Can back pain caused by symptom-giving sacroiliac joint relaxation during pregnancy be reduced by applying osteopathic treatment?

A Master's Thesis for the degree of
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by
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Author's declaration of originality

I hereby certify that I am the sole author of this Master's thesis.

I certify that all literal and paraphrased quotations of works of other authors, published or unpublished, are marked as such and that all resources are duly referenced. No paper with the same contents has ever been presented before any other examination authority.

LEOBEN_____ _____

Date

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Abstract

Objective: My objective was to test the hypothesis whether it is possible to reduce the symptom-giving sacroiliac joint relaxation in pregnancy with osteopathic treatment and whether three therapy sessions are adequate for this purpose.

Design: This is an empirical study with non-randomised sampling (haphazard sample) applying within subject design.

Subjects and methods: 14 pregnant women with symptom-giving sacroiliac joint relaxation were examined from the 12th week of pregnancy till the 34th week of pregnancy. Before the therapy they were observed during one reference week with regard to pain intensity and quality of life. Observation took place also after the therapy.

Interventions: Three therapy sessions took place in intervals of one to two weeks. Observation was based on questionnaires answered before the therapy sessions and after each treatment. The pregnant women were tested by means of manual examinations before the series of therapy sessions and after the last observation period.

Results: Very significant improvement of the primary dependent variables, i.e. pain intensity and quality of life, was observed after the series of therapy sessions. Various manual examinations also indicated that significant improvement of the symptom-giving SIJ relaxation in pregnancy was achieved.

Conclusion: Three osteopathic therapy sessions are necessary for the treatment of symptom-giving SIJ relaxation in pregnancy in order to reach significant improvement.

Key words: pregnancy, sacroiliac joint, relaxation, pelvic pain, osteopathy, clinical tests.

Abbreviations

+LR	Likelihood ratio for positive test
ASLR	Active straight leg raise
g	Gramm
I.A.	Interexaminar agreement
K	Kappa agreement coefficient
K-S Test	Kolmogorov-Smirnov Test
L2, 4, 5	Lumbar segment 2, 4, 5
LAS	Less affected side
Lig.	Ligament
LS	Lumbar spine
M.	Muscle
MAS	More affected side
ml	Milliliter
mm	Millimetres
OMT	Osteopathic manual treatment
PGR	Symptom-giving pelvic girdle relaxation
PJS	Pelvic joint syndrome
PPPP	Posterior pelvic pain since pregnancy
PT1W - PT3W	Post therapy 1 week – post therapy 3 week
RDQ	Roland-Morris Disability Questionnaire
RW	Reference week
S1-S4	Sacral segment 1 - 4
SIJ	Sacroiliac joint
PSIS	Posterior superior iliac spine
SLR	Straight leg raise
SPSS	Statistical package for social sciences
T10	Thoracic segment 10
TP5-22	Test person 5-22
VAS	Visual Analogue Scale

Table of contents

0. Introduction

Can osteopathic treatment reduce back pain in pregnancy caused by sacroiliac joint relaxation? This Master's thesis will try to answer this question.

In my daily work as an osteopath I have recognised my personal interest in the most diverse possibilities to treat women osteopathically during their pregnancy. Frequent positive feedback after having treated pregnant women was a motivation for me to investigate in this field. In fact it was during my wife's pregnancy, who gave birth to our daughter Iris in spring 2006, that the idea for this empirical study came to my mind.

In their article published in 2000 [9] DiGiovanna and Schiowitz describe the role of osteopathy during pregnancy very concisely: *Osteopathic care throughout pregnancy provides the woman with the special benefits of adjusting the functions of her body to the demands of the progressing pregnancy.* [9, p. 459] When treating pregnant women it is, time and again, a great challenge to adapt one's therapeutic techniques to the changes and developments taking place during pregnancy. There are studies [22, 23, 64] which show that osteopathic manual treatment (OMT) influences the birth process in a positive way, but there are hardly any studies [25] which account for a positive influence on mothers' health during pregnancy.

My study intends to show that OMT can considerably reduce back pain caused by SIJ relaxation which appears physiologically during pregnancy. As SIJ stability depends on various biomechanical factors [24], it seems obvious to me that great positive effects can be achieved by the application of OMT.

The hypothesis of my study reads as follows: After having treated a pregnant woman suffering from back pain due to sacroiliac joint relaxation three times with OMT, it is possible to demonstrate, by means of the two parameters *pain intensity* and *quality of life*, that the discomfort of a pregnant woman is clearly reduced in a given period of time after OMT compared to the discomfort in a given period of time before therapeutic intervention. For this purpose I used a study design of repeated measurements with non-randomised samples.

As the period of pregnancy is a very delicate time which is sometimes accompanied by diverse complications [13, 38], it is an interesting challenge for osteopathy to adapt OMT to the needs of pregnant women in a way that significant improvements

of their health state can be reached without causing any relevant side effects. It is equally interesting to find out if three OMTs are an appropriate number of treatments during pregnancy.

The **first chapter** of this study gives an anatomic introduction to my field of investigation as well as a description of biomechanical and pathophysiological models of the SIJ. Furthermore I describe anatomical and physiological changes during pregnancy and the epidemiology of back pain occuring during pregnancy.

In the **second chapter** I describe osteopathic intervention during pregnancy in greater detail.

The **third chapter** offers a detailed description of the methodology applied in this study, and **chapter four** contains the analysis of all collected data. The final chapter of this Master's thesis is **chapter five**, covering the discussion and evaluation of the empirical findings of my study.

In the analytical part (chapter 4) as well as in the discussion of results (chapter 5), the secondary dependent variables are described first and the primary dependent variables second, as this order corresponds to the practical organisation of my study.

1. Background

1.1. Anatomy

1.1.1. The sacroiliac joint (SIJ)

The pelvic girdle is an articulated bony ring composed of the left and right coxal bone and the sacrum. These three bony parts are dorsally joined by the two sacroiliac joints (SIJs) and ventrally by the pubic symphysis. Even though this anatomic structure has to assure high stability, the pelvis shows a certain inherent mobility which plays an essential role in the birth process. [58]

No consensus has been reached so far regarding the anatomic classification of the SIJs. This may be due to the fact that in former times it was assumed that the SIJs did not have any mobility at all. This assumption was based on findings of in vitro studies of preparations of older persons where SIJs have been ankylosed already [24].

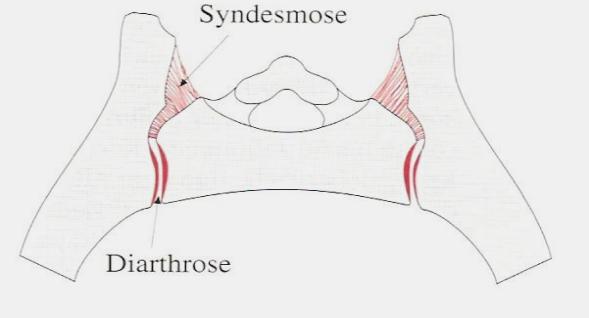


Fig. 1A: Transverse section of SIJ [24]

One part of the joint region can be described as a **diarthrosis**. It is a synovial joint composed of the joint cavity, joint capsule, ligaments and joint partners covered with hyaline cartilage. The first one to describe this joint as above was Von Luschka in 1854 [63]. [24, 58]

If the dorsal aspect between the ilium and the sacrum, which is filled with the interosseous sacroiliac ligaments, is seen as one separate part of the SIJ, this part of the joint can be described as a **syndesmosis**. [7]

1.1.2. Morphology of the joint surfaces

The joint surfaces of the SIJs are not plane; they show small ridges and grooves similar to a relief map. [7] These topographic features are very individual and do not develop before adolescence. [4]
According to Vleeming (1990) [60], these ridges and depressions develop in the third decade of life. The overall form of the joint surfaces is L-shaped or even resembles the form of an auricle. Therefore they are also named auricular surfaces. In humans the joint surface extends from the first to the third sacral segment. The number of vertebral segments embraced by this joint surface has increased in the course of evolution. [7] The shape of the joint surface depends on the curved shape of the sacrum. On average, the sacrum is more curved in men than in women. According to Meert, a less curved sacrum is more likely to cause a relaxation in the SIJ. [35]

1.1.3. Ligaments and fasciae

To cope with the great forces exerted on the pelvic girdle, the SIJ is surrounded and supported by very strong ligaments. These ligaments can be classified in two groups, the intrinsic and the extrinsic ligaments. **The intrinsic ligaments** are very short laminar bands that directly span the SIJ anteriorly and posteriorly. [58] These are:

- the ventral sacroiliac ligaments
- the superficial dorsal sacroiliac ligaments
- the deep dorsal sacroiliac ligaments
- the interosseous sacroiliac ligaments

The **extrinsic ligaments** are inserted into the respective bone, either the sacrum or the ilium, further away from the SIJ. [58]

The sacrotuberous ligament

The sacrotuberous ligament can be divided into three parts [58, 24, 35]:

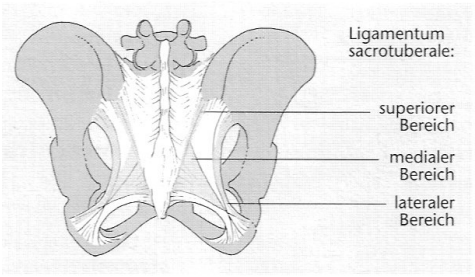


Fig. 1B: Sacrotuberous ligament [35]

- The **superior part** extends from the sacral inferior lateral angle to the PSIS. This part comprises fibres of the gluteus maximus muscle and of the deep lamina of the thoracolumbar fascia.
- The **medial part** extends spirally from the lateral aspect of the sacrum and the coccyx to the ischial tuberosity.
- The **lateral part** extends from the posterior superior iliac spine to the ischial tuberosity and is connected with the piriformis muscle. This part does not directly span the SIJ but represents an intraosseous bracing of the coxal bone between ischium and ilium.

Klein and Sommerfeld [24] specify the following main functions of the sacrotuberous ligament in the pelvis:

- support of the dorsal intrinsic ligaments
- closure of the pelvic floor
- region of insertion for the gluteus maximus muscle, the thoracolumbar fascia and parts of the tendon of the hamstring muscle
- damper of the sacral nutation (see chapter 1.2.3.) [24, p. 149]

The sacrospinal ligament

The sacrospinal ligament extends from the lateral margin of the sacrum and the coccyx to the ischial spine. It stabilises the coccyx in the frontal plane, closes the pelvic floor and serves as a nutation damper like the sacrotuberous ligament. [24, 35, 58]

The long dorsal sacroiliac ligament

Several anatomists [58, 62], Vleeming [62] even in greater detail, describe this ligament in addition to those named above. It runs between the superficial dorsal sacroiliac ligaments and the superior part of the sacrotuberous ligament and constitutes an important link in a chain of muscles and ligaments. The following structures blend into this ligamentous segment:

- hamstring muscle
- gluteus maximus muscle
- latissimus dorsi muscle
- erector spinae muscle
- deep lamina of thoracolumbar fascia

The iliolumbar ligaments

The iliolumbar ligaments extend from the transverse processes of L4 and L5 to the ilium. The orientation of these ligaments is highly individual. As they run across the SIJs as well as the joints between the vertebral segments L4/L5 and L5/S1, in terms of their function they are ligaments with various joints. [58]

The obturator membrane

The obturator membrane closes the obturator foramen almost completely, leaving a small gap of ten millimetres which forms, with the ischium as a further margin, the obturator canal. This membrane is a fibrous sheet consisting of tight connective tissue reinforced with diagonal fibres in certain areas. [58]

The thoracolumbar fascia [35, 58]

The thoracolumbar fascia forms the functional link between the nape, the trunk and the lower limbs. It consists of three layers:

- the anterior layer
- the middle layer
- the deep and superficial posterior layer

The thoracolumbar fascia is a very tight structure that inserts into the spinous processes of the lumbar spine, into the sacrum and into the iliac crest and continues further down as the fasciae of the buttocks and the lower limbs and laterally as the fasciae of the oblique abdominal muscles.

The posterolateral aspect of the thoracolumbar fascia is reinforced by the fascia of the latissimus dorsi muscle, which constitutes a link between the pelvis and the upper limbs, ending at the cranial aspect of the lateral bicipital groove. Furthermore it extends down to the inferior angle of the scapula.

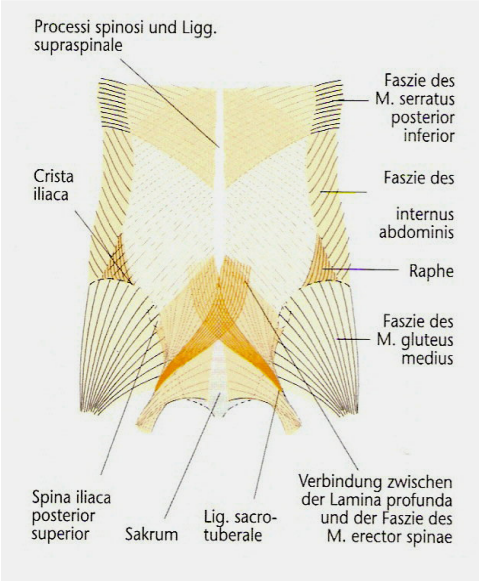


Fig. 1C: Thoracolumbar fascia [35]

The abdominal fascia

In its ventral aspect, the abdominal fascia has fibres that are crossed over. These fibres are the continuation of the dorsal fascia, lining the abdominal wall. Together with the dorsal fascia they provide for a stable and dynamic pelvic floor. [35, 58]

Fig. 1D: Abdominal fascia [35]

The peritoneum [18, 35]

The internal female genital organs are located subperitoneally in the pelvis, behind the bladder, and in front of the rectum. The uterus with the broad ligament of the uterus is located in the middle of this space. The uterus itself is partly covered by the peritoneum, which is firmly adhered to it. Only its lateral parts are linked to the hip bones exclusively by connective tissue. Recesses formed by the peritoneum ventrally and dorsally to the uterus enable it to glide in the subperitoneal space:

- the vesicouterine excavation
- the rectouterine excavation (pouch of Douglas)

The broad ligament of the uterus

In simple terms, the broad ligament of the uterus can be described as a subperitoneal space disposed in the frontal plane, filled with connective and adipose tissue and pervaded by supplying structures for the uterus and the vagina. The superior margin of the broad ligament forms a kind of "clothes line" which suspends the peritoneum and, like a septum, separates the pelvic bowl into the vesicouterine and the rectouterine excavation. [35, 40]

The round ligament of the uterus

The round ligament (ligamentum teres uteri) originates on both sides of the uterus at the uterine horns, goes down anterolaterally to the inguinal region, passes through the inguinal canal and continues on to the labium majus pudendi (large pudendal lip).

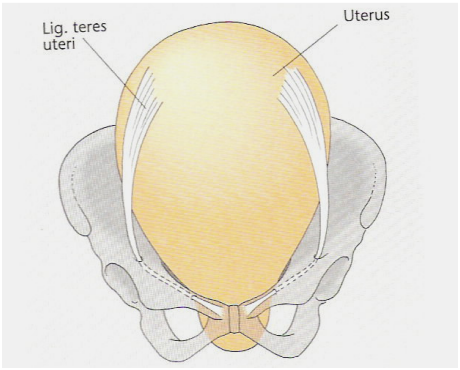


Fig. 1E: Round ligaments of uterus [3]

The round ligament develops in the female embryo from the lower gubernaculum. It consists of tight connective tissue and smooth muscle cells, and its function is to maintain the uterus in anteflexion. [3, 35, 40]
During pregnancy it has to be very elastic in order to enable the growth of the uterus. The round ligament shows a fourfold length expansion during these nine months. [3]

The suspensory ligament of the ovary

Laterally the broad ligament of the uterus forms, in its extension, a real ligament which joins the ovary, the infundibulum and the posterior aspect of the fallopian tube loosely to the lateral pelvic wall and the fascia of the psoas muscle. This ligament is called suspensory ligament of the ovary or, in clinical contexts, infundibulopelvic ligament. [18, 35, 40]

The sacrouterine ligaments

The sacrouterine ligaments attach at the level of the uterine isthmus and connect the uterus to the sacrum and the rectum. They constitute a posterior reinforcement of the rectouterine folds and prevent the cervix from moving in the direction of the urinary bladder and the symphysis. [3, 40]

1.1.4. Innervation

Innervation of the SIJ

The joint capsule is innervated by dorsal branches coming from S1, S2 and S3. [24, 58]

Innervation of the uterus

The uterus is innervated by sympathetic nerve branches coming out from the vertebral segments T10 to L2, running via the splanchnic nerves down to the celiac ganglion and superior and inferior mesenteric ganglion as well as to the renal plexus. These nerves extend, either together with blood or lymphatic vessels or as independent nerve fibres, to the hypogastric plexus and the uterovaginal plexus. There is discussion about a post-ganglionary innervation coming from the four sacral ganglia and the ganglion impar. [18]

The uterus also has a parasympathetic innervation coming out from the vertebral segments S2 to S4 and extending to the uterovaginal plexus.

1.1.5. Muscular structures

The pelvic floor, the abdominal wall and the thoracic diaphragm are three anatomic regions that play a central role in pregnancy and that are subject to major changes during this period. [35]

Any further detail in the description of the muscular structures would go beyond the scope of this study.

1.2. Biomechanics

1.2.1. Range of motion of the SIJ

In 2004 Klein and Sommerfeld [24] analysed several studies on the range and axes of motion of the SIJ. As a conclusion they found a total range of motion of only two to four degrees approximately.

Jacob and Kissling found out in their study (1995) [21] that symptomatic test persons with hypermobility in the SIJ showed a range of motion 3-4 times higher than normal, whereas Sturessan et al. (1989) [56] could not find any difference in bilateral comparison between symptomatic and asymptomatic SIJ test persons. Given these inconsistent findings, it seems to be possible to find individual cases showing very big ranges of motion due to unknown factors. However, the range of motion does not play a predominant role in the case of painful SIJ. [21]

Klein and Sommerfeld (2004) agree on the oblique helicoidal axes suggesting a three-dimensional motion sequence in this joint. The main component of motion takes place on a sagittal plane, but there is no common axis to the left and right joint, meaning that the sacrum cannot move freely in between the two iliac bones. If there is motion in one SIJ, there has to be motion in the other SIJ, too. [24]

1.2.2. Self-locking principles

When putting more pressure on the joint than there is in a neutral position (e.g. in the standing position, standing on one leg), the range of motion in the SIJ decreases and the joint locks up, a mechanism that may be potentiated by the surrounding muscular structures, which are pressing the joint surfaces together. Due to the ridges and grooves on the joint surfaces the friction becomes so strong that motion is hardly possible anymore in the joint. This entire mechanism has been described as *self-locking mechanism* by Vleeming et al. (1990) [60, 61] and Snijders et al. (1993) [52, 53]. They explain that according to their model the following muscle structures

contribute to this locking mechanism as they increase the pressure on the joint when contracted:

- the transverse abdominal muscle
- the middle part of the internal oblique abdominal muscle
- the piriformis muscle
- the coccygeal muscular structures and the pelvic floor

1.2.3. The pelvic shear

according to Klein and Sommerfeld [24]

The pelvic shear is a model which represents the pelvis as a buffer system in a sagittal plane. This model presumes certain mobility in the SIJ.

In the upright standing position, the two levers sacrum and innominate bone introduce a nutational motion in the SIJ. This nutation is slowed down by the sacrotuberous and the sacrospinal ligament. As they have a favourable leverage, they are the most effective dampers of the nutational motion, even though they act only passively. The following muscles are able to function as active nutation dampers:

- iliac muscle
- straight muscle of the femor, tensor fasciae latae muscle, sartorius muscle
- piriformis muscle
- muscles of the pelvic floor

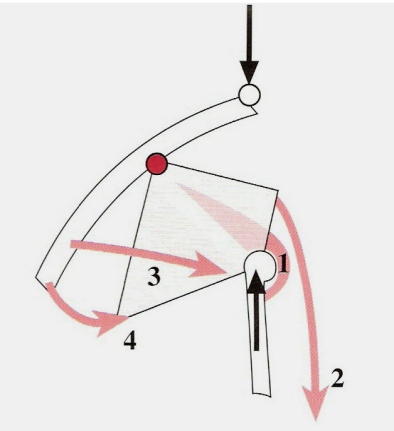


Fig. 1F: The pelvic shear [24]

During pregnancy the relation between the different levers changes and the stabilising ligaments get softer. Therefore the model of the pelvic shear can slightly deviate from its normal scheme.

1.2.4. Strain creep deformation

as described by Meert [35]

Connective and supporting tissue combine elastic and viscous properties, comparable with high polymer plastics. Therefore, they are described as viscoelastic tissues.

Viscoelastic material deforms slowly in the course of time until it reaches a steady state (strain). This deformation stays stable as long as a certain pressure or force on the material stays constantly the same. If the pressure or force releases suddenly, the material slowly "creeps" back into its original shape (creep phenomenon). A repeated stretching of the viscoelastic tissues leads to increasing deformation. During pregnancy the ligaments and fasciae in the pelvis and abdomen are subject to considerable changes, reaching their apex before delivery. It takes weeks for these structures to reassume their original shape.

If certain structures in a pregnant woman show weaknesses already before pregnancy and if there is not enough potential to adapt to or compensate for the changes, this may lead to problems and pain. [72]

1.2.5. Abdominal sagittal diameter

Back pain in pregnancy is a condition caused by many different factors. The primary biomechanical risk factor Östgaard et al. (1993) [45] have identified was the change in the abdominal sagittal diameter. This diameter increases on average by 55 % from the 12^{th} to the 36^{th} week of pregnancy. No other biomechanical factors have a greater effect on the development of back pain in pregnancy. [45]

1.3. Pathophysiology

In the literature [17, 29, 41, 35, 37] various denominations are used to describe "symptom-giving sacroiliac joint relaxation in pregnancy" or a similar complex of symptoms in the pelvic region. These symptoms are also interpreted quite differently depending on geographical regions or professional groups. Even every language has, within the scope of its linguistic possibilities, different descriptions of this phenomenon. In the following I want to illustrate briefly some of the denominations and diagnoses describing this complex of symptoms.

1.3.1. Blockage of the SIJ

.

Niethart et al. [41] define an SIJ blockage as an event where *usually a rotational movement gives rise to acute pain in the sacroiliac region. The reason for this pain is a blockage of the sacroiliac joint by a locking of the joint surfaces*. [41 p. 403]. As a consequence the range of motion in this joint is considerably limited. In osteopathy as well as in other manual therapeutic concepts (chiropractic, manual therapy according to the Kaltenborn or to the Maitland concept), the incorrect position of the sacrum and the ilium are analysed and treated in SIJ blockage. If one or both SIJ(s) is/are limited in its/their range of motion, this rarely causes symptoms in the affected SIJ; it rather affects the surrounding joints, especially the hip joint, the region of the lumbar spine, or even structures much further away, which become overstrained and therefore show symptoms in the respective region. [54]

Typical SIJ symptoms appearing in highly acute pain episodes are caused by great instability with very loose structures (ligaments) in the SIJ region.

As the SIJ is a planar joint with ridges or bumps, which normally increase stability, a very loose (or a very unstable) SIJ leads time and again to a so-called blockage of motion at the end of the range of motion. The two joint partners lock up and severe symptoms appear in the SIJ region. This complex pattern poses a great challenge for the therapist: to treat a blocked joint that, primarily, is a hypermobile one. Therefore it

is even more important to take a holistic look at the patient in order to include all different body regions in the therapy.

1.3.2. Instability and hypermobility

Klein and Sommerfeld [24] define an instable SIJ as a hypermobile SIJ causing problems or symptoms. Hypermobile joints can occur either isolated or as part of a syndrome, e.g. in case of excessively loose collagenous structures. [24]

1.3.3. Posterior pelvic pain since pregnancy (PPPP)

PPPP is often described as a distinct category. [37] It remains questionable whether PPPP is a specific syndrome or just a non-specific lumbopelvic pain with onset during pregnancy or delivery. Regardless of the answer, detailed study on the characteristics of PPPP could provide better understanding of lumbopelvic pain in general. Various instruments have been investigated to distinguish patients with PPPP from healthy subjects. Mobility of the pelvic joints assessed by the Chamberlain method showed a significantly higher range of motion between the pubic bones in women with PPPP than in a group of women without pelvic pain. [65] The specificity of this method was never studied in PPPP with disease duration exceeding six months. [37]

1.3.4. Symptom-giving pelvic girdle relaxation (PGR)

This concept is largely used in the Scandinavian region. It does not specify which joints are concerned. [17, 2, 37, 57]

Symptom-giving pelvic girdle relaxation is defined as a condition developing during pregnancy or delivery and is characterized by disabling pain located to the SIJs and/or the pubic symphysis. No objective criteria exist to confirm the diagnosis which is therefore one of exclusion. [29 p.105]

PGR can start to show in the first trimester; however, normally it does not occur before the fifth to eighth month of pregnancy. In most cases the symptoms disappear immediately after delivery, while in some cases the problems last for several more months. [29]

The study of Larsen (1999) [29] shows an incidence of 14 % during pregnancy for PGR, and 4 % still have problems during six more months after pregnancy, which are then called "pelvic joint syndrome".

1.3.5. Pelvic joint syndrome (PJS)

PJS often occurs after delivery as a consequence of PGR during pregnancy. W*omen with PJS suffer from constant and daily pain episodes located to the pelvis and symphysis pubis. The pain varies in intensity and strength and is enhanced by walking, when lifting light loads and when changing position. The pain in the joints is very often accompanied by uncharacteristic radiating pain to the gluteal region and thigh. The diagnosis is based on medical history. Thus, no objective criteria exist to confirm the condition.* [17 p.170]

1.3.6. Pain referral zones in SIJ instability

A hypermobile joint itself does not cause pain, but the structures surrounding such a joint like ligaments, joint capsule, muscles or even nerves, get irritated. In SIJ instability there are several different zones (see fig. 1G) where patients show painful symptoms. [14, 39]

The authors of the studies [10, 36, 44, 51, 57] indicate an incidence of pain of up to 95 % for the region directly above the SIJ and the region of the buttocks. Some authors examine both regions as one common pain referral zone. However, if this overall zone is diferrentiated and split up into two, the small region directly above the SIJ shows the highest incidence of pain. Pain in the lower lumbar spine is indicated with an incidence of up to 72 %. [36, 44, 51, 57, 10] Pain in the thigh on the affected side is indicated with an incidence of up to 48 % of the test persons. The inguinal region and the leg below the thigh show an incidence of only 28 %, if this percentage is indicated at all. [10, 51, 57]

The quality of pain caused by changing of the body position or by rotation movements is described as sharp and acute in the region of the SIJ. Pain felt in the buttocks, lower lumbars and legs is described as a constantly tearing and dull pain. [36, 57]

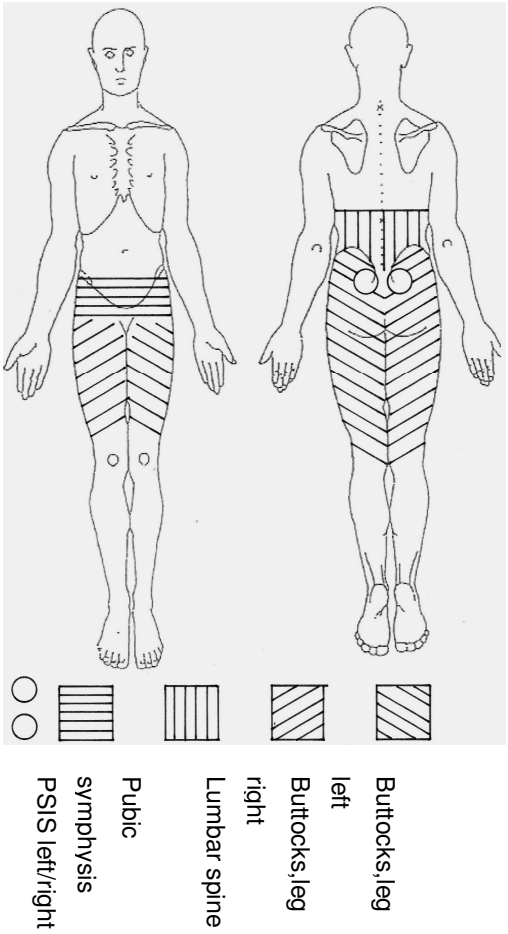


Fig. 1G: Pain referral zones

1.4. Changes in pregnancy

1.4.1. General aspects of pregnancy

Pregnancy is a very special time in a woman's life and the life of her unborn child. A pregnant woman is very sensitive to environmental influences, her body perception changes, and she lives impressions more intensely than before. [13]
Pregnancy should always be regarded as a natural process and not as a disease. More and more frequently pregnancies are classified as high-risk pregnancies, often because of the increasingly higher age of pregnant women (older than 35) or because of early pregnancy complications. [38]
Due to increasing application of medical technology in prenatal care in the field of orthodox medicine and the multiple possibilities of preventive medical services, all done in order to exclude potential disablements, future parents worry about many possible diseases. [13]
This diversity of information raises a lot of questions and uncertainties, which very often are left behind without answers or explanations, simply because gynaecologists do not have the time to care about them or because pregnant women do not dare pronounce them. A balanced psychological state of the future mother is very important for a good pregnancy and for the birth process. Furthermore, the way a pregnant woman deals with stressful situations has great influence on her physical well-being. [38]

1.4.2. Elasticity of ligaments

In order to facilitate the birth process for the fetus, the extensibility of the pelvic ring increases, which challenges the ligaments surrounding the SIJ considerably. How these physiological changes are controlled is still subject to investigation.
As early as 1926, Hisaw [19] published a study which proved that a substance isolated from pregnant women's serum caused relaxation in pelvic ligamentous structures of female guinea pigs eight to twelve hours after injection. [34] In 1955, the

hormone relaxin could be isolated from women's placenta and corpus luteum for the first time. [69]

The hormone relaxin has been identified as being responsible for allowing increased joint laxity during pregnancy, and levels of relaxin are highest in the third trimester. [49] Relaxin also has a direct effect on collagen remodelling. [70] In addition to relaxin, progesterone also contributes to increased joint laxity during pregnancy. [8]

A study by MacLennan et al. [32] has shown that the serum level of relaxin in women who are incapacitated by pelvic pain during pregnancy is significantly higher than in those women who do not suffer from pain. Serum levels return to near-normal levels in both groups by the third postpartum day. [20]

Relaxin is a protein in which its encoding genes reside on the short arm of chromosome 9. It is secreted by the yellow body (corpus luteum) of the decidua and the placenta. Experts assume that this hormone is only effective in the presence of oestrogene. Apart from the above-mentioned effect on connective tissue, experts suppose that this hormone also has an effect on the cervix and the myometrium. [34]

Kristiansson et al. showed in their study of 1996 that, in case of very early production of progesterone and PIIINP (a serum marker of collagen turnover) during pregnancy, pain felt in the pelvic region is aggravated during the later stages of pregnancy. [27]

Hence there are hormones that directly increase the elasticity of ligaments and others that particularly control the perception of pain in the pelvic region.

1.4.3. Weight gain and oedema

Most of the weight gained during pregnancy is due to the enlarging uterus, fetus and breasts and due to the increased blood volume, extravasation of extracellular fluid, and water retention. On average, a woman will gain approximately eleven kilogrammes during pregnancy. [20]

The anatomic structures in the pelvic region have to adapt to this gain of weight and emergence of oedemas. These adaptations can unbalance a pregnant woman's body and amplify instability.

1.4.4. Posture and postural changes

During pregnancy the organs in the upper abdomen such as liver, stomach and spleen have to make way for the enlarging uterus with its growing placenta and fetus and are therefore moved cranially and slightly laterally. Likewise, the third lumbar vertebra, representing the apex of lordosis, offers more space to the uterus when shifted posteriorly. This shift occurs by a lowering of the lordosis in the lumbar spine, and this lowering can only take place if the pelvis straightens up. This straightening up advantageously enables the SIJ to withstand the considerably greater pressure on this joint due to weight gain in pregnancy (see chapter 1.2.). If such a flattening of the lumbar lordosis is not possible, the forces within the pelvic ring increase according to the model of the pelvic shear (see chapter 1.2.3.), and that alone can lead to increased strain in the SIJ. [34]

In the course of the ninth month of pregnancy the anterior weight increases in relation to the posterior weight due to the size of the uterus, so that the muscular structures are not able any more to keep the pelvis in an upright position. In most cases this leads to an increased lordosis in the last stages of pregnancy. As a compensatory mechanism, the thoracic spine and the nape are stretched; in other words, these two curves of the spine are flattened and the shoulders are pulled backwards. [25]

1.4.5. Uterus

During pregnancy the uterus undergoes a twenty-fold increase in weight from 50 g to 1,100 g at term. It grows from 7 cm to a length of 30 cm and the cavity expands from some 40 ml to 4,000 ml. [68]

The uterus consists of bundles of smooth muscle cells separated by thin sheets of connective tissue. Myometrial growth is almost entirely due to muscle hypertrophy, although some hyperplasia may also occur. The stimulus for myometrial growth and development is derived from the direct effects of the growth processes in the uterus and from the effects of oestrogen and progesterone produced by the ovaries and the placenta. The muscle cells are arranged in three layers with muscle bundles running

in longitudinal and circular directions and in spiral lines. Through this construction the uterus can optimally adapt to the growing volume without stress or mistimed contractions. [68]

Given such a strong growth of the uterus, the ligaments constituting the fixation of the uterus to the pelvis have to lengthen considerably as well. This stretching of ligaments may be sensible in the elongated structures themselves or at the insertion into the bone. In the region of the symphysis the ligament concerned is the round ligament of the uterus, or, slightly laterally and cranially of this region it is the broad ligament of the uterus. [81] Under hormonal control, these ligaments are subject to strong hypertrophy and become very thick. [25]

1.4.6. Cardiovascular system

During pregnancy the maternal plasma volume increases by 40 % to 90 % and the blood volume increases, on average, by 45 % to meet the demands of the enlarged uterus and to protect the mother and the fetus from the effects of impaired venous return during pregnancy. The increased blood volume also serves to protect the mother from blood loss during the birth process. The mother's heart rate at rest increases by ten to fifteen beats per minute during pregnancy. As the uterus enlarges and displaces the diaphragm superiorly, it also displaces the heart superiorly and to the left, rotating on its axis. [20]

1.4.7. Pulmonary system

The upward displacement of the diaphragm by the uterus affects the lung volume. The subcostal angle widens, the transverse diameter of the thoracic cage increases by approximately 2 cm, and the circumference increases by 6 cm. However, this increase is not large enough to prevent a decrease in lung volume attributable to the elevated diaphragm. [20]

Diaphragmatic excursion is increased during pregnancy and therefore the tidal volume increases by about 200 ml and the residual volume is reduced by the same amount. [25]

1.5. Epidemiology

The number of women who suffer from pelvic joint pain and low back pain during pregnancy is considerable. Nine-month prevalence rates ranging from 48 % up to 90% have been reported. [2, 11, 17, 28, 29, 37, 46, 47]

These significant studies with high populations of 200 to 500 test persons have been designed especially in Scandinavian countries. In Sweden for example, all pregnant women are offered free maternity health care during pregnancy at local antenatal clinics run by the Country Health Care Board. More than 95 % of women make use of this offer, which makes this organisation suitable for clinical epidemiologic studies. [27]

The incidence of "pelvic pain during pregnancy causing **considerable impairment of daily functions**" is approximately 14 %, and in most patients the symptoms cease shortly after delivery. [17] These numbers point out the great need of thorough investigation in this subject area in order to develop a suitable therapeutic method for the women concerned. Most authors describe pelvic pain as a kind of back pain, although some emphasise the importance to differentiate between the two. Only a few studies differentiate between pain from the lumbar back and pain from the pelvic joints. [2, 46]

A study conducted by O. Kogstad [26] has shown that pain intensity during pregnancy registered on a visual analogue scale (VAS) was higher among women with posterior pelvic pain than among women with back pain. [[26], quoted from [2], p. 505] This suggests that posterior pelvic pain is a bigger problem in pregnancy than back pain. [2]

2. Osteopathy during pregnancy

2.1. History

The use of osteopathic manipulative treatment (OMT) during pregnancy has a long tradition, but systematic examination of its applications and outcomes is still rare. During the first half of the 20th century, osteopathic medical literature included thorough discussions of the applications of OMT in prenatal care. Many articles contained descriptions of specific OMT techniques. [22] Empirically-oriented articles of OMT in obstetrics with larger subject samples published in the second half of the last century recurringly addressed the theme of pain reduction during pregnancy and labour. [15, 22, 25]

2.2. Osteopathic care in pregnancy and in preparation for delivery

During pregnancy it becomes increasingly difficult for the woman to lie in a prone and supine position. Considering that it is typically these positions that are used in OMT techniques, this is already one good reason for osteopaths to develop special approaches. [39]

The osteopathic doctrine builds on a holistic view of anatomy. Especially during pregnancy the woman's anatomy changes concerning the form and size (abdominal region, pelvic region and posture) of various ligaments, muscles and fasciae. (see chapter 1.4.) Now the tension in these structures may already be overly high, and since they additionally have to provide space for the growing fetus by relaxing and prolonging, these changes may result in disorders. [39, 64] The osteopath helps the body relieve these unnecessary tensions and provide for the mobility of the maternal structures required for the growth of the fetus. Artificially induced spinal strain in experimental animals at least suggests that, in the presence of such dysfunction, an excessive number of fetal anomalies appear in comparison with the controls. [64]

Differences in cellular activity have also been described, [23] and pertinent embryological factors in similar experiments have been reviewed. [64, 42, 5]
Effects of manipulative therapy on fetal electrocardiograms have also been studied. [15, 59] The consensus seems to be that routine OMT applied during pregnancy significantly reduces both fetal and maternal fatalities as well as difficulties of parturition. [15, 59, 64]
Generally speaking, all concepts of osteopathy are applied in the treatment of pregnant women, including muscle energy techniques, myofascial release, ligamentous articular strain, balanced membranous tension, high-velocity low-amplitude thrust, strain/counter-strain techniques, visceral techniques, and osteopathy in the cranial field, depending on the needs of the patient. [39]

2.3. Sensitivity and response to treatment

Clinically the puerperal mother often exhibits extreme sensitivity of the soft tissues and articular structures to manipulative treatment. Preceding and during parturition the degree of reactivity is at a level like that of the young child or fevered adult.
A noticeable physiological response to treatment can be relatively fast if intervention is not delayed. It may prove to be life-saving in cases of rapidly rising blood pressure and pre-eclampsia. [64]

3. Methodology

3.1. Study design

I decided to choose an experimental study for my topic in order to be able to clearly demonstrate the cause-effect relationship.

As discomfort and symptoms increase considerably in the course of pregnancy [2, 17, 28, 29, 36, 37, 43, 45], the **repeated measures design** is a very favourable means to demonstrate the effectiveness of the osteopathic treatment.

The 1999 study of Hansen et al. [16] came to the following conclusion: women with early onset of pelvic girdle relaxation (PGR) felt pain for more hours during the day (gamma = -0.31) and they suffered more often from previous low back pain (gamma = 0.32) than women with later onset of PGR. It further points out that in cases where the pain starts at an earlier stage in the pregnancy it tends to either increase or stay the same in the course of pregnancy. [16]

In 1993, Östgaard et al. were able to demonstrate in a study [45] that only one biomechanical factor, namely the abdominal sagittal diameter, correlates with the increasing pain during pregnancy. (see chapter 1.2.5.) [45]

These studies provide a good basis for the repeated measures design. The advantage of this design is that the characteristics of a test person stay the same (age, intelligence, social and family situation), thus providing for a clearer visibility of the treatment effect.

Another great advantage of the repeated measures design is that no additional test persons are needed to form a control group, especially when taking into consideration that it is always an ethical problem not to treat people who are in pain. In this design the test persons act as their own control group – hence the denomination **within-subject design.** [54]

The following is a schematic representation of the study design:

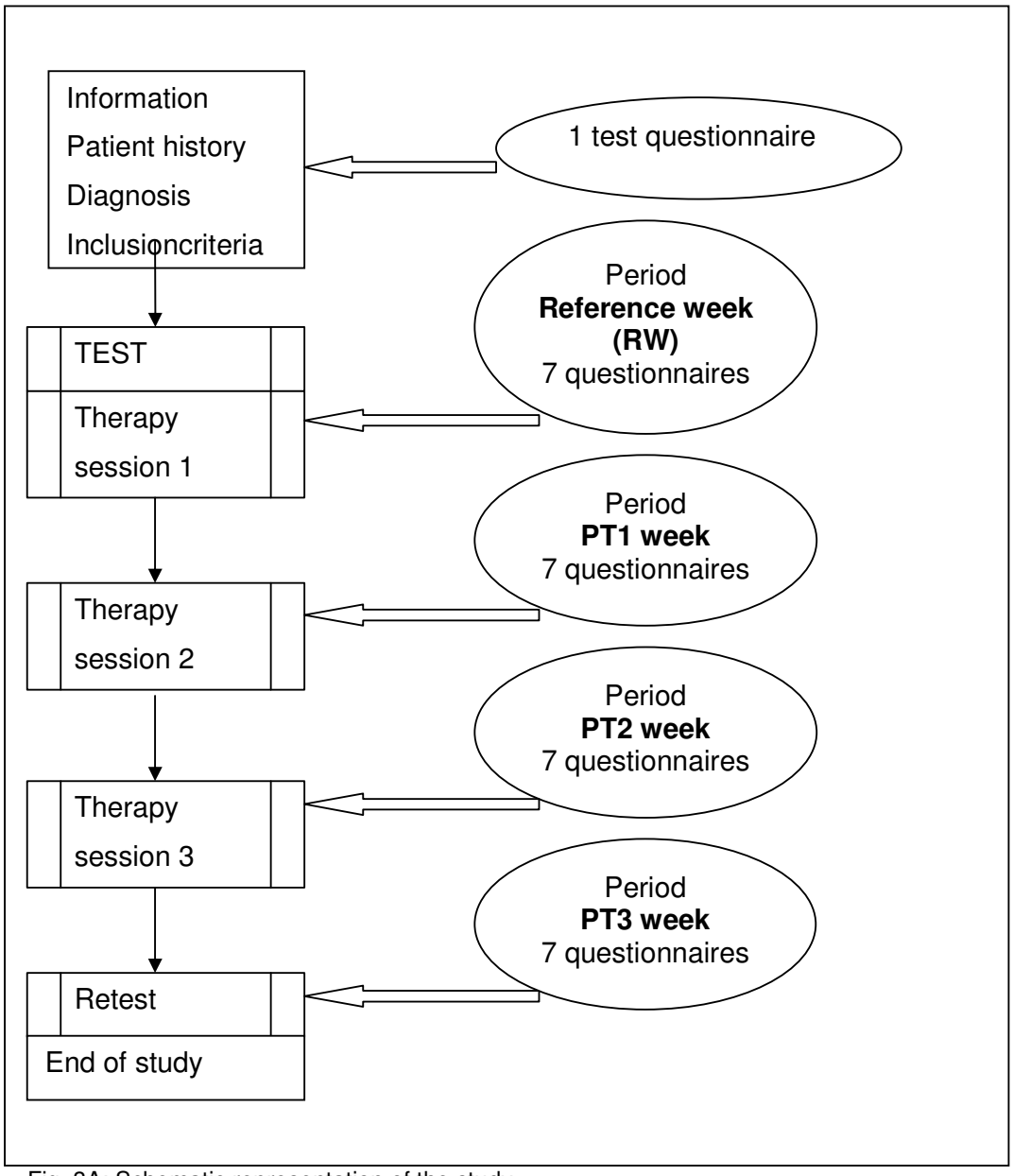


Fig. 3A: Schematic representation of the study

Sample size:

For my study I had 17 test persons as a non-randomised sample. Two of them did not meet the inclusion criteria and one quit during the study. This leaves a total of **14 persons** for the execution and evaluation of the study.

Inclusion criteria:

- 13^{th} – 34^{th} week of pregnancy

Before the 13^{th} week of pregnancy there is an increased risk of miscarriage [13].

After the 34^{th} week of pregnancy the time left before birth is not sufficient for conducting my study.

- 3 (out of 6) positive provocation SIJ tests (see chapter 3.4.2.)
- Patients have to give their consent

Exclusion criteria:

- Risky pregnancy (e.g. gestosis, risk of premature birth, premature labour,...)
- The patient is younger than 18 years.
- When taking the patient history, the patient reports that she has been suffering from an acute illness.
- The patient is undergoing analgesic, myorelaxative or antiphlogistic therapy one week before or during the period of my study.
- The test person does not sign the declaration of consent (see annex B).

Dependent variables (Target behaviour):

Primary dependent variables:

- Quality of life: Roland-Morris Disability Questionnaire [12, 49, 67]
- Pain: Visual Analogue Scale (VAS) [27, 28, 69]

Secondary dependent variables of clinical relevance:

- Series of provocation SIJ tests according to Laslett
- ASLR test
- Faber test
- Sacral shear
- SLR test
- Palpation tests
- Pain areas

Independent variables:

- Whole group during the test period: period after the first, second and third osteopathic therapy session (PT1W, PT2W, PT3W)
- Whole group during the control period: period between diagnosis and first osteopathic therapy session (RW)

The validity and reliability of the variables will be discussed in detail in chapters 3.4. and 3.5.

3.2. Execution of the study

3.2.1. General information

In June 2006 I presented the idea of my Master's thesis to four gynaecologists (one with a contract with the Austrian Health Insurance and three without) in Leoben, Trofaiach and Bruck an der Mur and asked them to send pregnant women with back pain to my practice for osteopathic treatment.
The gynaecologists gave the patients an information sheet (see annex A) together with a business card and a folder of my practice. They issued a referral for physiotherapeutic and osteopathic treatment.
The patients came to my practice five times:

- Diagnosis & test
- 1st therapy session
- 2nd therapy session
- 3rd therapy session
- Post diagnosis & retest

The patients had to fill in a questionnaire (see annex E) every day (seven days) after the first consultation and each therapy session (that is 4x7= 28 questionnaires).
Previous experience in osteopathic therapy shows that in pregnant women the success rates concerning pain and quality of life are highest after three therapy

sessions. Since this observation was also backed up by my study, the chosen number of therapy sessions seemed reasonable.
The individual treatment sessions were 7-14 days apart.
I started the practical part of my study in July 2006 and finished it in January 2007.

3.2.2. Diagnosis

I gave the patient information about the study and asked her if she would like to participate. She confirmed in writing that she was going to participate in the study (see annex B).
I asked the patient to think of a particular day during the previous week on which she had felt severe pain and to fill in a questionnaire (see annex E) in reference to this day in order to help her get used to the handling of the questionnaire and to give her the opportunity to ask questions to clarify doubts. This questionnaire was not included in the evaluation process. Then I took a typically osteopathic patient history and diagnosis (see annex C) including contraindications for therapy as well as inclusion and exclusion criteria.
Then I assessed the inclusion criterion painful SIJ instability with the help of a test sheet (see annex D) to identify the positive side. It was also possible that both sides were affected by SIJ instability. In these cases I defined the side which was more painful as the *more affected side*. If all criteria were met, the patient was able to participate in the study; otherwise I recommended an osteopathic therapy at the regular price.

At this stage I did not give any tips or advice for dealing with the pain in everyday life, nor did I answer any specific questions; instead I told the patient that we will attend to her concerns on the first day of therapy.
On the day of the first therapy session, before the treatment, we went through the whole test sheet (see annex D), even though the provocation SIJ tests for the inclusion criteria had already been made on the day of diagnosis. We carried through additional tests (see chapter 3.4.1.) which were essential for the treatment.

3.2.3. Therapy

In each of the three therapy sessions the patient handed in seven questionnaires from the previous week.

In this study the osteopathic therapy served as a black box and was adapted completely to the individual needs of the patients. My choice of technique was based on strict consideration of the previously created “osteopathic diagnostic findings“. The therapy was conducted according to the doctrine of the Vienna School of Osteopathy. I considered it to be very important to see the pregnant patient as an entity and thus I took into account that causes may originate from all parts of the body.

Contents of the therapy:

- Tips and advice for daily life
- Mobilisation of the iliopsoas muscle, the thoracolumbar fascia, the obturator membrane, the adductor muscles of the hip, the coccyx etc.
- Mobilisation and thrust techniques in the thoracic spine and thoracolumbar junction, upper and lower ribs, and partly also in the cervical spine
- Fascial techniques in the areas of the iliotibial tract, thoracolumbar fascia, thoracic spine, obturator membrane etc.
- Mobilisation in the visceral area: very frequently at the diaphragm including the crura, at the stomach, liver, kidneys and bladder, ligaments of the uterus etc.
- Intraosseous techniques at the sacrum, coccyx, occiput, temporal bone, sternum, …
- Craniosacral techniques: SSB techniques, CSF techniques, techniques on the reciprocal tension membrane, synchronisation of the sacrum and the occiput
- Compensatory movements and exercises for stabilisation of the pelvis

3.2.4. Post diagnosis

The patient handed in the last seven questionnaires.

The painful SIJ instability was checked a second time by means of the test sheet and the additional tests were made for evaluation.

3.3. Core data

A patient history sheet (see annex C) was filled in at the beginning of the first consultation. This sheet adheres to the doctrine of the Vienna School of Osteopathy.
The core data necessary for the study were collected and evaluated in chapter 4.1. The assessment of indications and contraindications for the treatment of the patient was very important in this context. Therefore previous illnesses, existing diagnoses and the current discomfort of the patient were identified and assessed.
The patient history sheet contains two body charts. One body chart served for the patient to indicate her areas of pain on the day of diagnosis. On the other body chart the patient indicated her areas of pain once again on the day of post diagnosis.

3.4. General tests and provocation SIJ tests

One test sheet each was filled in on the day of diagnosis and on the day of post diagnosis (see annex D), enabling direct comparison of the test sheet for the period before treatment with the one for the period after treatment.
The test sheet contains:

- General osteopathic SIJ tests
- Pain provocation SIJ tests
- Palpation tests
- Areas of pain

3.4.1. General osteopathic SIJ tests

Mobility testing of the pelvis with the Michaelis Rhombus (Diamond test)

The Diamond test is used to assess the mobility of the SIJ in relation to the mobility of the lower lumbar spine and the hip. It provides information as to which structures influence the mobility of the SIJ. [39]

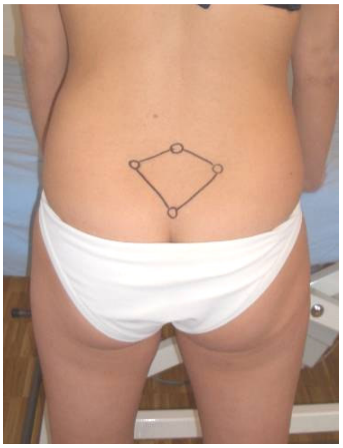


Fig. 3B: Rhomboid drawing

A rhombus is drawn on the sacrum with a skin safe pen: the upper tip is on L5, the two lateral tips are on both posterior superior iliac spines (PSIS), and the lower tip is on the sacral hiatus (S5). (fig. 3B)

The woman now goes into the squatting position; the heels have to stay on the ground. The osteopath now observes closely how this diamond changed. (Fig. 3C)

The following results are important especially for the osteopathic treatment [39]:

- The upper part of the diamond is too flat: L5 might be in extension and hypomobile.
- The heel position cannot be performed: the thoracolumbar fascia pulls too strong.
- The distance between L5 and PSIS does not widen in squatting: the iliolumbar ligaments are too short.

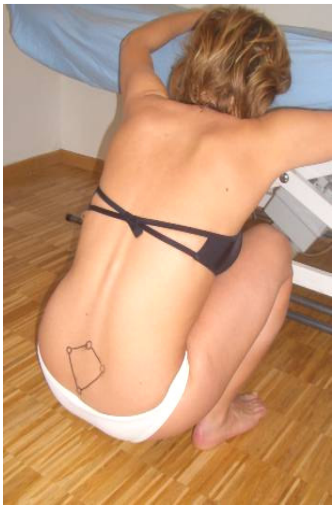


Fig. 3C: Rhomboid squatting

- The lower tip of the diamond is too long: the sacrum is in counternutation.
- The horizontal line becomes oblique: the sacrum is in torsion.
- The lower tip of the rhombus deviates to one direction: there is a dysfunction in the hip.
- The upper tip is very high: L5 might be hypermobile.

In order to assess the mobility of the SIJ, I measured the distance between both PSIS (indicates the mobility of the SIJs) and the distance between L5 and S5 (indicates the mobility of the lower lumbar spine and the hip). In the course of pregnancy the

mobility of the SIJs should increase considerably in relation to the lower lumbar spine. However, if the difference in mobility is too high, then this is a sign of SIJ instability. [39]

In her work with pregnant women, Hampel [15] was able to demonstrate that after OMT, which also included intense treatment of the thoracolumbar fascia, the mobility of the lower lumbar spine improved considerably. [15]

Flexion test, standing position:

The flexion test is used to assess the mobility of the SIJ on both sides. Greenman [14] describes the test as follows:

Fig. 3D: Flexion test

- The therapist palpates the lower margin of the PSIS on both sides.
- The patient slowly bends forward as far as possible.
- The therapist keeps his fingers on the PSIS and follows the movement. The test is positive on the side (i.e. less mobile than on the other side) on which the PSIS seems to move further in the cranial-ventral direction.
- The sensitivity of this test is not specific as respects the restriction of an SIJ. Diagnosis can be erroneously positive when the ischiocrural muscles are shortened on the contralateral side or when the quadratus lumborum muscle is shortened on the ipsilateral side.

Straight leg raise test (SLR):

The straight leg raise test is used to assess additional pain in the intervertebral discs and in the spine. [1]

Fig. 3E: SLR

3.4.2. Pain provocation SIJ test

Provocation SIJ test series according to Laslett

In 1994, Pescioli et al. first reported study results on a good to excellent agreement of seven provocation SIJ tests according to Laslett [30]. [48] The authors state that at least four of these tests have to be positive in order to be able to speak of an SIJ dysfunction.

The pain provocation tests of distraction, compression, thigh thrust, and pelvic torsion (see table 3A) have **substantial** intertherapist reliability (see table 3C). The sacral thrust and cranial shear procedures (see table 3A) are **moderately** reliable (see table 3C). [30]

Sacroiliac test	**Picture**	**I.A.** (n=51) [30]	**K** (n=51) [30]	**Sensitivity** (n=48) [31]	**Specificity** (n=48) [31]
Distraction	Fig. 3F	88.2	0.69	0.60	0.81
Compression	Fig. 3G	88.2	0.73	0.69	0.69
Sacral thrust	Fig. 3H	78.0	0.52	0.63	0.75
Thigh thrust	Fig. 3I	94.1	0.88	0.88	0.69
Pelvic torsion right	Fig. 3J	88.2	0.75	0.53	0.71
Pelvic torsion left	Fig. 3K	88.2	0.72	0.50	0.75
Cranial shear	Fig. 3L	84.3	0.61	X	X

I.A. = interexaminar agreement; K = kappa agreement coefficient

Table 3A: Specific values of the tests according to Laslett

In 2005 Laslett published a study [31] on the sensitivity and specificity of the provocation SIJ test in which he examined only six pain provocation SIJ tests. Unfortunately in this publication he did not refer to the 1994 study; hence it is not clear why he examined one test less in the latter study.

The thigh thrust test is the most sensitive test and the distraction test is the most specific one. In order to increase the sensitivity and the specificity, all six tests are assessed together.

6 tests	2 or more positive	3 or more positive	4 or more positive
Sensitivity	0.93	0.94	0.60
Specificity	0.66	0.78	0.81
+LR	2.73	4.29	3.20

+LR= likelihood ratio for positive test

Table 3B: Sensitivity and specificity of the test series according to Laslett [31]

In the results of Laslett's study the version with three and more positive tests shows the best specific values with a still high sensitivity and an already considerably high specificity and the highest +LR value. (see table 3B) [31] As three or more out of six tests have the best predictive power in relation to the results of intra-articular anaesthetic block injections [31], I chose to apply these six provocation SIJ tests as inclusion criteria. For the examination I included the seventh provocation test as in Laslett's 1994 study.

Fig. 3F: Distraction

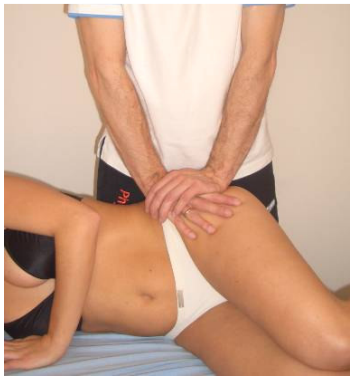


Fig. 3G: Compression

Fig. 3H: Sacral thrust

Fig. 3I: Thigh thrust

Fig. 3J: Pelvic torsion right

Fig. 3K: Pelvic torsion left

Fig. 3L: Cranial shear

Active straight leg raise test (ASLR)

The active straight leg raise test was performed as a pain provocation test: as soon as pain is felt it is considered to be positive.

Fig. 3M: ASLR-Test

In 2001, Mens et al. [37] studied the reliability and validity of the ASLR test in PPPP. They subdivided the results on a scale from 0 (not difficult at all) to 5 (unable to do). The study concludes that the ASLR test is a suitable diagnostic instrument to distinguish between patients who are disabled by PPPP and healthy persons. The test is easy to perform. Reliability, sensitivity and specificity are high. It seems that the integrity of the function to transfer load between the lumbosacral spine and the legs is tested by the ASLR test. [37]

Faber test

In 1994 Wormslev et al. [71] studied the reliability of the Faber test. With inter-observer variation they obtained a kappa value of 0.62, which is substantial (see table 3C).

Fig. 3N: Faber test

Level of agreement	Value of kappa
Poor	<0
Slight	0-0.20
Fair	0.,21-0.40
Moderate	0.41-0.60
Substantial	0.61-0.80
Almost perfect	0.81-1.00

Table 3C: Assessment of kappa [1]

In 2000 Albert et al. [1] studied several clinical tests used in pregnancy-related pelvic joint pain in pregnant women in the 33rd week of pregnancy, amongst others the Faber test. They allocated the patients to the following four groups (see table 3D). The results of the first part of the study showed an interexaminar reliability of only 88 %, and with the chance agreement discounted, the kappa coefficient was 0.54, which is only moderate (see table 3C). But the sensitivity (see table 3D) and specificity with 0.99 of the classification test related to the four different classification groups was much better.

	Sensitivity
Pelvic girdle syndrome	0.70
Symphysiolysis	0.40
One-sided SIJ syndrome	0.42
Double-sided SIJ syndrome	0.40

Table 3D: Sensitivity of the pelvic syndromes [1]

3.4.3. Palpation

The sensitivity to pressure of the following six anatomical structures was assessed by means of palpation, classifying them as *tender* or *normal*.
Hansen et al. in 1999 [16] and Wormslev et al. in 1994 [71] conducted studies to test these structures in pregnant women, too. I also took the results from these studies into consideration.

PSIS

Since the mobility of the SIJ increases during pregnancy, the joint capsule and the adjoining ligaments get increasingly irritated. [39]
70 % of the 220 persons tested by Hansen et al. [16] showed tenderness to palpation of the PSIS.

Pubic symphysis

Since the mobility of the symphysis increases during pregnancy, the joint capsule and the adjoining ligaments get increasingly irritated. [39]
80 % of the 227 persons tested by Hansen et al. [16] showed tenderness to palpation of the pubic symphysis. Wormslev et al.'s test of this structure in 40 pregnant women indicates a reliability of kappa=0.55. [71]

Iliopsoas muscle

69 % of the 227 persons tested by Hansen et al. [16] showed tenderness to palpation of the iliopsoas muscle.
Wormslev et al.'s test of this structure in 40 pregnant women indicates a reliability of kappa=0.40. [71]

Piriformis muscle

The increase of weight in the abdomen gives rise to a nutation torque in the SIJ and a flexion torque in the hip joint, which is why the piriformis muscle, amongst others, has to be activated more strongly. The tension in the muscles increases and becomes painful more frequently. [24, 39]

Sacrotuberous ligament

50 % of the 225 persons tested by Hansen et al. [16] showed tenderness to palpation of the sacrotuberous ligament.
Wormslev et al.'s test of this structure in 40 pregnant women indicates a reliability of kappa=0.54. [71]

Pelvic floor

The pelvic floor muscles need a certain level of tension in order to be able to stabilise the SIJ. When the ligaments in the pelvic girdle become softer, the tension in the pelvic floor muscles usually increases. This can also lead to pain in the areas where these muscles attach to the bone. [39]

Obturator membrane

According to Molinari [39] the tension of the obturator membrane plays a major role in the pelvic region. In a healthy state the membrane should be under a slight and balanced tension and thus without pain. If there is an imbalance in the pelvis, e.g. due to instabilities, the tension in the obturator membrane increases and palpation can be painful. [39]

3.4.4. Areas of pain

I asked the patient to mark her pain in the corresponding areas on a body chart (see fig. 3O). The following six areas of the body were defined:

- Lower lumbar spine and transversely across the back
- PSIS left
- PSIS right
- Pubic symphysis and ventrally in the lower abdomen
- Buttocks and left leg
- Buttocks and right leg

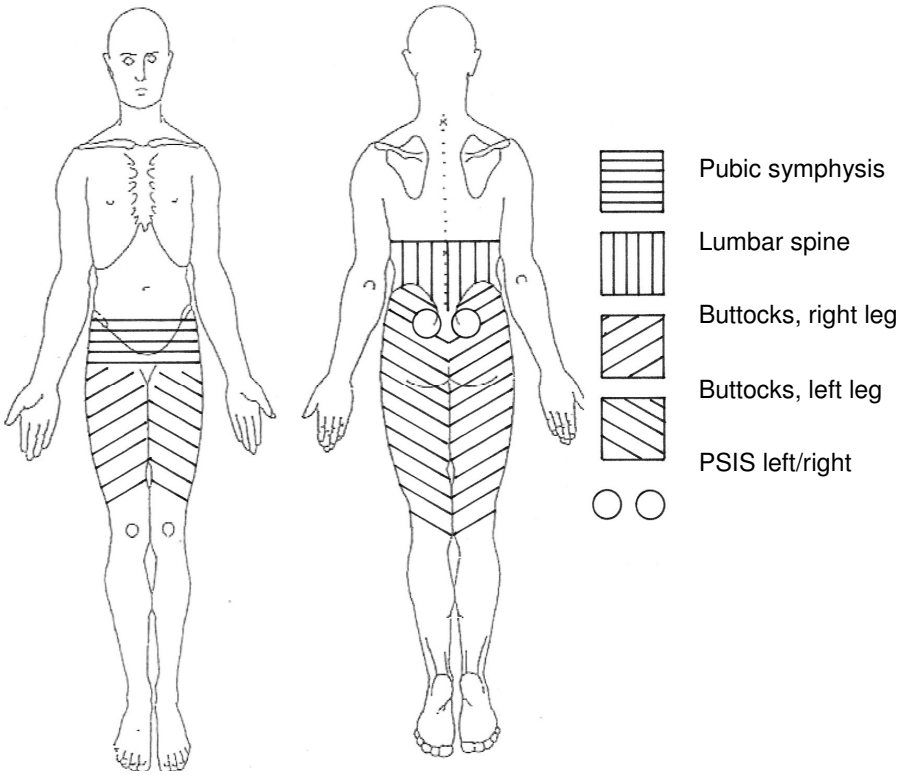


Fig. 3O: Body chart

3.5. Primary dependent variables

The definition of the primary dependent variables was based on the questionnaire. On the day of diagnosis, the questionnaire was explained in detail and the test person answered the questions. In case of doubts she could ask questions immediately. This questionnaire is not included in the evaluation.
This provides for equal conditions for the test period and the control period and hence for increasing reliability.

3.5.1. Roland-Morris Disability Questionnaire (RDQ)

Especially in back pain diseases, no causal relation between damage, pain and impairment could be identified. The pain and impairment suffered by the patient cannot sufficiently be explained on the mere basis of objective medical diagnoses. [12] This is why condition-specific health status measures are commonly used as outcome measures in clinical practice.
The expert panel of *The Spine Journal* that met to discuss this special issue recommended that, when possible, a condition-specific measure for back pain should be chosen from two widely used measures, i.e. the Roland-Morris Disability Questionnaire (RDQ) or the Oswestry Disability Index. These two measures have been used in a wide variety of situations for many years. [49] I chose the RDQ because a German-Austrian version had already been tested by Wiesinger et al. [67] This German-Austrian version of the RDQ (see annex E) is a translated version of the test which is widely used in the Anglo-Saxon countries. [12] The statements were chosen in a way to cover the most important aspects of everyday life. The phrase „because of my back“ was added to every statement in order to emphasise that the statement was answered positively only in reference to the impairment which was caused by the back.
The questionnaire was designed in a way that the patient was able to answer it alone without any help in no more than five minutes. When a statement applied on the day of consultation, the patient was asked to tick it off. For every item that was ticked off

one point was added. An individual patient score, thus, varies between zero points (no disability) and 24 points (worst disability).

The RDQ has proven to be a reliable, valid and change-sensitive instrument which can differentiate also between patients with different back pain intensities. [12]

The following statistical values of the German-Austrian version of the RDQ were identified in 1999 by Wiesinger et al. [67]:

- Pearson's correlation coefficient for test-retest reliability was r=0.82 (P=0.0001).
- Cronbach's alpha was 0.81.
- The concurrent validity r was 0.81 (RDQ/pain rating; P=0.0001).

3.5.2. Visual Analogue Scale (VAS)

The VAS has established itself internationally as an easy to handle instrument for the quantitation of pain. [69] According to a study conducted by Scott and Huskisson in 1976 [50] the use of visual analogue scales is the best available method for measuring pain and pain relief. With its specific way of asking questions, various subjective criteria for feeling pain can be expressed. Numerous validations of the VAS show that this clinical instrument is exceptionally reliable and valid. [50, 69] Pain assessment with VAS is in general easily comprehensible and logical for the patients; however, it does require constructive participation of the patient. In the practitioner's practice the VAS is a good instrument for assessing the immediate effects of a therapy, but also for development monitoring of therapy series.

Its length is 100 mm and it is horizontally oriented. It is scaled with the numbers 0 to 10 and divided in sections of shades of white, yellow and red. (see annex E). The text reads: "Indicate the pain which you have felt on average during the day on a scale of 0 to 10."
Point 0 on the scale: no pain
Point 10 on the scale: worst imaginable pain
For evaluation, the distance from "0" to the mark was measured in millimetres and for clear representation in the graph it was converted into centimetres with indication of one decimal point.

3.6. Statistics

For the evaluation and preparation of the data I used the German version of the „Statistical Package for Social Sciences 11.5“ (SPSS) for Windows and for the graphs I used Microsoft Excel 2000. The following procedures were applied for the data preparation:

Kolmogorov-Smirnov test (K-S test)

In order to be able to choose a test for the statistical significance of two measurement scales, first it has to be proven that the sample taken from the statistical population represents the normal distribution. I chose the K-S test because it is more significant for smaller sample sizes. [66] The level of significance is represented in table 3E.

Null hypothesis test

In order to be able to deduce therapeutic success, the dependence of two result measurement scales has to be outruled. On the basis of the positive K-S test, now the general test of the “difference of two mean values with known variances” can be carried through for the primary dependent variables. [66] The corresponding quantile of the normal distribution is applied for significance. (see table 3E)

The formula reads: $$Z = \frac{(\overline{X}_1 - \overline{X}_2) - d}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Null hypothesis $H_0 : \mu_1 - \mu_2 = d = 0$

Rank correlation according to Spearman

The relation between two variables can be expressed by means of the correlation coefficient, which indicates the extent of correlation, i.e., the extent of relation between two variables. [66]

CHI-square (X^2) test for fourfold tables

The easiest way to assess the independence of two alternative characteristics is by means of the CHI-square test for fourfold tables. The independence of the secondary dependent variables is identified with the help of this test. The level of significance is represented in table 3E.

Significance

The levels of significance are defined in the presentation of the results for all used procedures (see table 3E), [54, 66]

Level of significance (α or P)	Assessment	Symbol	Quantile for K-S test (n=14)	Quantile of the normal distribution	X^2 test
α ≤ 0.05	significant	*	Z ≥ 0.349	Z ≥ 1.645	Z ≥ 3.84
α ≤ 0.01	very significant	**	Z ≥ 0.418	Z ≥ 2.326	Z ≥ 6.64
α ≤ 0001	highly significant	***		Z ≥ 3.090	Z ≥ 10.83

Table 3E: Levels of significance

4. Evaluation

4.1. Evaluation of the test persons' core data

17 persons took part in my study. In treatments previous to the present study I had already tested symptom-giving sacroiliac joint relaxation in pregnancy in four persons. These tests served as a basis for optimisation of the test sheet and the questionnaire.

Two persons did not match the inclusion criteria, that is, no symptom-giving SIJ relaxation was identified. One person did not want to continue and dropped out of the study. The following evaluation is a result of the data of those **14 women** who followed through with the study.

The women's ages range from 22 to 35; the mean age is 28.14.

On the first day of the study, i.e. on the day of diagnosis, the women were in their 14^{th} to 29^{th} week of pregnancy, the median being the 19^{th} week.

Four of the women had not given birth yet; at the same time it was also their first pregnancy. Seven of the women had already given birth to one child and it was their second pregnancy. Three women had already given birth to several children. None of the women had had a miscarriage or a stillbirth. It happened to be the three women who had had a miscarriage that dropped out.

Only one woman had resorted to the help of assisted reproductive technology (in vitro fertilisation).

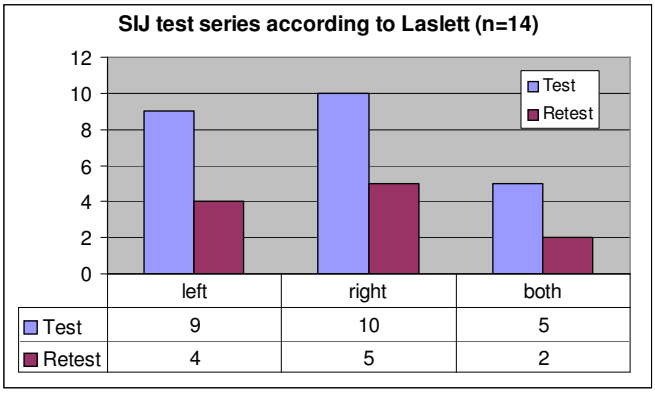
At the outset of the study, five of the women were still working. Nine of them were already on maternity leave and did not have to go to work on a regular basis.

The women's weight gain during pregnancy was between -1 kilo and 17 kilos with a median of 5.8 kilos.

4.2. Test sheet evaluation

4.2.1. Pain provocation SIJ tests

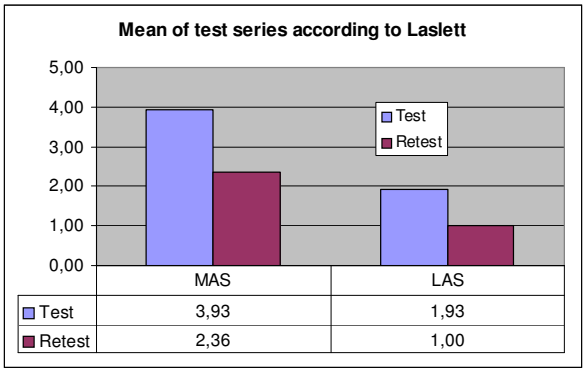
Laslett's test series



Graph 4A: Results of the test series according to Laslett

In order to match the inclusion criteria, three out of six provocation SIJ tests had to be positive. Nine women tested positive on the left SIJ and ten on the right SIJ; accordingly, five women tested positive on both SIJs (see graph 4A). The retest after three osteopathic treatments showed positive results in only nine test persons. Only two of the women were SIJ positive on both sides. Five women showed such a high degree of physical improvement that they no longer matched the inclusion criteria for SIJ instability.

Based on the number of positive provocation SIJ tests it was possible to identify a *more affected side* and a *less affected side* in the test persons. In case of an identical result on both sides, the results of the sacral shear, ASLR and Faber tests were also consulted.

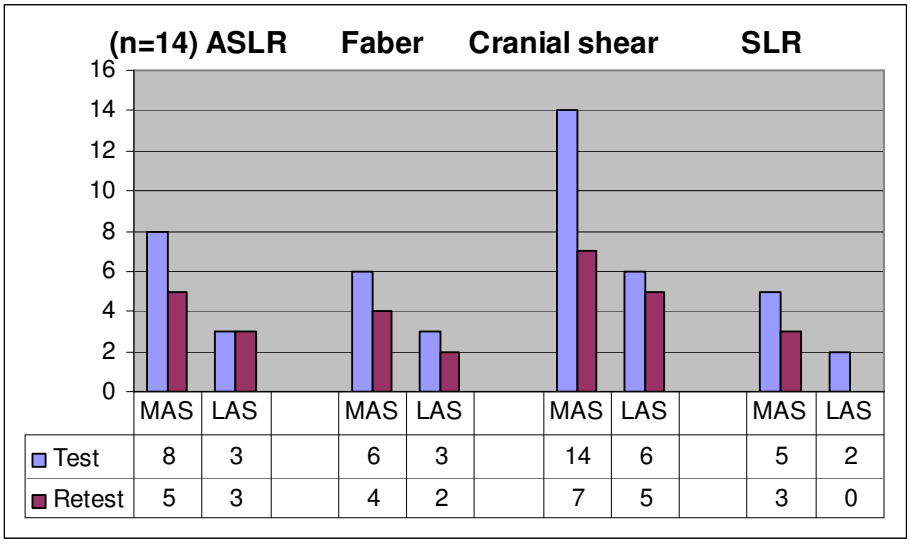


Graph 4B: Mean of test series according to Laslett

On average, the number of positive provocation SIJ tests on the *more affected side* (MAS) decreased from a mean of 3.93 tests before the three osteopathic treatments to a mean of 2.36 tests after the treatments. On the *less affected side* (LAS), the number of positive tests decreased from a mean of 1.93 tests to a mean of 1.00 tests. (see graph 4B)

Active straight leg raise test (ASLR) and Faber test

The ASLR and Faber provocation tests were also considerably more often positive on the *more affected side* (MAS) than on the *less affected side* (LAS). Even though the ASLR test does not show any improvement in results on the LAS, the improvements on the MAS are considerable.



	MAS	LAS		MAS	LAS		MAS	LAS		MAS	LAS
Test	8	3		6	3		14	6		5	2
Retest	5	3		4	2		7	5		3	0

Graph 4C: Results of the provocation tests

Cranial shear

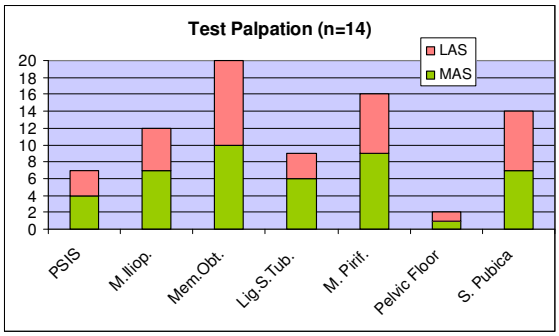
This test, which was one of the provocation tests included in Laslett's study in 1994, was positive in all women on the MAS.In the retest only 50 % of the women tested positively on the *more affected side*. (see graph 4C)

Straight leg raise (SLR)

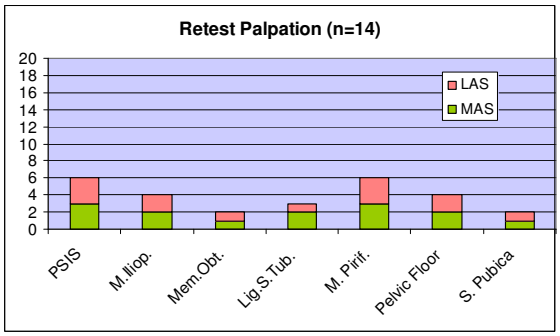
In retesting the SLR test, which is used for testing the lumbar vertebrae, showed considerably fewer positive results than before the treatments. (see graph 4C)

4.2.2. Palpation

Assessment by means of palpation showed considerably less tenderness of certain structures after the treatments than before the therapy. (see graphs 4E and 4D) Contrary to the posterior superior iliac spine, which was hardly influenced by the therapy, the obturator membrane was tender before therapy in many cases, but only in few cases after therapy. The pelvic floor muscles showed tenderness even more often after therapy than before. In the following two graphs the two sides (MAS and LAS) are illustrated in one bar, one above the other. Graph 4D shows the test results without treatment and in graph 4E we can see the results of the retest after treatment.

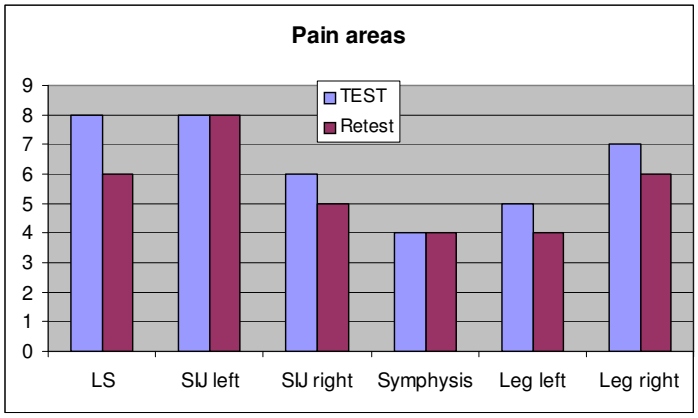


Graph 4D: Test results of palpation



Graph 4E: Retest results of palpation

4.2.3. Pain areas



Graph 4F: Test results of pain areas

The test persons located the areas of pain using the body chart.

The number of pain areas hardly decreased after treatment. (see graph 4F)

4.2.4. Significance of the test results

The significance of the provocation tests and palpation was verified with the help of the chi-square test for fourfold tables. Table 4A shows the significance levels. Since both SIJs of each test person were tested separately, the sample is n=28. Due to the minimal changes in the pain areas and the resulting lack of significance, the significance test was not applied to this category.

Test	N	Z	α	Significance
Laslett (3 out of 6)	28	7.143	≤ 0.01	**
ASLR	28	0.717	>0.05	
Faber	28	0.820	>0.05	
Cranial shear	28	4.667	≤ 0.05	*
SLR	28	1.948	>0.05	
PSIS	28	0.100	>0.05	
Iliopsoas muscle	28	5.600	≤ 0.05	*
Obturator membrane	28	24.257	≤ 0.001	***
Sacrotuberous ligament	28	3.818	≤ 0.05	*
Piriformis muscle	28	7.487	≤ 0.01	**
Pelvic floor	28	0.747	>0.05	
Pubic symphysis	28	12.600	≤ 0.001	***

*significant; **very significant; ***highly significant

Table 4A: Evaluation of significance

The palpation of the pubic symphysis and the obturator membrane shows a highly significant result; the result of the test series according to Laslett and the palpation of the piriformis muscle are very significant. Furthermore, significant results were obtained through cranial shear and palpation of the iliopsoas muscle and the sacrotuberous ligament. On the other hand, the results obtained through the ASLR, Faber and SLR tests as well as the palpation of the PSIS and the pelvic floor are not significant.

4.3. Evaluation of the questionnaire

4.3.1. Test results of the dependent variables

The primary dependent variables of this study are **quality of life** and **pain**. Disabilities encountered in everyday life were evaluated based on the number of statements marked on the Roland-Morris Disability Questionnaire. A pain scale from 0-10 was used for pain assessment.

From the seven questionnaires handed in during the observation period by each of the test persons, a mean value was calculated. Thus, we have a value for the quality of life and a value for the pain intensity for each observation period.

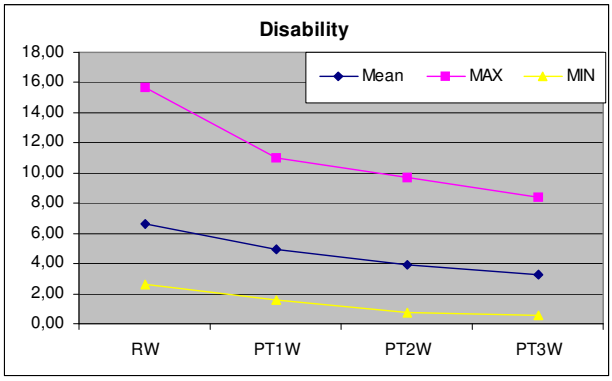
There are four observation periods for the 14 test persons:

1. without therapy – reference week (RW)
2. after the first therapy (PT1W)
3. after the second therapy (PT2W)
4. after the third therapy (PT3W)

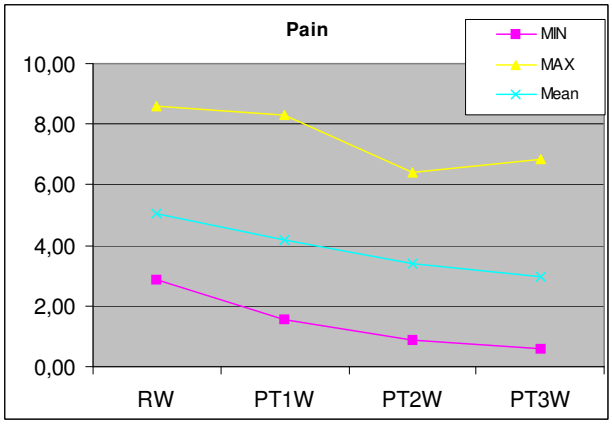
For each of the observation periods, the mean, minimum and maximum values were calculated. (see graphs 4G and 4H)

The mean values of each dependent variable (pain and disability in everyday life) show a significant reduction.

When assessing the progress of each of the graphs (see annexes F-G), it becomes evident that the results of only one test person (TP13) show a very distinct development; in her case,



Graph 4G: Results of RDQ



Graph 4H: Results of VAS

both dependent variables, i.e. pain and disability, show continuous increase throughout the observation periods.

4.3.2. Development of the primary dependent variables

In order to assess the development of the dependent variables pain and disability throughout time, the values of the first observation period (RW) were compared to the values of the last observation period (PT3W). (see table annex H)

The results of the observation period RW serve as a reference value at 100 %. Accordingly, the calculation of the difference between RW and PT3W shows the decrease in percent. A negative number indicates an increase in PT3W.

	RDQ (%)	VAS (%)
Max	86.21	81.28
Mean	49.80	44.39
Min excluding outlier	0.00	3.14
MIN (outlier)	-11.32	-30.64

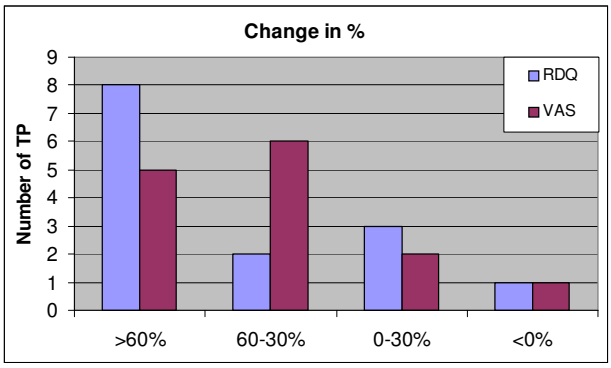
Table 4B: Decrease of dependent variables

In table 4B, the mean, maximum and minimum values (including and excluding outlier) indicating the degree of change in pain and disability are shown in percent.

Subsequently, the results of the test persons were grouped:

> 60 %	Very strong decrease
30-60 %	Strong decrease
0-30 %	Medium to slight decrease
< 0 %	Increase

Table 4C: Decrease categories



Graph 4I: Decrease of dependent variables

Significantly more than half of the test persons show at least one strong decrease; this decrease is even more evident in the disability category than in the pain category.

The values that can be seen in the category *Increase* (referring to pain and disability) are derived from the results of only one test person. Hence we can speak of an outlier; this can also be identified clearly on the graph.

4.3.3. Correlation between pain and quality of life

In order to assess the correlation between pain and quality of life, I calculated the difference between the test results of the reference week (RW) and those of the observation period after the third therapy (PT3W). Subsequently, the statistics software SPSS was applied for comparing the changes in the VAS test results to the changes in the RDQ results.

Table 4D shows the very significant ($\alpha<0.01$) correlation between the development of the primary dependent variables (VAS and RDQ). This supports the assumption that the relation between pain and quality of life is very high and, at the same time, confirms the validity of these methods of measurement.

Spearman-Rho		RDQ (RW-PT3W)	VAS (RW-PT3W)
RDQ (RW-PT3W)	Correlation coeffiziency	1.000	0.768*
	Significance (2-tailed)	.	0.001
	N	14	14
VAS (RW-PT3W)	Correlation coeffiziency	0.768*	1.000
	Significance (2-tailed)	0.001	.
	N	14	14

*. The correlation is significant at the 0.01 level (2-tailed).

Table 4D: Correlation of RDQ and VAS according to Spearman

4.3.4. Significance of the test results

Testing for normal distribution

By using the Kolmogorov-Smirnov test with a significance level of α = 5 %, I tested the mean values (RW-PT3W) of the test results of pain and disability for normal distribution. With 14 test persons, the critical value ($d_{0,95}$) is at 0.349. (see table 4E)

	Z (RDQ)	Z (VAS)
RW	**0.735**	**0.416**
PT1W	**0.854**	**0.468**
PT2W	**0.893**	**0.551**
PT3W	**1.000**	**0.955**

Table 4E: Significance of normal distribution

Since the results from the K-S test are not below the critical value of $d_{0,95}$=0.349, we can assume that the sample is taken from a normally distributed statistical population (with a significance level of α = 0.05).

Difference in mean values

For a clear demonstration of the effectiveness of the treatment, I will illustrate the differences in mean values from the various different observation periods by comparing the observation period *reference week* (RW) with the observation periods after the treatments (PT1W, PT2W, PT3W). (see table 4F)

Difference	Z (RDQ)	Z (VAS)
RW-PT1W	**1.297**	**1.358**
RW-PT2W	**2.200***	**2.502****
RW-PT3W	**2.759****	**2.869****

*significant (α=0.05) **very significant (α=0.01)

Table 4F: Test statistic Z (dependent variables)

After the first therapy session, the results show no significant changes. After the second therapy session, however, we can observe a significant change in the dependent variable *quality of life* (RDQ) and a very significant change in the dependent variable *pain* (VAS). After the third therapy session, test results even show very significant results for both dependent variables (VAS, RDQ).

5. Discussion and assessment of the results

5.1. Discussion of the methodology

Within-subject design

Pregnancy has a defined time frame and brings about certain physiological and pathophysiological changes which the body reacts to with numerous compensatory mechanisms. In the course of pregnancy these changes increase constantly; after having given birth, however, the body changes back to its original state. [2, 17, 27, 29, 45] When the body does not manage to compensate sufficiently for the increasing physiological changes, pathologies arise. And, since the physiological changes continue to increase during pregnancy, it can be assumed that the pathology does not go back to normal without intervention. This situation provides the physiological basis for the possibility to use the test persons as their own control group in this study. [45] Since I compared a control period (RW) with various experimenting periods (PT1W-PT3W), this study applied the “within-subject design“. Following the measuring of the results during the various observation periods, a mean value was calculated.

Participant number

In order to achieve scientific acknowledgement a certain number of test persons is necessary. Unfortunately, my study included a relatively low number of participants (14), which is due to the fact that, at my practice, I was not able to find and treat a greater number of test persons within the limited period of six months. More time would have been necessary to do so. However, the low number, which was mainly due to the limited selection criteria, also had an advantage: it improved the homogeneity of the sample.

Psychosocial aspects of the diagnosis

Especially in pregnant women, psychological and psychosocial aspects are of major importance when it comes to a holistic therapy method like osteopathy. [38] To take these into account, however, would go far beyond the scope of this thesis. Although it would be very interesting to quantify these aspects, this would be too great an undertaking as they even provide enough material for a continuative study.

5.2. Assessment of the results

5.2.1. Core data

The core data of the test persons show both a good homogeneity and no one-sided characteristics. Primigravidae were well represented, as were secundi- and multigravidae. Some of them were still confronted with working life stress, a slightly greater part was not. According to the core data, the sample of 14 test persons thus corresponds very well to the statistical population of pregnant women. [13]
Nevertheless, one aspect of my sample is in fact one-sided: none of the test persons had had a miscarriage in the past. Exactly those two test persons who did not match the inclusion criteria had had a miscarriage, as did the one who abandoned the study.

5.2.2. Secondary dependent variables for clinical relevance

Pain provocation SIJ test series according to Laslett

Since Laslett's study of 2005 [31] we can refer to two versions of pain provocation SIJ tests. The first test series that includes seven SIJ provocation tests was established following a study in 1994 [30] with the purpose of evaluating SIJ instability in the German-speaking countries. [48] The second test series, encompassing six pain provocation SIJ tests, was published by Laslett in 2005; in

this study he included the examination for sensitivity and specificity. Only a minimum of three tests have to be positive to indicate SIJ instability. Since the latter series with six provocation SIJ tests offers more accurate results as regards specificity and sensitivity, I chose to apply these tests in my study. [31]
For the assessment of pain provocation SIJ tests, pain areas and palpation, a *more affected side* (MAS) and a *less affected side* (LAS) were defined. This classification refers especially to the instability of the SIJ. However, it contradicts the holistic approach of osteopathy, as restrictions in an osteopathic sense can be found especially on the LAS.
The results obtained from Laslett's test series were very significant. However, it is important to point out that the inclusion criterion of this study was the test series itself, which raises the significance of its results.

The **cranial shear** test also shows significant results for my work and a clear coherence with Laslett's test series of 2005. [31] In Laslett's study of 1994 this test still formed part of his test series. Unfortunately the current study report does not offer any explanations as to why this test is no longer included in the test series.

The **ASLR** and **Faber tests** also show an improvement after therapy. However, their results do not significantly point towards the presence or absence of SIJ instability.
With their ASLR test method Mens et al. [31] have shown good results regarding reliability and the specificity and sensitivity on the Quebeck Back Pain Disability Scale. Due to the scaling of results, using this test version in day-to-day work life is considerably less convenient.

The **SLR tests** after the treatments do not only show improved results in the area of the SIJ but also in the adjacent areas. However, the significance of these results is not sufficient to draw generally valid conclusions.

As regards the **pain areas**, these were not assessed according to their quantity, but regarding whether pain occurs at all in these areas. In many cases it was possible to achieve pain reduction in a certain area, but never painlessness. Thus, the indication of the pain area(s) is not significant for the success of the therapy.

Palpation to assess tenderness showed considerable improvements especially in the area of the piriformis muscle, the pubic symphysis and the obturator membrane. In some areas the results were even highly significant. In the studies of Hansen [16] and Wormslev [71], palpation showed far less positive results.
One exception, however, is the pelvic floor. In palpation it proves to be significantly more tender than before the therapies. Nevertheless, this can still be regarded as a therapeutic success, since the pelvic floor is activated more strongly and thus the muscle fibres close to the attachment sites on the bone have become more tender. [39] The activation of the pelvic floor is consistent with the model of the pelvic shear. (see chapter 1.2.3.) [24]

5.2.3. Primary dependent variables

The calculation of the mean value of seven measurements in each observation period served as a basis for the definition of the primary dependent variables. The studies on reliability and validity [12, 49, 50, 67, 69] of the VAS and RDQ scales do not mention the significance of the scales when they are measured multiple times within a certain period of time.

After the series of therapies, the dependent variables quality of life and pain show very significant improvements. The change after one therapy session is not yet significant; however, the measuring after the second therapy shows significant results. Due to the considerable increase in significance after the third therapy, it is recommended to treat pregnant women with symptom-giving SIJ relaxation three times.

It has become obvious that an OMT has significantly positive consequences on pain and quality of life of women during pregnancy. In my literature survey I did not find any studies answering this question. Osteopathy in childbirth preparation seems to be of much more interest for researchers. Some studies [22] prove that in these cases complications during the birth process are much less common. [22, 6, 64]

5.2.4. Outlier

The results graph of VAS and RMQ of test person TP13 (see annex H) shows a contrary development to the graph indicating the mean values. Her symptoms worsened considerably. This can also be seen clearly on the test sheet, since the number of positive provocation SIJ tests increase notably. Also, the number of tender palpation points rose. However, since there was only one outlier, these results do not influence the mean values of the test group.

5.3. Conclusion

The intention of this study was to analyse whether and how pregnant women with instable SIJs react differently when receiving osteopathic treatment or not by using measurable parameters. Since in pregnancy the discomfort rises up to the point of giving birth [2, 17, 27, 29, 45], the test persons can serve as their own control group. They are observed during one week without receiving any treatment. This time frame serves as a reference week. Subsequently, the test persons are treated three times at an interval of at least one week. During these periods of time they also undergo observation. As a last step, the observation week after the third treatment is compared to the reference week. We speak of a **within-subject study** with 14 test persons.

A series of tests consisting of six pain provocation tests following **Laslett** serves as inclusion criterion. [31]

The primary dependent variables are quality of life, analysed on the basis of the **RDQ**, and pain, measured with the **Visual Analogue Scale**. Further variables are the **pain provocation SIJ tests**, palpation tests and the indication of pain areas.

I do not elaborate in detail the osteopathic treatment used in this study; it is only mentioned as a black box.

The study showed **therapeutic success** in pregnant women due to the application of OMT. Both dependent variables, pain and quality of life, showed a very significant ($\alpha \leq 0.01$) improvement after the therapy. Manual tests, especially the provocation SIJ

tests according to Laslett [31] and the palpation of the obturator membrane and the pubic symphysis, also showed significant ($\alpha \leq 0.05$) to highly significant improvements after the therapy. No negative effects could be observed in the pregnant women after treatment.

I was able to confirm my hypothesis that pregnant women with symptom-giving SIJ instability undergoing osteopathic treatment show considerably less discomfort in pregnancy. This study further proves the necessity of three osteopathic treatments for a very significant improvement for the pregnant women. The results support the relevance of this study for the field of osteopathy.

Due to the highly relevant results, the present study confirms the significance of the provocation SIJ test series according to Laslett. I thus recommend that osteopaths use these tests in pregnant women in order to decide on the proper therapy on the basis of their results.

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List of figures

List of tables

List of graphs

Annex

Annex	A	Patientenzettel
Annex	B	Zustimmungserklärung
Annex	C	Anamnesebogen
Annex	D	Testbogen
Annex	E	Fragebogen
Annex	F	RDQ - Verlauf der einzelnen TP
Annex	G	VAS - Verlauf der einzelnen TP
Annex	H	Tabelle der Wertsenkung

Annex A

Kreuzschmerzen in der Schwangerschaft ?

Sehr geehrte Schwangere !!!

Die Schwangerschaft ist ein ganz besonderer Abschnitt im Leben und sollte als schöne Zeit erlebt werden können. Leider treten immer wieder Probleme auf wie z.B. **Kreuzschmerzen.** Diese werden in der Schwangerschaft bereits als NORMAL betrachtet, weil die Bänder und andere Körperstrukturen durch die hormonelle Umstellung elastischer werden und die Bänder um die Kreuzdarmbeingelenke zu elastisch werden.
ABER Schmerzen treten erst dann auf, wenn zusätzliche Verspannungen der Muskulatur und der Bänder ein großes Ungleichgewicht darstellen.
Diese unnötigen Spannungen können mit den Techniken der Osteopathie (=manuelles Therapiekonzept) stark verringert werden und somit können auch **die Schmerzen häufig deutlich reduziert werden**!!
Genau das will ich nun anhand einer Studie im Rahmen meiner Diplomarbeit belegen.

50 schwangere Frauen werde ich nach den osteopathischen Prinzipien behandeln. Die Therapie wird genauestens dokumentiert und mit klinischen Tests und Befunden untermauert.

Es finden 3 Behandlungen statt. Vor der 1. Behandlung ist 1 Termin zur genauen Anamnese und Untersuchung notwendig.
Eine Behandlung dauert maximal eine Stunde
Die Therapiekosten werden nach Kassentarif von der Krankenkasse vollständig rückerstattet.
Eine Verordnung (Überweisung) mit Diagnose vom Gynäkologen zur **Physiotherapie** ist notwendig
Voraussetzung: Kreuzschmerzen in der Schwangerschaft,
zwischen 12. und 32. Schwangerschaftswoche .

Weitere Informationen und Terminvereinbahrung bitte bei:

PhysioLeoben-Praxis für Physiotherpie + Osteopathie TEL.: 03842/25560

Alles Gute in Ihrer Schwangerschaft !!!

Wolfgang Aspalter
Physiotherapeut und Osteopath und Vater einer 6 Monate alten Tochter ☺

Annex B

Zustimmung

zur Teilnahme an der Studie: „Können die Kreuzschmerzen bei Schwangeren, welche eine ISG-Instabilität besitzen, mit Osteopathie reduziert werden?

NR. TP: _____

Name: _____ Datum: _____

Geburtsdatum: _____

Errechneter Geburtstermin: _____

Ich gebe meine Zustimmung zur Teilnahme an der Osteopathiestudie:

Unterschrift: _____

Ich gebe meine Zustimmung zur Osteopathiebehandlung während meiner Schwangerschaft in rahmen der Studie. Ich kann jederzeit aus der Studie aussteigen!

Unterschrift: _____

Annex C

Datum der Behandlung: **NR.TP:_____**

Befundung		SSW
1.TH		SSW
2.TH		SSW
3.TH		SSW
Abschlußmessung		SSW

Name:	Geburtsdatum:
Beruf:	Err. Geburtstermin:
Familiensituation:	Tel:
Sport:	
Behandelnder Arzt:	
Medikamente:	
Anz. der Schwangerschaften:	
Anz.: der Kinder:	

Derzeitige Beschwerden

Hauptbeschwerden	Jahr

- Seit wann?
- Bereits vor der Schwangerschaft?
- Gab es Auslöser der Beschwerden?
  - Beschreibung der SS: US?,Labor?,KiBew?
  - RR: links_____rechts_____Puls:_____
  - Gewicht:_____vor der SS_____

- Sonstige Behandlungen
-
- Entwicklung/Verschlimmerung/Verbesserung
- Art des Schmerzes
- Schmerz im Tagesverlauf

Frühere Krankheiten

Operation	Alter	Schwere Infektionen/Krankheiten	Alter

Verletzungen/Unfälle ohne Naht	Alter	Verletzungen/Unfälle mit Naht	Alter

Schwere psychische Traumata	Alter	Zahnärztliche Eingriffe	Alter

Befunde Blut/Intern.....
Rönt.....
MRI. .....
Neuro.....
OS – Dichte.....
Krebs in Fam.....

Interne.....

GI – Trakt o Blähungen o Stuhlunregelm. o Leber o Kaffee
o Sonstiges o Nachtsicht o Extremitäten

Neurostatus o zentral.....
o Sinne.....
o peripher.....
o Vertigo.....

Hormone o Zyklusstörung o PMS
o Thyrioidea o Hypo o hyper o Knoten
o Osteoporose

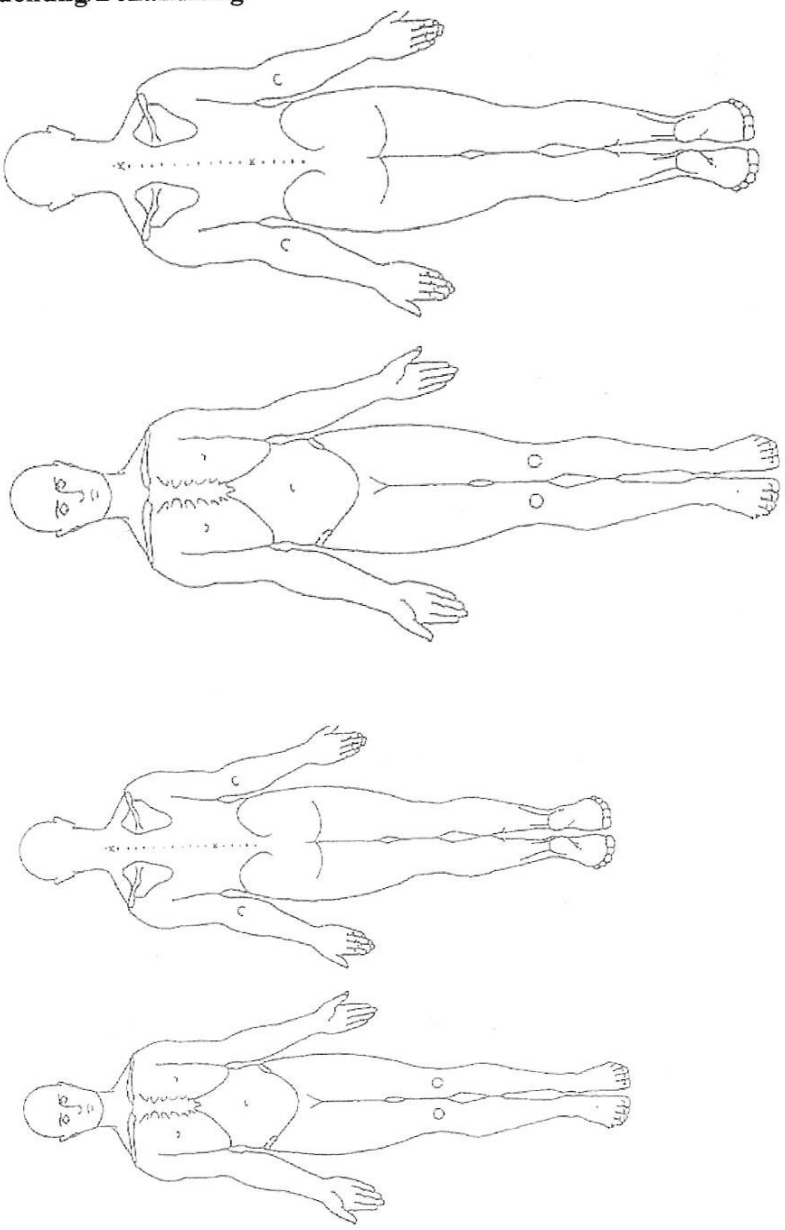
Urogenital o Nieren_____
o Blase_____
o Uterus_____

HNO o Ohren o Mittel o NNH o Larynx o Tinnitus
o Sonstiges.....

VEG. Anamnese:

o Schlaf	o Medikamente
o Nikotin	o Stuhlgang
o Appetit/Diät	o Allergien
o Alkohol	o Immunsystem
o Miktio	o

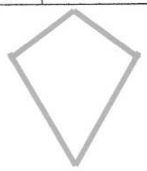
Untersuchung/Behandlung



Annex D

Datum	SSW	Bef	TH1	TH2	TH3	Me5	NR.TP

1. **Schmerzbereiche** Einzeichnen - Bodychart
2. **Rhomboid**-Test- Hockerlpostition –Fotos?



3. Flexion-Test –Stehend	Re	li
4. Flexionstest – Sitzend	Re	li
5. SLR Klassisch	Re	li
6. **ASLR**-Test 7. +Kompresion	Re	li
8. Faber	RE	li
9. BWS-Rotation	Re	li

10. ISG – Provokationsteste

Distraction; RL	Re	li
Tight thrust,RE, LI	Re	li
Pelvic Torsion RE post	Re	li
Pelvic Torsion LI post	Re	li
Compression,SL	Re	li
Sacral Thrust; BL	Re	li
Cranial Share; BL	Re	li

11. Palpationsteste:
    - SIPS :
    - Psoas :
    - Piriformis:
    - Memb. Obt. :
    - Lig. Sacr. Tub:
    - Bebo-Tib Isch :
12. ROM LWS
13. ROM ISG
14. ROM Pubis
15. ROM Hüfte
16. Beinlänge
17. Uterus- Viszeral ,(Höhe)
18. Diaphragma
19. SSB
20. Occiput Sacrum
21. allg. Craniosacral

Annex E

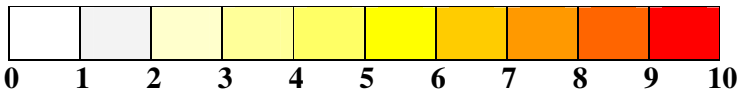
Roland Morris Fragenkatalog **SSW:_____ Datum:_____**

Wenn Sie Rückenschmerzen haben, fällt es Ihnen schwer, Tätigkeiten oder Bewegungen auszuüben die ganz alltäglich sind. Die folgenden Sätze beinhalten Aussagen, die Personen in solchen Situationen gemacht haben und die Ihnen helfen sollen, Ihre derzeitige Verfassung genauer zu beschreiben. Denken Sie daran, wie Sie sich im Moment fühlen und markieren Sie nur jene Sätze, die mit Ihrem Befinden übereinstimmen. Bitte denken Sie daran, dass sich diese Aussagen allein auf den Rückenschmerz und nicht auf die Schwangerschaft als solches beziehen.

1. Aufgrund meiner Rückenschmerzen verlasse ich das Haus/die Wohnung selten.
2. Ich wechsle häufig meine Körperhaltung, um meinen Rücken zu entlasten.
3. Ich gehe aufgrund meiner Rückenschmerzen langsamer, als üblich.
4. Meine Rückenschmerzen hindern mich daran, ansonsten übliche Arbeiten im Haushalt zu verrichten.
5. Aufgrund meiner Rückenschmerzen halte ich mich beim Stiegensteigen stets am Geländer fest.
6. Aufgrund meiner Rückenschmerzen lege ich mich häufig zum Ausruhen hin.
7. Aufgrund meiner Rückenschmerzen muss ich mich an etwas festhalten, um auch einem Polstersessel hochzukommen.
8. Aufgrund meiner Rückenschmerzen bitte ich häufig andere Menschen, etwas für mich zu erledigen.
9. Aufgrund meiner Rückenschmerzen brauche ich beim Ankleiden länger als üblich.
10. Aufgrund meiner Rückenschmerzen achte ich darauf, nie allzu lange Zeit stehen zu müssen.
11. Aufgrund meiner Rückenschmerzen achte ich darauf, mich so wenig wie möglich zu bücken oder niederzuknien.
12. Ich komme aufgrund meiner Rückenschmerzen nur schwer aus einem Sessel hoch.
13. Ich leide beinahe ständig unter Rückenschmerzen.
14. Meine Rückenschmerzen erschweren mir das Umdrehen im Bett.
15. Meine Rückenschmerzen wirken sich negativ auf meinen Appetit aus.
16. Bedingt durch meine Rückenschmerzen habe ich Probleme beim Anziehen von Socken (Kniestrümpfen).
17. Meine Rückenschmerzen erlauben es mir nicht, längere Strecken zu gehen.
18. Meine Rückenschmerzen beeinträchtigen meinen Schlaf.
19. Aufgrund meiner Rückenschmerzen brauche ich beim Ankleiden Hilfe.
20. Bedingt durch meine Rückenschmerzen verbringe ich die meiste Zeit sitzend.
21. Aufgrund meiner Rückenschmerzen versuche ich, schwere Arbeiten im Haushalt zu vermeiden.
22. Aufgrund meiner Rückenschmerzen bin ich wesentlich reizbarer und launischer als üblich.
23. Bedingt durch meine Rückenschmerzen kann ich Treppen nur sehr langsam hinaufgehen.
24. Aufgrund meiner Rückenschmerzen verbringe ich die meiste Zeit im Bett.

Schmerzskala

Tragen Sie auf einer Skala von 0-10 die Schmerzen, die durchschnittlich im Tagesverlauf aufgetreten sind, ein:



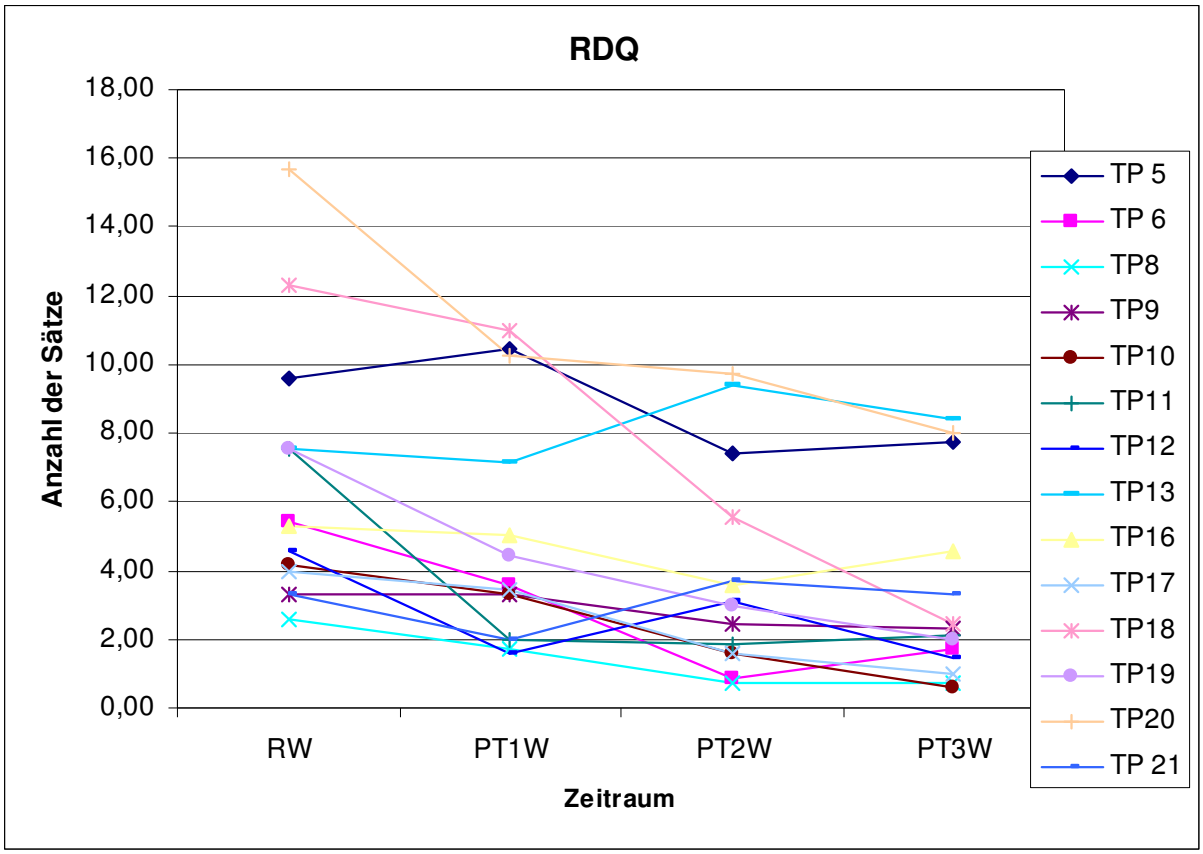
Kein Schmerz stärkster vorstellbarer Schmerz

Besondere Tätigkeiten und Vorkommnisse im Tagesverlauf:

Nr. TP	Befund	2.TH
	1.TH	3.TH

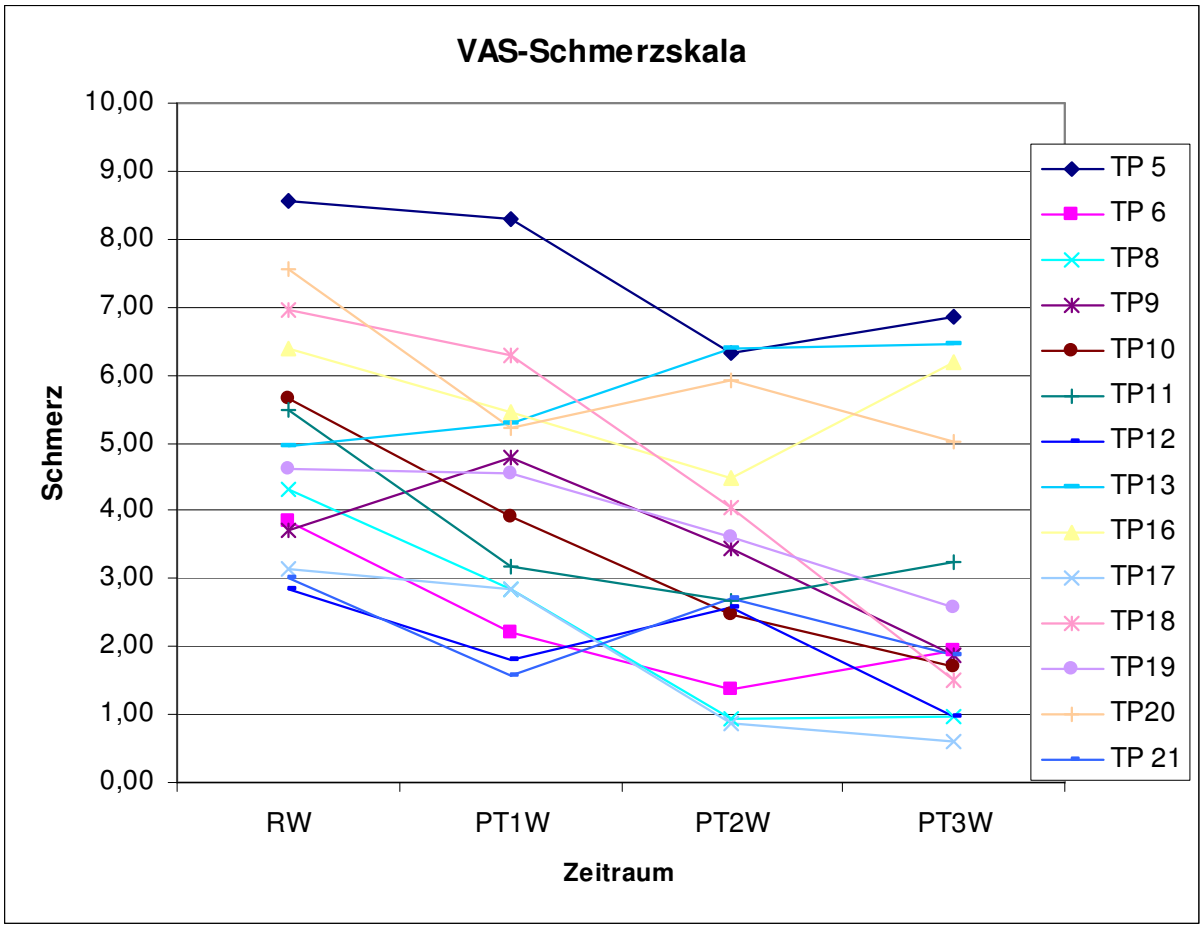
RMQ	
VAS	

Annex F



Verlauf der RDQ -Werte der einzelnen Testpersonen

Annex G



Verlauf der VAS -Werte der einzelnen Testpersonen

Annex H

Wertsenkung (X) von RW zu PT3W

$$X = (1 - \frac{PT3W}{RW}) * 100$$

Wertsenkung X wird für RDQ uns VAS berechnet:

(Werte unter 0 entsprechen einer Wertsteigerung)

	(X_{RDQ})	(X_{VAS})
TP 5	19,40	20,17
TP 6	68,42	49,81
TP8	72,22	77,41
TP9	30,43	50,00
TP10	86,21	69,62
TP11	71,70	40,99
TP12	68,75	65,33
TP13	-11,32	-30,64
TP16	13,51	3,14
TP17	75,00	81,28
TP18	80,23	78,48
TP19	73,58	43,96
TP20	49,09	33,77
TP 21	0,00	38,10