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Abstract of dissertation

Pelvis malposition is related to knee dysfunction by loading of long duration

(presentation in the case of endurance runners)

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Prague, 2009

Title: **Pelvis malposition is related to knee dysfunction by loading of long duration (presentation in the case of endurance runners)**

Purpose: During endurance run knee problems often appear. This study wants to show the connection between a one- sided malposition of the pelvis and pain of the knee during an endurance run.

Hypothesis: Based on a literature research we expect: that there is a relation between a pelvis malposition and a knee joint dysfunction and that there is no specific relation between the localisation of pain in the knee region and the type of pelvis malposition.

Method: We tested endurance runners which had pelvis malposition and knee dysfunction. Therefore 100 athletes were tested, 50 with knee pain and 50 without knee pain. Manual examination and clinical instruments (measure tape and goniometer) were used for examination of sacro-iliac joints, for measurement of vertical distance between spinae iliacae anteriores superiores and anatomical leg lenght and for measurement of hip and knee movement ranges. Collected data were analysed by appropriate statistical methods.

Results: The results show that there is a connection between a one- sided pelvic malposition and pain of the knee of endurance athletes. But localization of the knee pain can not be related to the type of os coxae malposition. These relations are probably realized by changes in lower extremity kinematics as a result of pathological muscle chains. But we can not say where the primary cause of them is.

Conclusion: On the base of our results we can accept both hypothesise which we wanted to test. But the study couldn't work out if the pain was caused by the knee itself and could not clarify whether knee complaints or an os coxae dysfunction or another cause activated the pain in the first place. This is part of further scientific research.

Main importance of our work can be seen in application of anatomical, biomechanical and clinical knowledge to such specific movement like long distance running where many different factors can negatively influence physiological movement.

Keywords: Pelvic malposition, os coxae, sacroiliac joint, cause- and- effect chain.

Content

1. Introduction

Long distance runners often have problems with their knees. In my own clinical experience and in my physical therapy practice as a sports physiotherapist of international sports championships I treat a lot of persons who complain about having problems with their knees. Treating the symptoms of the knee often leads to a temporary success, which usually ends with the return of the same symptoms after a short period of time.

The reasons why endurance runners suffer from knee pain quite frequently is polymerous. They can be subdivided into anatomical, biomechanical and functional reasons. The anatomical factors for example may be connected with different anatomical leg lengths on both sides of the body or with a congenital position of a joint, which is disadvantageous for running. The biomechanical factors may be connected with the kinetics of running and with an overstrain put on the joints and muscles of the lower extremities. The functional factors are connected with the development of pathological muscle chains which pass through the body and even include the lower extremities. The chains cause muscle dysbalances which then cause not the uneven distribution of strain put on joint structures. However, the main cause of the chains may be located in the locomotor apparatus itself but also in internal organs which irritate the muscles, or they can be caused directly by close contact or by means of autonomous nerve reflexes. In most cases the causes for those problems cannot be found within the knee joint itself.

While examining the movement it became evident that they consist of a line up of complex motions. The pelvis is, because of its anatomic position within the body, a central organ (Kapandji, 2001). If there are any blocks or malpositions within the pelvic area, the ongoing movements during running which take place especially in the lower extremities, cause a so called cause- and- effect- chain (Richter and Hebgen, 2006). Especially malpositions of the iliac bone, fixed by hypertone muscles, joint blocks or shortening of fascial structures lead to consequences for the musculoskeletal system (Auerbach and Heyde, 2005). Within the movement chain, especially the knee joint reacts very sensitive to dysfunctions and blocks in the lower extremities (Niemuth, 2005). In the clinical, sports physiotherapists and orthopaedic practice, the work on knee problems normally concentrates on the isolated assessment of findings and treatment of the knee joint, according to the symptoms.

2. Summary of literature overview

In this chapter we point out the main informations we introduced in previous chapters and which could serve like important backgrounds for targets and hypothesises for this study.

A dysfunction of the pelvis may be diagnosed according to two main signs, the position of the anterior and posterior superior iliac spines and a dysfunction of the sacroiliac joints (Thiel and Richter, 2009). Changes in the spine position can be measured with a scale. We can measure the vertical distance between them. A dysfunction of the sacroiliac joint may be diagnosed through different manual methods (Frisch, 2001). We prefer the leaning-forward test.

The two most important pathologies inside the pelvis are os coxae anterior and posterior (Meert, 2003). Each of them can be present only on one body side, the other side can be healthy, without a dysfunction (Vleeming and Snijders, 1990) or can suffer from the same or opposite dysfunction. As a result of a one-sided dysfunction, a cause-and-effect chain appears in the lower extremities (Deleo et al., 2004).

The long muscles which interconnect the pelvis and the knee joint, such as the m. biceps femoris (caput longum) and the m. rectus femoris have a direct influence on the knee joint (Hossain and Nokes, 2005). The m. iliopsoas and the m. piriformis influence the position of the os coxae on the same side (Auerbach and Heyde, 2005). If there is a blockade of the iliosacral joint or a malposition within the pelvic area, a so-called cause-and-effect-chain could arises in the lower extremities as a result of these pelvic pathologies (Richter and Hebgen, 2006). In this case, the knee joint is especially sensitive to these dysfunctions (Niemuth, 2005). A malposition of the iliac bone which has developed as a result of muscle hypertonus, joint blocks or shortening of fascial structures leads to dysfunctions in the musculoskeletal system and activates the myofascial trigger points (Licht et al., 2008). Anatomically shorter lower extremities cause a lateral tilt of the pelvis. This pelvis position could overstrain the knee joints, too.

A shorter leg gets compensated by genu varum through overstrain put on the medial meniscus and a stretching of the ligaments on the lateral joint side (Lanz and Wachsmuth, 2004), a longer leg gets compensated by genu valgus through overstrain put on the lateral meniscus and a stretching of the medial ligaments (Frisch, 2001). We aim to measure the anatomical length of the lower extremities, because if there is a big difference in a bilateral comparison we can draw conclusions about its influence on the position of the pelvis (Kayser et al., 2008).

The ranges of movement in the knee joints in direction to flexion and extension depend on the tonus and power of the muscles which move the knee joints (Lane et al., 1987). If any cause-and-effect chain is present in the lower extremities, the agonistic muscles causing the chain will be hypertonic, the antagonistic muscles will be stretched and hypotonic as a result of reciprocal inhibition (Simon and Travel, 2000). This results in a muscle dysbalance and bad muscle coordination which then cause the knee pain. Degenerative (structural) changes in a joint cause the reduction of the full range of a movement and negatively influence the cause-and-effect chains (Deleo et al., 2004). That is why we want to measure the full range of movements of the knee joints (Brosseau et al., 2001) and the hip joints (Auerbach and Heyde, 2005). There are two reasons for this measurement. First: (as an exclusion criterion) persons with structural changes in these two joints cannot be members of our experimental group. Second: we expect changes in the knee joint movement ranges (in comparison to the knee joint of the other side) when a cause-and- effect chain is present during long distance running (Niemuth, 2005).

The results of the literature overview show that there are some difficulties in the understanding of the interrelation of a pelvis malposition and knee complains of long distance runners. We would like to fill this gap through a study of the relation between a pelvis dysfunction and the presence of pain in the knee region.

3. Purpose of the study

The aim of the study is to test whether there is a relationship between a one-sided malposition of the pelvis and knee pain and if there is an influence of sportive activities because of the stress caused by a long duration of the activity. Therefore, we want to measure the position of the pelvis through the measurement of the vertical distance between the anterior superior iliac spines in order to diagnose a pelvis dysfunction, to examine sacro- iliac joints through the leaning-forward test and to state which side of the pelvis does not function normally. We want to examine the ranges of movement in the hip and the knee joints in order to exclude structural damage and to say if there is a relation between a pelvis malposition and a knee joint dysfunction. We want to measure the anatomical leg length, as big differences get compensated through a change in the knee joint position resulting in an overstrained joint. The persons get a paper in which they describe where the pain in the knee region is situated and report the subjective pain. We describe qualifying and disqualifying criteria to get (if possible) a homogeneous group of probands and to prevent the affection of the results through unexpected factors. Up to now it is not clear whether there is a specific local relation between the knee pain and the type of the pelvic dysfunction. This is one of the reasons for our study.

Scientific results which we receive through this study could help clinicians to improve the examination of patients and invent further treatment, especially in sports physiotherapy.

4. Hypotheses

In our study we search for relations between a pelvis malposition and knee pain. This is a common problem which can affect any person regardless of gender, age, job or sport. Endurance running was selected for our work because of the multiple repetition of the same cyclic movement and the increased stress put on the lower extremities and their joints which include the knee joints. Than the forces caused by the lower extremities are high enough. By doing so we were able to work out that it is not possible to compensate this dysfunction with other joints of the lower extremities.

Two hypotheses were set up as a consequence of the literature research:

1. There is a relation between a pelvis malposition and a knee joint dysfunction.
2. There is no specific relation between the localisation of pain in the knee region and the type of the pelvis malposition.

5. Methodology

A group of long endurance runners got examined with the help of manual and instrumental methods which measure distances in cm (Berg, 2007) and angles in degrees ° (Leighton, 1994). A documentation of the localization of pain in the knee region will be provided in written form. In the following chapters we will describe the study plan, the sample, the strategy of analyzation, the anamnesis data, the methods of examination, the collection of data and the statistics.

5.1 Study plan

We want to test endurance runners which have a pelvis malposition and a knee dysfunction. The running is a specific movement of permanently repeating stereotype movements without the quick changing of the direction of the movement (Hohmann and Wörther, 2005) and without direct contact with other sportsmen. During the running events between Stuttgart and Heilbronn, every participant gets a handout in addition to his starting documents. On this handout, there is a note that runners who have problems with their knees without any pain in the knee and who are interested can take part in the study and may in return participate in a raffle. The persons who show one or more of the disqualifying criteria will be excluded and cannot participate in the examination (see following chapter).

After documentation about the knee pain the persons will examined manually and with simple instruments. These tests and measurements should show whether there is a block of the iliosacral joint and if the ossa coxae are in a malposition (Zeller et al., 2005). We will examine 2 groups, one proband and one control group, they will select according to the disqualifying criteria (see following chapters).

5.2 The sample

The participants of the examination are female and male persons. We plan to test 100 probands. They will be subdivided into two groups: one group (50 persons) with knee pain, second group (50 persons) without knee pain. We will compare the measurement results of both groups and they will be selected according to the same criteria.

Qualifying and disqualifying criteria for probands selection:

1) The age of the runners should not be higher than 50 years, as over 50, secondary influences like arthrosis, injuries, problems with inner organs are more frequent (Lane et al., 1987). Persons who are younger than 20 years are also excluded, as the growth of their bones has not yet been finished completely (Niethard and Pfeil, 2003).

2) We test persons who have been running a minimal average of 40 km per week during the last 6 months. Than the forces caused by the lower extremities are high enough for us to assume that it is not possible to compensate them with other joints of the lower extremities (Deleo et al., 2004) if there is a malposition of the pelvis (Hohmann and Wörther, 2005).

3) Runners with acute stabbing knee pain who have had a knee operation or who have had an accident where the knee was involved. Such knees are not qualified for the study because their structural dysfunction or pain can originate from other health problems and not from running (Niethard and Pfeil, 2003).

4) If the difference of the whole range of movement is greater than 15% in the hip and in the knee joint if we compare the left and the right side, the test person cannot participate either. If there is an even greater difference we can assume that there is a structural (damage) problem (Shellock and Mink, 1999).

5) Runners who have huge problems with the internal organs of the small pelvis cannot participate as we can assume that these illnesses will have an effect on the position to the os coxae (Meert, 2003).

6) Persons with a dysplasia of the hip joint will not be tested because the kinesiology and function of movements will differ on both body sides (Bachmann et al., 1999).

7) People with a neurological affection in the lumbosacral area will not be tested because the control they have over their body and especially over their muscles is different (Berg, 2007).

5.3 Strategy of analysis

The 100 probands (50 with, 50 without knee pain) will be measured in the lower extremities and will be asked for general data, running strain and pain (feeling and localization) while running. The relevant data will be measured again 4 weeks later. This retest will show if anything changed. In the statistic evaluation we describe the results and introduce tables and graphics there (diagrams, boxplotts).

The normal deviation of the date will be checked with the Kolomogorov- Smirnov- test, to see if the groups are normally deviated. The F- test (Levene- test) is used to check the homogenity of variance (Thomas and Nelson, 2001).

5.4 Anamnesis data

We asked members of our sample for the gender, age, body high and body weight and for intensity of running load (how many km they run weekly).

Distribution of men and women

Persons of both sexes were present in our sample of 100 persons, 57 men and 43 women, the average age was 34 +/- 10 years, ranging from 20 - 50 years. In the proband group there were 32 men and 18 women, in the control group there were 25 men and 25 women.

Age distribution in proband and control group

The average age was different in the two groups. In the proband group, the persons were between 21 and 50 years old, in average 39 +/- 8 years old. In the control group the persons were between 20 and 50 years, in average 29 +/- 8 years old. (The mean age of the proband group was approximately 10 years higher than the mean age in the control group).

Body heigh and weight distribution in proband and control group

The *body heigh* in the proband group ranged from 163 to 189 cm, in average 176 +/- 7 cm. The body height in the control group ranged from 156 to 191cm, in average 174 +/- 8 cm. (The difference was only 2 cm).

The *body weight* in the proband group ranged from 49 kg to 81 kg, in average 68 +/- 8 kg. The body weight in the control group ranged from 44 to 79 kg, in average 65 +/- 8 kg. The body weight in the proband group was approximately 3 kg higher than in the control group.

Strain during running in proband and control group

One of the qualifying criteria for the sample was running at least 40 km weekly. Our athletes ran between 40 and 90 km per week during the last 6 months, the average value came to 55.8 +/- 11.5 km.

The 50 persons of the proband group ran between 40 and 90 km weekly, in average 55.8 +/- 11.5 km. 15 people ran 50 km and 13 people ran 60 km per week. 9 athletes ran over 60 km. 10 probands ran less than 50 km.

The 50 persons of the control group ran between 40 and 90 km weekly, in average 55.9 +/- 11.7 km during last 6 months. 47 persons ran between 40 and 70 km weekly, 2 persons ran more than 75 km per week (both groups ran nearly the same distance per week).

5.5 The methods of examination

For our examinations we used instruments which are obviously used in clinical practice and which are used to measure the distances and the angle grades. The literature data (Brosseau et al., 2001; Kool and Bie, 2001; Berg, 2007) and logical validity attest the validity of the instruments used for the measurement of distances and angles.

Parameters for measurement

a. Testing of sacroiliac joint function. I use the leaning- forward test while sitting as it has been described by Frisch (2001). In the starting position the person is sitting upright on the treatment couch without any contact of the proband´s feet with the ground. The therapist's thumbs palpate the skin depressions in the area of the spina iliaca posterior superior while the proband moves his upper part of the torso forwards and downwards. It has to be tested which side of the spina iliaca posterior superior moves earlier towards cranial ventral, which means that an ongoing movement that starts too early is initiated. This is an accepted qualitative test, to see if there is a difference between movements of the iliosacral joint on both body sides. If the test is positive there is a blocked iliosacral joint (Brokmeier, 2001). Joint blockage is present on that side where the spine movement starts earlier.

b. The anatomic leg length is to be measured. The person lays in back position. The most prominent point of the trochanter major is measured in relation to the foot sole (lateral margin of the heel). The unit is measured with the help of a tape measure. The units of measurement are centimetres (cm). The measurement takes place in bilateral comparison. We need the data in order to find out if there is an anatomical length difference, as a difference of over 1.5 cm in bilateral comparison influences the position of the pelvis (Kayser et al., 2008).

c. The position of the two anterior superior iliac spines in relation to one another within the frontal section is to be measured. It is also called one sided pelvic or os coxae malposition, these 3 definitions mean the same. The proband lays in back position. The distance from the right to the left spina iliaca anterior superior in direction towards cranio- caudal of the frontal section is being measured. The units of measurement are centimetres (cm). The instrument used for the measurement is a pelvimeter with tape measure inside. It was built by professionals for our study. We have tested the validity of the measurement in the biomechanic institute.

d. The movement amplitude of the knee joints in relation to the active flexion and extension is being measured. The goniometer is placed with its axis in the middle of the knee seen from the lateral side. The persons moves their knee joint active into flexion and extension, this is to be measured in angle grades (Brosseau et al., 2007). If there is a difference greater than 15% in comparison to the other side, we can assume that there is a structure problem in the knee joint (Hohmann et al., 2004).

e. The movement amplitude of the hip joints in relation to the active rotation is being measured. The knee joint is 90° flexed. The proband is being asked to move his leg in the hip joint actively in the endorotation and after that in the exorotation. The end of the movement is reached if the os coxae of the same side start to move as well (Meert, 2003). The angles are being measured. The unit of measurement is angle grade (°). The measurement compares the two sides. If there is a difference of more than 15% in comparison to the other side, we can assume there is a structure problem in the hip joint (Brokmeier, 2001).

f. Documentation of pain localization in the knee region. Only the group of probands with the knee pain will be asked. The probands will be asked about their pain during running and its exact localization, if possible. The probands have to answer if their pain is located ventral, dorsal, medial or lateral, or in a combination of ventral and medial, ventral and lateral, dorsal and medial, dorsal and lateral.

g. The probands will be asked to describe the subjective intensity of their knee pain during running and to put it into a scale between 0 and 100 mm. 0 means the probands have no pain, 100 means the probands have so much pain that they would not be able to run. The persons make a point in the protocol scale.

5.6 Collecting the data

We prepared some protocols and tables for each test person. In which we fill in the results of the measurements, which means all the measured distances and angles. During the measurement of the distances (unit are cm) the athletes' anatomical leg length and the cranio- caudal distance of the spinae iliacae anteriores superiores get measured. The athletes' range of movement (units in angle degrees) from maximal knee flexion to maximal knee extension and the endrorotation and exorotations of the hip joint get tested. The documentation will provide information about the localization and subjective feeling of the knee pain (pain scale).

5.7 Statistics

We use descriptive and interference statistics to show and describe correlations and differences. With the help of dependent and independent t- tests (middle value, t- value, df) we are able to decide if mean differences between two groups are statistically significant or not. The Pearson correlation coefficient will be calculated to quantify the correlation between two variables. These results will be described (t- test and correlations). In addition we will show the result of a t- test with a 95% interval of confidence (Cuming and Finch, 2005). The measurement method has to be valid and reliable (Thomas and Nelson, 2001). The validity of our measurements has been proven, see literature data (Brosseau et al., 2001; Kool and Bie, 2001). The validity and the coefficient of reliability were provided for devices we used for the measurement.

The validity and reliability of the pelvimeter got tested. To show the validity of the pelvimeter method, we compared it with the optic system simi motion 3- D. We carried out this test in the biomechanical institute in the department of biomechanics. Then we calculated a reliability coefficient r. Our result shows a high level of correlation so that we can accept the pelvimeter for measurement of SIAS vertical distances.

We have proven the pelvimetertest, goinmetertest and tape measure are proved with the test- retest method (Thomas and Nelson, 2001). The correlation coefficients show a significant level between p< 0. 01 and p< 0. 05. So we can accept it for our work.
We have proven the objectivity. This means how independent is our test from the individual tester. Different therapists measured the same joint in the same person with the same method on the same therapy table at the same day. It was measured by 3 persons, by myself (therapist 1) and by two other therapists (therapist 2 and 3) with a long- time experiences of making measurements with these instruments. 10 persons were measured in the test- retest with a goniometer for measuring the angles in degrees by knee flexion/ extension (Brosseau et al., 2001). We measured also the anatomical leg length (cm) with a tape measure (Zöfel, 2003). With the pelvimeter we measured the distances of the two spinae iliacae anteriores superiors (SIAS) in bilateral comparison (cm scale). The correlations coefficients show a significant level between p< 0.01 and p< 0. 05. So we can accept it for our work.

6. Summary of the results

In regard to the **results** of examinations I started with the *leaning forward test* to see if there is a dysfunction of the iliosacral joint. In the proband group all 50 persons had positive results, what means that the test was positive for all persons in the proband group on the same side where the knee pain occurred. The distribution of dysfunctions on the left and right body sides was almost identical. In the control group only 5 persons had an iliosacral dysfunction.

We compared the **range of movement** in the *knee joint* of the two body sides. We found no one whose difference was greater than 15% of the full range of movement, which is why nobody was excluded from our sample. If we go into detail we can see there that is a similar tendency in both groups. In both groups the knee joint flexion in both groups is in average slightly stronger on the right body side, whereas the extension is slightly stronger on the left side.

A similar tendency could be seen in regard to the *hip joints*. If we compared the full range of movement between the hips on both body sides we found nobody who exceeded 15% of difference. In a similarly way as the knee joints, the hips showed a tendency to a stronger endorotation on the right side and a stronger exorotation on the left one. In regard to the knee and hip joint we only speak about tendencies as the differences were to small.

All members of our proband group had a **pelvis malposition** with knee pain and most members of the control group had one without knee pain. But in the proband group the differences shown in the bilateral comparison of the os coxae position were way bigger (in average 0.9 +/- 0.4 cm) than in the control group (in average 0.3 +/- 0.1 cm). We can conclude that a transfer of the pain from a pelvis dysfunction to the knee joint only takes place if there is a much higher deviation of the os coxae bones. In the *retest* 4 weeks later we found minimal differences of the middle values. We can assume that the differences of the pelvic position and malposition are stable over a period of time of 4 weeks. If we go into detail we can see that during the second examination persons who have had an injury in the 4 weeks showed bigger differences (supination injury or problems with lumbar spine). These persons had a relatively high deviation of the spinae iliacae anteriores superiors in bilateral comparison towards vertical. As for the persons who suffered a supination trauma, their malposition of the os coxae of the same side changed towards posterior, in one case 1.7 cm in the other case 1.9 cm. We could say that there is a tendency of the os coxae towards posterior, after a supination trauma. Regarding the persons who had problems with the lumbar spine we found one whose os coxae had moved towards anterior (2.3 cm) and one towards posterior (1.7 cm). We were not able to measure 3 persons of our sample the second time. One left the town and his new address was unknown. 2 have had a knee operation in the meantime and were not measured.

In the proband group (50 persons) **a one-sided malposition** of the os coxae toward anterior of the right side was found more often (18: 6), on the left side a posterior os coxae malposition was more frequent (19: 7). In conclusion we could say that the left os coxae show a stronger tendency to a posterior malposition, whereas the right os coxae could have a tendency to an anterior malposition.

During the examination of the pelvic deviation and the **subjective intensity of knee pain** we found differences within the proband group in bilateral comparison. In regard to a malposition towards posterior the subjective knee pain was stronger, in average (72 +/- 9) than in regard to a malposition towards anterior (51 +/- 7). So we could assume that the malposition towards posterior provokes a stronger subjective pain than the malposition towards anterior.

We were only able to produce a descriptive statistics of the relation between a pelvis malposition and the **localization of knee pain**, because the number of persons in the individual groups who helped with the pain localization was to small.
The localization of knee pain in the proband group differed in regard to the location of the one-sided os coxae malposition. In regard to an anterior malposition (24 persons) the medial knee pain dominated (20 persons). In regard to a posterior malposition (26 persons) the lateral knee pain dominated (15 persons). In conclusion we could say that a pelvis anterior malposition is often connected with medial knee pain, a posterior pelvis malposition is often connected with lateral knee pain. This part of the chapter concentrates only on tendencies. There are too few persons in each group for statistic calculations, which is why we cannot find a correlation or a difference between the position of the os coxae and the localization of the knee pain. However, the diagrams clearly show that there is a deviation to all parts of knee localization. This supports our second hypothesis.

7. Discussion

The study was carried out in order to verify the relation between a pelvis malposition and the knee pain of endurance athletes. Based on our literature research (Richter and Hebgen, 2006; Peeters and Lason, 2000; Frisch, 2001; Meert, 2003; Snijders, 1995), we hypothetically expected that there is a correlation. All these authors believe this relation to be a result of so-called cause-and-effect-chains, seen from a functional, anatomical point of view.

7.1 Discussion of the results

According to our results we can state that higher age and higher body weight (Kleindienst et al., 2006) could be risk factors for endurance runners for the development of knee pain.

All members of the proband group had an iliosacral joint dysfunction and an os coxae malposition on the same side. It was diagnosed through the examination of the iliosacral joint function and through the measurement of the vertical distance between the SIAS of the two body sides. It corresponds with findings of other authors (Thiel and Richter 2009) who believe these two signs to be typical and characteristic symptoms for a pelvis dysfunction (Zeller et al., 2005; Vleeming and Snijders, 1990).

As a result of our measurements we could conclude that the os coxae anterior on the right side have the tendency to be connected with the endorotation of the hip and flexion of the knee joint. The os coxae posterior on the left side has the tendency to be related to the exorotation of the hip and extension of the knee joint. This finding differs from the literature data (Richter and Hebgen, 2006) which describes the endorotation of the hip to be a part of extension muscle chains. But we got these results through the measurement of healthy persons.

One could expect a similar distribution of anterior and posterior os coxae malpositions on the left and right side. We conclude on the base of our results that the right os coxae have a stronger tendency for an anterior malposition and the left os coxae for a posterior malposition.

All members of the proband group showed a connection between the pelvic malposition and the pain in the knee joint on the same body side. This result supports our first hypothesis about a relation between a pelvis malposition and knee pain. This relation is probably realised by cause-and-effect chains which have been described by many authors on the base of muscle interconnection between the pelvis and the knee (Richter and Hebgen, 2006; Peeters and Lason, 2000; Frisch, 2001; Meert, 2003; Snijders, 1995).

Our results show that if there is an os coxae anterior malposition the medial knee pain dominates. Contrary to this, the posterior malposition is in most cases connected with a stronger lateral knee pain. This difference in the pain localization in both knee joints is reciprocal to the different tendencies of the ossa coxae for anterior and posterior malpositions.

Pain is a very subjective feeling. Every person has another pain threshold. A feeling of pain is influenced by different factors such as the psychological state, fatigue, parameters of weather and so one. But our results show that knee pain which is linked to an os coxae posterior malposition is more intense than pain which is linked to an os coxae anterior malposition. The os coxae posterior belongs to the extension muscle chain. This chain is realised by postural muscles which are stronger than phasic muscles which are part of the flexion muscle chain. (Chaitow, 2002). Especially the postural muscles of runners are overloaded (Kleindienst et al., 2006).

Between the first and second examination (4 weeks later) is not enough time for the development of degenerative changes. We did not expect changes in regard to the members of the proband group, because their activities were not limited during the break time. It means that pelvis position and malposition are relatively stable and a result of intensive endurance running.

On the base of our results and previous discussion, we can conclude:

We can accept the hypothesis number 1 because:

- the knee pain of all the members of the proband group was linked to an os coxae malposition on the same body side,
- ilio-sacral dysfunction in the proband group was present on the same body side where os coxae malposition and knee pain were present, whereas most members of the control group (without knee pain) did not suffer from an ilio-sacral dysfunction.
- os coxae deviation was much bigger in the proband group in comparison with the control group. This difference was statistically signíficant.

We can accept hypothesis number 2 because:

- this study concludes that there exists only a tendency for a relation between the type of the os coxae malposition (anterior or posterior) and the localisation of knee pain. The os coxae anterior causes predominantly medial knee pain, the os coxae posterior lateral pain.
- we speak only about tendencies as these relations cannot be supported statistically. The reason for this is that the number of probands who localized the knee pain individually was not big enough for statistical processing.

Our work could not clarify whether knee complaints or an os coxae dysfunction (or another cause) activated the pain in the first place. This is part of further scientific research.

7.2 Clinical usage of the results

People who do other sorts of sports or people who do not do any sports at all can also suffer from pain of the knee joint as the result of a so called cause-and-effect chain (Kleindienst et al., 2006; Hohmann und Wörther, 2005). Especially in regard to physiotherapy, sports physiotherapy and manual therapy it is important to differentiate between a dysfunction which is located in the knee area and a morphologic problem of the knee joint (Berg, 2007).

Especially young physiotherapists without any work experience might have problems if they want to make a proper statement about whether the patient has a one-sided pelvis malposition and about which side of the os coxae shows a malposition towards which direction. Similarly, they can have a problem with manual treatment of joints and muscles because relatively long time training of manual skills is needed to treat successfully. In order to achieve a professional result of examination it might be useful to use the device (pelvimeter) our company has developed to make an exact and fast diagnosis in regard to a comparison of the os coxae of both sides. For treatment, not only manual but also technical methods may be used. Different methods of so called physical therapy are beneficial for muscle relaxation, reduction of pain or for improvement of blood supply. Bathes, electrotherapy (ultrasound, currents, magnet) or laser may be selected according to the clinical signs.

Another important clinical outcome is the fact that the primary cause of a knee joint pain may be situated in another part of the human body. Unfortunately do most physicians and rehabilitation workers only treat the painful area of their patients' bodies without taking the chaining into consideration (Werner et al., 2000).

8. Conclusion

The study describes the relation of a pelvic malposition and knee problems as a result of long distance running. The results of our study show that a one- sided malposition of the iliac bone can probably cause knee problems because the knee pain and ilio-sacral dysfunction of all the members of the proband group was linked to an os coxae malposition on the same body side. In addition, os coxae deviation was much bigger in the proband group in comparison with the control group.

On the other hand, this study concludes that there exists only a tendency for a relation between the type of the os coxae malposition (anterior or posterior) and the localisation of knee pain. The os coxae anterior causes predominantly medial knee pain, the os coxae posterior lateral pain.
On the base of our result we can accept hypothesises number 1 and 2.

9. Literature

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This work will be publishing by the profession journal for sports medicine/ sports injuries. Stuttgart- New York: Thieme, 2010.