1,83	2,75	-0,44		2,89	2,87	0,04	
U131	16.Mär	4,81				6,74				3,53				2,93			
U132	16.Mär	5,81				5,18				5,03				4,32			
U133	16.Mär	7,15	5,92			3,52	5,15			5,71	4,76			4,73	3,99		
U134	16.Mär	3,63				2,65				3,03				3,74			
U135	16.Mär	4,55				2,35				1,99				3,76			
U136	16.Mär	3,94	4,04	-1,88		3,27	2,76	-2,39		2,15	2,39	-2,37		2,37	3,29	-0,70	
U151	16.Mär	8,72				3,56				7,02				5,88			

U152	16.Mär	5,09				4,92				4,53				3,58			
U153	16.Mär	6	6,60			5,39	4,62			7,38	6,31			1,63	3,70		
U154	16.Mär	9,29				9,58				4,23				8,28			
U155	16.Mär	5,46				2,78				4,46				3,55			
U156	16.Mär	4,07	6,27	-0,33		2,87	5,08	0,45		3,94	4,21	-2,10		1,94	4,59	0,89	
U171	16.Mär	11,39				11				10,49				9,4			
U172	16.Mär	9,74				6,73				8,43				10,62			
U173	16.Mär	14,91	12,01			11,9	9,88			16,26	11,73			15,43	11,82		
U174	16.Mär	11,94				6,41				15,03				8,17			
U175	16.Mär	9,4				9,74				5,9				10,86			
U176	16.Mär	14,49	11,94	-0,07		4,86	7,00	-2,87		17,3	12,74	1,02		10,85	9,96	-1,86	
U191	16.Mär	5,17				7,12				3,42				4,06			
U192	16.Mär	7,47				6,94				7,69				6,91			
U193	16.Mär	6,8	6,48			5,94	6,67			8,88	6,66			3,64	4,87		
U194	16.Mär	6,67				7,4				3,8				5,35			
U195	16.Mär	5,85				4,11				4,98				6,59			
U196	16.Mär	4,53	5,68	-0,80		4,52	5,34	-1,32		3,1	3,96	-2,70		3,11	5,02	0,15	
U211	16.Mär	8,89				7,8				9,16				3,81			
U212	16.Mär	10,55				4,26				8,99				5,95			
U213	16.Mär	8,49	9,31			10,37	7,48			4,8	7,65			3,81	4,52		
U214	16.Mär	11,07				7,9				6,39				15,05			
U215	16.Mär	6,73				7,32				7,87				3,02			
U216	16.Mär	11,97	9,92	0,61		4,74	6,65	-0,82		12,69	8,98	1,33		12,27	10,11	5,59	
U251	16.Mär	5,36				2,35				4,81				2,85			
U252	16.Mär	5,09				3,55				3,5				4,65			
U253	16.Mär	4,28	4,91			3,11	3,00			4,72	4,34			3,85	3,78		
U254	16.Mär	8,17				4,51				6,07				7,91			
U255	16.Mär	3,17				3,18				1,81				2,83			
U256	16.Mär	6	5,78	0,87	-0,30	2,33	3,34	0,34	-0,82	2,96	3,61	-0,73	-0,78	1,85	4,20	0,41	0,48
					-0,20				**-1,17**				**-0,65**				**0,68**