Pregnancy-related low back and pelvic girdle pain

With reference to joint hypermobility and treatment

Licentiate thesis

ANNE LINDGREN
ABSTRACT

Objectives: To explore if joint mobility, as a measure of connective tissue quality, could be a predictor for pregnancy-related low back pain after pregnancy and to evaluate local corticosteroid injection treatment in women with persistent pelvic girdle pain long after childbirth.

Material and methods: To investigate joint mobility in relation to pain, 200 women were examined repeatedly from early pregnancy until three months after delivery. Their mobility in left fourth finger abduction in early pregnancy was compared with clinically assessed low back and pelvic pain 3 months after delivery. To evaluate local corticosteroid injection treatment, 36 women with persistent PGP were included in a randomised controlled trial (RCT) and randomised to either corticosteroid injection or saline injection on one occasion at the ischial spine bilaterally, with a follow-up after four weeks. In both studies, the women were asked about obstetric history, to complete a pain drawing, estimate their level of pain on a visual analogue scale (0-100) and estimate how they manage their everyday activities on a questionnaire, Disability Rating Index (DRI). In the RCT, the 36 women also completed Short Form 36 (SF-36), a quality of life questionnaire, six-minute walk test (6MWT), and isometric trunk flexion and extension were examined.

Results: Women with low back and pelvic pain three months after pregnancy had increased finger laxity in early pregnancy. The larger the finger angle and the more pregnancies, the greater the risk of low back and pelvic pain after pregnancy. In the RCT, at follow-up, the women who received corticosteroid injection treatment improved in walking ability, estimated physical ability and isometric trunk extension more than those who received saline injections.

Conclusions: Increased joint mobility, as measured by finger joint mobility, together with the number of previous pregnancies, may be an indicator of low back and pelvic pain postpartum. One single corticosteroid injection treatment to intra-pelvic structures improved function in women with persistent PGP which may indicate a source of pain.
List of Papers
This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLR</td>
<td>Active Straight Leg Raising test</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>DRI</td>
<td>Disability Rating Index</td>
</tr>
<tr>
<td>FABER</td>
<td>Flexion Abduction External Rotation</td>
</tr>
<tr>
<td>GJH</td>
<td>Generalised Joint Hypermobility</td>
</tr>
<tr>
<td>GW</td>
<td>Gestational Week</td>
</tr>
<tr>
<td>LBP</td>
<td>Low Back Pain</td>
</tr>
<tr>
<td>MCP</td>
<td>MetaCarpoPhalangeal joint</td>
</tr>
<tr>
<td>PGP</td>
<td>Pelvic Girdle Pain</td>
</tr>
<tr>
<td>PP</td>
<td>Post-partum</td>
</tr>
<tr>
<td>P4</td>
<td>Posterior Pelvic Pain Provocation test</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised Controlled Trial</td>
</tr>
<tr>
<td>SF-36</td>
<td>Short Form 36 Health Survey</td>
</tr>
<tr>
<td>SIJ</td>
<td>Sacro Iliac Joint</td>
</tr>
<tr>
<td>SLR</td>
<td>Straight Leg Raising</td>
</tr>
<tr>
<td>VAS</td>
<td>Visual Analogue Scale</td>
</tr>
</tbody>
</table>
Introduction

Low back pain (LBP) and pelvic girdle pain (PGP) with onset during pregnancy are commonly described by women from different parts of the world [1-4] and was described already by Hippocrates [5]. Up to 10% of all women who have given birth report disabling LBP and PGP, persistent several years post-partum [6-10]. The underlying physiological processes of pregnancy-related LBP and PGP during and after pregnancy are unclear, and there is a lack of effective management strategies [11, 12]. Still, LBP and PGP have high impact on the women, their families and indirectly on society, both during and after pregnancy [13-16].

Generalised Joint Hypermobility (GJH) refers to the ability of one or more joints to actively and/or passively move beyond normal limits. It may affect a few joints or present in multiple body sites [17]. GJH is associated with pain development, especially when the primary role of the joint is to provide axial support during sitting or standing [18-20].

Chronic musculoskeletal pain

Musculoskeletal disorders comprise a lot of chronic pain, of which back pain constitutes to a high extent [21]. A minority of patients with pain consume vast majority of resources from healthcare and public insurance costs [22-24] due to suffering, sick leave and early retirement expenses worldwide [23, 25-29].

Low back and Pelvic girdle pain in general

In 1962, Walde recognised and described the differences between lumbar pain and pelvic girdle pain [30], and Östgaard and co-workers suggested a differential criteria between these two entities in 1991 [31]. Later, a European workgroup, WG4, developed diagnostic criteria for pelvic girdle pain PGP based on available research [32]. Throughout history, symptoms, pain characteristics and by performing specific provocation test, it seemed possible to distinguish between PGP and LBP [32, 33]. Distinguishing between these two diagnoses is recommended for successful treatment [34].
Diagnosis

There is still no worldwide consensus regarding requirements for the diagnosis “PGP”. So far, there is no blood tests or imaging that can verify the PGP diagnose. Besides history, most studies recommend a combination of pain provocation tests [35-38].

The definition of PGP in the present thesis is that ‘pain is experienced and marked on a pain drawing in-between the posterior iliac crest and the gluteal fold particularly in the vicinity of the sacroiliac joints (SIJ) and verified by Posterior Pelvic Pain Provocation test (P4) test. The pain may radiate into the posterior thigh and can also occur in conjunction with/or separately in the symphysis pubis’ [32]. The pain should have debuted in relation to pregnancy and increases when the women load the pelvis. It may also include pain in the pubic symphysis with or without radiation to the anterior thighs. In study II, the women also had provoked pain at the spina ischiadica.

The definition of LBP in the present thesis is ‘discomfort and pain from the area between the costal margin and the inferior gluteal folds, with or without radiation to one or both legs and sometimes to the foot’ [39, 40].

Pregnancy-related low back and pelvic girdle pain

Prevalence during pregnancy

During pregnancy, as compared to the non-pregnant state, a remarkably increased prevalence of LBP and PGP is reported by women in all continents [1-3, 31, 41, 42]. The reported prevalence rates for LBP and PGP during the whole pregnancy period are widely spread between 3.9 and 89.9% [32, 41, 43-47]. A Cochrane review from 2015 stated a pregnancy prevalence of 70-85% [48]. Definitions, diagnostic and study methodology explain some of this variation.

Prognosis

Among most women with pregnancy-related LBP and PGP, the pain disappears within six months after delivery [49-51]. However, at 18 months post-partum, 7% of all women still experienced disabling pain [52], and the prevalence of PGP two years after was 5–8% [53-55].

Aetiology and pathogenesis

The aetiology and pathogenesis of pregnancy-related LBP and PGP are uncertain but probably multifactorial. Suggested causes are biomechanical [56-60] hormonal [61-68], genetic [9, 69-71], degenerative [30] and metabolic [72].
One hypothesis is that the pain may arise from the pelvic joints or structures surrounding these joints, in particular the strong ligamentous apparatus of the pelvis (Figure 1). These structures may be influenced by the pregnancy and in certain circumstances develop pain [3, 34, 56, 57, 59, 60, 73]. Changes in the SI-joint bone and ligament structures have been displayed in regard to age, activity, pregnancy hormones and stress of delivery [73].

Figure 1. Ligamentous apparatus of the pelvis.

The high incidence of back pain during the first half of pregnancy [3], starting just a few weeks after conception, indicates an influence of pregnancy-specific hormones. This view is supported by the suggested relationship between circulating ovarian hormone levels as relaxin and increased collagen turnover or tissue remodelling mechanism in early pregnancy [74] and the incidence of low back pain during pregnancy [75, 76].

Many women report that the intensity of pregnancy-related LBP and PGP increases during and/or after lifting, bearing and standing. This type of load causes the ligaments around the pelvis to stretch, which corresponds with increased range of motion [77] and inflammation [78]. Also, decreasing bone mineral density during pregnancy has shown to have an association with LBP [79].

It is possible that movements with many repetitions, high loading or high tempo and with short rest between loadings make a cumulative micro-trauma, which may lead to low-grade inflammation, tissue degradation, creep, laxity and reduced stability [78].

Risk factors

Several risk factors have been associated with PGP during pregnancy, such as trauma of the back and/or the pelvis before pregnancy, multi pregnancy, heavy or excessive lifting at work, reported joint hypermobility, age, high Body Mass Index (BMI), physical inactivity before pregnancy, hormonal changes, early menarche and smoking [5, 9, 10, 31, 47, 49, 62, 70, 80-86]. There are
also several psychological risk factors such as work dissatisfaction, stress at work, adverse childhood experiences and emotional distress [49, 70, 81, 87, 88]. In relation to a new pregnancy or/and menstruation, recurrence of PGP is common [9, 89].

Factors related to prognosis of pregnancy-related LBP and PGP after delivery have also been reported. Such factors during pregnancy are: high intensity of pain, onset of pain in early pregnancy, multiple back pain locations, high disability, higher BMI during pregnancy, poor endurance of the trunk flexor muscles, high number of pelvic girdle pain provocation tests, high score on the ASLR test, poor belief in improvement, prolonged duration of labour, other diseases, emotional distress, lack of belief in improvement and work dissatisfaction [6, 8, 10, 51, 52, 55, 89-91]. Risk factors for PGP revealed after pregnancy are positive (P4) test on one side, the Active Straight Leg Raise (ASLR) score ≥4, sitting during breast-feeding and caesarean delivery [92].

Exercise can reduce the risk of developing LBP and sick-leave during pregnancy but not the risk for PGP [85, 93]. Also, exercise can decrease the severity of LBP and PGP during the following pregnancy, but de-conditioning can sometimes be a consequence of backpain and not a cause thereof [94, 95]. The introduction of exercise therapy may be difficult because of high pain intensity levels and easily provoked pain.

Symptoms and consequences

The pregnancy-related LBP and PGP may result in major changes in activities of daily living, leisure time activities and work choices [67], restricted walking distance [45, 63, 89] and reduced general well-being [53, 96]; moreover, it is the major cause of sick leave during pregnancy [97, 98]. Also, activities such as turning in bed, getting out of bed and the bath as well as hip adduction/adduction movements may be difficult to perform while having PGP [63, 89, 99].

Pain in both the SIJs and the symphysis or combined with LBP and/or with upper back pain, has higher impact on health and function [6, 14, 100]. Living with PGP during pregnancy is described as ‘struggling with daily life and enduring pain’ [96].

When pelvic girdle pain persists after childbirth, women may have difficulties in managing the new life situation and looking after their new-born baby [101]. Furthermore, sexual activities may increase pain, which may affect the couple’s relationship and reduce sexual health [102]. This could lead to feelings of failure both as a mother and as a partner [103].

After pregnancy, women often feel ignored by healthcare personnel [104] not asking, supporting or having enough knowledge about PGP [13, 105]. Despite the fact that their functional disability may result in problems returning to work after maternity leave [83], only a few have been on sick leave or
sought health care 6–12 months after pregnancy [106]. More acknowledgement and help from family, friends and colleagues are necessary [105].

Management and treatment during and after pregnancy

There is still a lack of high-quality studies about management of pregnancy-related LBP and PGP during and after pregnancy. Today, there are no Swedish guidelines for prevention or how to treat LBP and PGP during pregnancy or thereafter, but there are European guidelines for PGP [32]. A Cochrane overview of interventions [48] for PGP during pregnancy concluded some good evidence for acupuncture, moderate evidence for pelvic belt (recommended as complement), low-moderate evidence for exercises (individual and/or stabilising), and information plus reassurance are recommend.

After pregnancy, the most common recommendations are to use the same treatment as during pregnancy, with addition of guided stabilising exercises and pelvic floor exercises [32, 107].

Also, the use of pain killers and anti-inflammatory medication remains controversial, both during pregnancy and breastfeeding [108].

Corticosteroid treatment

Corticosteroid injections have powerful anti-inflammatory effects, used in treatment of inflammation in soft-tissues such as tendons, joints, bursa and muscles, including pain in the back and pelvic area [109-112]. The corticosteroid treatment has proven to have beneficial effect in the short-term on tendinopathies but compared with other treatments, it could even be worse in the long-term [113].

Hypermobility

Generalised Joint Hypermobility is a reliable marker for altered connective tissue and a principal finding in conditions of known connective tissue abnormalities [114]. GJH is correlated with pain, especially when the primary role of the joint is to provide axial support during sitting or standing [18-20]. Finger joint laxity can reflect GJH [115, 116].

The prevalence of GJH varies between 4–40%, depending on diagnostic criteria, age, gender and ethnicity [117-121]. A higher prevalence of LBP and PGP is described among Swedish pregnant women who reported GJH [10, 70], but no such correlation could be observed in South Africa [122]. Also, association between PGP and women with hereditary connective tissue defects such as Ehler-Danlos syndrome and Osteogenesis imperfecta has been observed [82, 84, 86].
Biomechanics

The connective tissue of the low back and pelvis are fundamental for transmitting the body forces between the trunk and the lower extremities [123, 124]. The SIJs main role is to transmit these forces and provide stability [125]. The form and surface of the connecting bones in the SIJ provide a form closure, and the muscles around the pelvis make a force closure to provide stability [124, 126] (Figures 2 and 3). If this fails, parts of the pelvis are subjected to forces for which they are not designed [127].

A theory is that laxity in the ligaments, especially the long dorsal sacroiliac ligament (LDL) and excessive loading, leads to diminished force closure and pain in women with PGP [128, 129] as the ilium rotate anteriorly and counternutates the sacrum [57, 130] (Figure 3).

![Figure 2](image1.png)

*Figure 2.* The anatomic form of the SIJ (a) together with forces from muscles (b) and ligaments provide the stability in the pelvic joints (c).

![Figure 3](image2.png)

*Figure 3.* Nutation (A) is limited by interosseous, anterior sacroiliac, sacrotuberous and sacrospinous ligament, together with biceps femoris muscle. Counternutation (B) is limited by the long dorsal sacroiliac ligament.
Sacro-Iliac joint stability

Simulation tests on 3-dimension finite element models of the human pelvis, sacroiliac joints and sacroiliac ligaments revealed increased sacroiliac joint stress and angular motion, with decreasing sacroiliac ligament stiffness during pelvic load [77, 131].

However, minimal increased elasticity in connective tissue might change the biomechanical properties of ligaments in the pelvis [127]. This could be a pain developing factor since the pelvis becomes more vulnerable to biomechanical loading and prone to developing pain [66]. The translation has been reported to increase with the number of pregnancies [132-135] and diminish by stabilising muscles [136].
Aims

Study I: to study the association between the left fourth finger joint mobility in early pregnancy and low back pain with onset during present pregnancy, persistent three months after delivery.

Study II: to evaluate the effect of corticosteroid treatment injected to the sacrospinous ligament attachment to the ischiadic spine on physical function in women with persistent pelvic girdle pain, persistent several years after childbirth.
Material and methods

Study I

Study population and recruitment
During 1991, all women in early pregnancy living in two districts of Sundsvall, Sweden (district’s population 23,350 of 93,800 in Sundsvall) were consecutively and prospectively invited to participate in the study. They were asked to participate by the midwives during check-ups at the antenatal care units in the city, in the local clinic at the hospital, city surroundings and at the gynaecologist’s offices. In total, 227 women were eligible in the area, and all of them were Caucasian. Permission for this study was obtained from the Research and Ethics Committee of the University of Umeå, and all women gave their informed consent.

Inclusion criteria
The inclusion criteria were: Swedish speaking healthy women, without continuous medication, attending an antenatal care unit in their early pregnancy. Women with severe obstetric problems were included in the study but had an obstetric consultant handling that problem.

Two hundred and twenty-two pregnant women fulfilled the sampling criteria and were invited to participate in the study. Thereafter, 200 (88.1%) women accepted to participate and were included in the study. Ten women left the study because of spontaneous abortion, and two women left the study for unknown reasons and one woman moved to another place (Figure 4).

Data collection
Data were collected three times during pregnancy and once three months after delivery. The appointments at the antenatal clinics were, on average, at 11 (range 6 to 19), 24 (range 21 to 27) and 36 (range 34 to 38) completed Gestational Weeks (GW), and 13 (4 to 29) weeks post-partum. All visits except the second visit was a scheduled ante- or post-natal appointment. A questionnaire was filled in at each appointment (Appendix 1), followed by a clinical examination with assessment of the passive abduction angle of the left fourth finger.
and back status. Ultrasonography in estimated GW 19 confirmed the duration of pregnancy—and was registered as completed weeks of gestation. At each study appointment, women were examined by the same physician, who ensured that the women completed the! questionnaires and indicated their pain onset via the pain mapping.

*Figure 4. Flowchart study I. GW: Gestational Week, pp: post-partum*
Study II

Study population and recruitment

Women with pregnancy-related PGP were consecutively and prospectively assessed for eligibility between 18 October 2004 and 13 November 2007. All women had PGP, with onset during a previous pregnancy and persisting long after delivery. The women were referred to the Department of Physiotherapy, Sundsvall Hospital, or recruited by advertisement in the local press.

Inclusion and exclusion criteria

The inclusion criteria were: pain in the sacral region (buttocks included), with onset during a previous pregnancy, lasting between six months to seven years after delivery, at least one out of three ipsilaterally positive PGP provocation tests, reported pain intensity at present between 30 and 70 mm on a Visual Analogue Scale (VAS) [137, 138], and pain induced by internal palpation at the ipsilateral ischiadic spine as well as ability to understand the Swedish language. Exclusion criteria were: positive straight leg raising test and loss of Achilles or patellar tendinous reflex [139], LBP or PGP with onset prior to pregnancy and previous back surgery. Thirty-six women fulfilled the inclusion criteria, met no exclusion criterion and were eligible to participate in this RCT (Figure 5).

Data collection

Data were collected before study inclusion and four weeks after intervention. The women were examined by one of two experienced physiotherapists who performed both the assessment at baseline and the subsequent follow-up, blinded to the intervention and previous test result (Appendix 2). Disability Rating Index (DRI) [140] and Short Form 36 Health Survey (SF-36) [141] were filled in at each appointment as well as Visual Analogue Scale (VAS) and a pain drawing [142].

Randomised controlled trial

A person not engaged in the study made a computer-generated random allocation sequence, with block size of four. The randomisation was concealed from the investigators until study closure. A pharmacist conducted the blinding performance, prepared and delivered allocated treatment, after receiving a message from the Department of Physiotherapy when a woman was included in the study. The participant, the physician who gave the injection, the assessing physiotherapist and the examining physiotherapist, were all blinded to the allocation.
Participants were randomised to the triamcinolone treatment or to the saline treatment group. The triamcinolone treatment group received an injection treatment of a compound of 1 ml triamcinolone 20mg/ml (Lederspan®, Meda AB, Solna, Sweden) and 1 ml lidocaine hydrochloride 10mg/ml (Xylocain®, Astra Zeneca, Södertälje, Sweden). The placebo treatment group received an injection of 0.99 ml saline solution 9mg/ml, 1 ml lidocaine hydrochloride and 0.01 ml fat emulsion (Intralipid®, Fresenius Kabi, Uppsala, Sweden), the latter to make the solution as opalescent as Lederspan® (Figure 5).

![Flowchart study II](Image)

**Figure 5. Flowchart study II**

**Questionnaires**

Questionnaires used in both studies

Baseline questionnaires were fulfilled at the first visit and follow-up questionnaires at the last visit. At baseline and follow-up, the women also reported
pain intensity on VAS and pain drawings. All the questionnaires were com-
pleted in seclusion without time limit and checked for completeness by the
investigator, after the clinical examination was finished.

The questionnaires included questions about previous back pain, obstetric
history, smoking habits, lifestyle, socio-demographic factors (Appendices 1
and 2), pain intensity and disability. Pain drawings were used to report ongo-
ing pain and its locations.

The pain intensity at present and the worst pain during the past week were
assessed on two 100 mm long VAS: 0 mm indicating no pain and 100 mm
indicating unbearable pain [137, 138]. The patients were asked to indicate
where the pain intensities were located.

Pain drawings were used to indicate the location of the pain perceived at
present at each study visit [142]. The women were asked to indicate the loca-
tion of the pain and time of onset of the ongoing pain for each pain location.
Several locations could be specified. In study I, the locations were coded as
sacral spine, lumbar spine, thoracic spine and cervical spine. If any of these
locations were indicated, they were pooled into the back pain group; other-
wise, it was categorised as no back pain group. If they had indicated more than
one location, only one onset time and the lowest back pain location were reg-
istered.

To assess the ability to perform physical activities of daily living, the Dis-
ability Rating Index (DRI) questionnaire was used. The women indicated their
capacity to perform twelve, easy to heavy, daily activities using VAS, ranging
from 0 to 100 mm, where 0 mm indicated no problem to perform the activity
and 100 mm indicated total incapacity. The mean value of the twelve ques-
tions was calculated and documented as a score [140].

Questionnaires only in study I
The baseline questionnaire included study specific questions on earlier obstet-
ric history, smoking habits, occupation and an estimation of physical condi-
tion.

Questionnaires only in study II
The baseline questionnaire also included questions about education, mode of
delivery (vaginal/Caesarean), date of latest delivery and sick leave for LBP or
PGP (no/yes).

The SF-36 [143] was used to measure quality of life. The SF-36 contains
eight dimensions of functional health for the past four weeks: four dimensions
measuring physical health and four mental health. The physical and the mental
component summary were calculated separately. Higher levels of self-rated
functional health were associated with higher scores on SF-36.
Clinical examination

Clinical examination in both studies

On each study visit, clinical examination of the lumbar spine and pelvis were performed by pain provocation tests, palpation and Straight Leg Raising test (SLR) [144]; Achilles and Patellar tendon reflexes were tested on both legs. All tests were performed by the same physician in study I. In study II, the patients were examined by the same physiotherapists at all appointments. The examiners had no knowledge of the women’s medical history or treatment group.

Performing the SLR, the examiner elevated each extended leg in turn, and the angle between the femur of the tested leg and the examining table was estimated. In study I, it was considered positive if the angle was <70°, and the tightness in the hamstrings muscle was recorded. In study II, the physiotherapist expanded the test by lowering the leg until the pain disappeared, then a dorsal flexion of the foot was performed. SLR was here considered positive if neurological symptoms occurred and/or the woman’s radiating pain was provoked.

Posterior Pelvic Pain Provocation (P4) test [145] was performed with the woman in supine position. While holding the hip and knee at 90°, axial femoral pressure was applied. In study I, it was a manual pressure force of approximately 50 to 150 N to the knee, and the test was considered positive if the woman reported pain in the sacral and/or buttock region on the ipsilateral side. The P4 test in study II was modified to a semi-quantitative test, with a load of 1 kg, 5 kg or 10 kg applied to the knee while the femur was in 90° flexion of the hip, with the patient in supine position. The test was considered negative when no pain was elicited despite maximum load of 10 kg; otherwise, it was positive according to the applied weight.

Clinical examination only in study I

The passive abduction angle of the left fourth finger was measured in early pregnancy using a protractor (Figure 6). The device immobilised the second finger with the forearm and hand in a horizontal position. A constant force of 1.7 Newton was applied to the medial side of the fourth finger’s distal phalanx, with the woman’s hand relaxed. The abduction angle between the second and fourth finger was assessed to the nearest degree.
The tests of the back included control of configuration and mobility.

Clinical examination only in study II

Pain provocation tests
The pain provocation tests of the pelvis were Menell’s, Patrick’s Flexion Abduction External Rotation (FABER) test [34, 56, 146] and semi-quantitative P4 test (described above). These tests were considered positive if the provocation elicited ipsilateral pain in the sacral area. Menell’s test was performed with the patient in supine position and one leg in 30° abduction and 10° flexion in the hip joint. To cause a sagittal movement, the femur was first pushed in to then pulled out from the pelvis. Patrick’s FABER test was performed in supine position with one leg flexed, abducted and outward rotated with the heel on the opposite kneecap.

Physical functioning tests
Four physical function tests were performed: the six-minute walk-test (6MWT) [147], isometric flexion and extension tests [148, 149] and the ASLR test [150, 151].

The 6MWT assessed physical function capacity regarding walking speed and endurance on a treadmill in horizontal position. The women were asked to choose their own walking speed, similar to her normal walk speed. The total distance covered during the six-minute walk was recorded in metres and the speed was recorded in km/h.

The isometric flexion and extension tests were performed to test the strength and endurance of trunk muscles. The trunk flexors were tested with the women lying in supine position, with knees flexed and the arms crossed.
over her chest. The woman was asked to lift her head and thoracic spine until her scapulae did not have contact with the table and hold this position for as long as possible, but maximum 90 seconds (Figure 7).

![Figure 7. Isometric trunk flexor test position](image)

The trunk extensors were tested with the woman lying prone position, with flexion to 30° in the hips. The woman was asked to move and hold her upper body in horizontal position and remain in that position for as long as possible, but maximum 180 seconds (Figure 8).

![Figure 8. Isometric trunk extensor test position](image)

**Vaginal palpation test**

A vaginal palpation was performed at baseline by a physician without information of the examination and test results of the physiotherapist. This procedure was performed with the woman in supine position on an ordinary examination bench, with the feet together on the bench, hips in abduction and with support for the femurs on pillows.
Information
All women received information about findings of the examination and were
told to continue to live their lives as they had done before, without any changes
between baseline and follow-up.

Treatment study II
A physician injected the allocated treatment to the anterior aspect of the sac-
rospinous ligament, with insertion bilaterally after thorough localisation of the
ischiadic spine (Figure 9). The injection was distributed through the vaginal
wall, using a Franzén needle guide with a 200 mm long, 21-gauge needle in-
serted inside (Figure 10).

Figure 9. Localisation of the ischiadic spine.

Figure 10. The Franzén needle guide
Outcome measure

Study I: Peripheral joint mobility assessed by the passive abduction angle of the left fourth finger and reported back pain distribution on pain drawing and pain intensity as worst past week on VAS.

Study II: Physical function assessed with DRI and SF-36 questionnaires, with 6MWT and isometric trunk flexor and extensor ability tests.

Statistical analyses

For studies I and II, descriptive data were given as frequencies, percentages, means and standard deviations (SD). Comparison of categorical data between the groups was made with $\chi^2$ and continuous data with Student’s t-test. No interpretation was done concerning multiple comparisons. P-values less than 5% were regarded as statistically significant, and two-sided probability tests were used.

For study I, paired t-test was used to test differences between the dependent intra-individual abduction angles at different time intervals. To test association of inter-individual abduction angles at different time intervals, spearman correlation was used. Multiple logistic regression analysis was used to control for possible confounding and confidence intervals (CI), and P-values were given. In the regression analysis, the time since last delivery was excluded since they excessively reduced the total number of women included in the analysis. Passive abduction angle of the left fourth finger, number of previous pregnancies, reported previous back pain problems, age, weight, height and current smoking habits were the set of possible determinants in early pregnancy. The categorisation of the ordinal nominal factors used in the model were 0, 1, 2, 3 or ≥4 previous pregnancies and no/yes for previous back pain problems. The intra–individual coefficient of variance was used to calculate the reliability of the abduction angle assessments. To find an abduction angle cut-off for a higher risk of pregnancy-related back pain, we used the receiver operation characteristic curve, and logistic regression was used. To compute expected mean incidence estimates of back pain post-partum, the logistic regression model was used based on the passive abduction angle of the left fourth finger in early pregnancy and the number of previous pregnancies (Figure 11).

To estimate the sample size of study I in a post-hoc calculation, the primary outcome measure abduction angle was used. Abduction angle is a continuous variable, and there were two independent groups. With a power of 0.80, a significance level of 0.05, standard deviation of $6.58^\circ$, a study population of 200 women was enough to detect a difference in the abduction angle of $2.6^\circ$. 
In study II, we had a small number of observations; therefore, possible statistical differences between the groups were tested with non-parametric tests such as Wilcoxon signed-rank test for paired comparisons, Wilcoxon rank-sum test to compare median values of continuous data and Fisher’s exact test for categorical data. Spearman’s ρ-coefficient was used for correlation analysis. The results are presented with 25th and 75th percentiles where appropriate.

To estimate the sample size of this study, we used the primary outcome measure 6MWT. There were two independent groups. The outcome measure 6MWT is a continuous variable so with a power of 0.80, a significance level of 0.05, a standard deviation of 85 and a clinically acceptable difference of walk distance between the groups of 80 m, a study population of 36 women was estimated.


Ethical considerations

The studies were approved by Swedish medical ethics committee in Umeå and Uppsala with reference number 121/90, dated 1990-06-12 for study I and reference number 02-484, dated 2003-03-11 for study II. Study II was also approved by the Medical Products Agency, Uppsala, Sweden and a clinical trial registration was made with number NCT 00757016.

All women gave written informed consent to participation. We used clinical tests that physiotherapists and physicians use in daily practice with minimal side effects. In addition, all tests have been used before in several studies. The device for finger angle assessment has been used in a previous study with no reported negative events. The injection method has not been used for this kind of treatment, but the device has been used for biopsies without negative events [152]. Our perception is that the advantages of the study treatment regime outweigh the marginal ethical problems.
Results

Study I

Characteristics of the women at study inclusion are shown in Table 1. The women had eleven completed GWs, on average. No social, occupational or educational differences were shown between pain and no pain group (data not shown). No differences in hip status or palpation tests were found between the groups (data not shown).

Table 1. Characteristics of the women included in study I. Means (s.d.) and numbers (%) are presented.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n=</th>
<th>Mean (S.D.) or number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>195</td>
<td>27.8 (4.6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>188</td>
<td>63.7 (8.7)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>187</td>
<td>1.66 (0.06)</td>
</tr>
<tr>
<td>BMI</td>
<td>187</td>
<td>23.0 (2.9)</td>
</tr>
<tr>
<td>Non-smoking (%)</td>
<td>195</td>
<td>151 (77)</td>
</tr>
<tr>
<td>Pregnant for the first time (%)</td>
<td>194</td>
<td>79 (41)</td>
</tr>
<tr>
<td>Nulliparous (%)</td>
<td>194</td>
<td>116 (60)</td>
</tr>
<tr>
<td>Number of previous pregnancies</td>
<td>194</td>
<td>0.9 (0.9)</td>
</tr>
<tr>
<td>Number of previous deliveries</td>
<td>194</td>
<td>0.5 (0.7)</td>
</tr>
<tr>
<td>Time since previous delivery (years)</td>
<td>78</td>
<td>3.3 (0.4)</td>
</tr>
<tr>
<td>Previous back pain, not during pregnancy (%)</td>
<td>195</td>
<td>113 (58)</td>
</tr>
<tr>
<td>Back pain in previous pregnancy (%)</td>
<td>115</td>
<td>46 (40)</td>
</tr>
</tbody>
</table>
The mean passive abduction angle of the left fourth finger increased significantly (p<0.0001) from 40.1° at the first visit in early pregnancy to 41.8° at the post-partum visit (Table 2). Throughout pregnancy, the mean passive abduction angle of the left fourth finger increased significantly from the first to second appointment, followed by a non-significant decrease between the second and third appointment in late pregnancy. A further increase was shown from third appointment in GW 36 to the fourth appointment 13 weeks post-partum. There was a high inter-correlation between the individual angle measurements at the four appointments (0.68<ρ<0.76, p<0.001) although the dispersion was small (Table 2). The coefficients of variance were 0.08 between the first and second assessment and 0.07 between the second and third and 0 between the third and fourth. Across the nine months study period for all four angle assessments, the coefficient of variance was 0.085.

The point prevalence rate of women with onset of back pain during the present pregnancy increased from 19% at first appointment, to 47% at second and 49% at the third appointment in late pregnancy. A clear decline to 9% (16 women) was reported at the post-partum visit; furthermore, two of these women reported pain in the lumbar region, and 14 reported pain located in the lumbosacral or the sacral back region. Among those 16 women with back pain post-partum, the mean pain intensity estimated with VAS was 38.1 mm (SD 31.3), which was significantly higher (p<0.001) compared to the mean pain intensity of 12.4 mm (SD 23.4) reported by the 154 women without back pain at this visit. Also, a significant difference (p=0.04) was shown for the DRI of 13.3 (SD 17.5) for the women with back pain post-partum compared to 3.4 (SD 9.0) for the no-pain group.
Table 2. *Mean (SD) and range of the passive abduction angle (AA) of the left fourth finger throughout pregnancy and 13 weeks post-partum, besides the mean (SD) intra-individual changes of the AA between the different time points.*

<table>
<thead>
<tr>
<th>Time</th>
<th>n</th>
<th>Mean (SD)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW 11</td>
<td>194</td>
<td>40.1 (7.0)</td>
<td></td>
</tr>
<tr>
<td>GW 24</td>
<td>187</td>
<td>41.0 (6.8)</td>
<td></td>
</tr>
<tr>
<td>GW 36</td>
<td>173</td>
<td>40.6 (6.9)</td>
<td></td>
</tr>
<tr>
<td>13 weeks pp</td>
<td>167</td>
<td>41.8 (7.0)</td>
<td></td>
</tr>
<tr>
<td>Change GW 11 - 24</td>
<td>186</td>
<td>0.9 (5.5)</td>
<td>0.02</td>
</tr>
<tr>
<td>Change GW 24 - 36</td>
<td>172</td>
<td>-0.4 (4.9)</td>
<td>0.18</td>
</tr>
<tr>
<td>Change GW 36 - 13 w. pp</td>
<td>155</td>
<td>0.9 (5.2)</td>
<td>0.03</td>
</tr>
<tr>
<td>Change GW 11 – 13 w.pp</td>
<td>167</td>
<td>1.7 (5.2)</td>
<td></td>
</tr>
</tbody>
</table>

*p-value refers to the intra-individual mean difference between the time points. Statistical test: paired two-tailed t-test. GW = Gestational Week, pp = post-partum.*

Characteristics in early pregnancy among women with and without back pain after pregnancy, with onset during recent pregnancy are shown in Table 3. Women with persistent back pain had a larger passive abduction angle of the left fourth finger of 4.4° (p=0.019), more than twice as frequent back pain in previous pregnancies and twice as many previous pregnancies and deliveries, compared with women with no back pain. Regarding the change of abduction angle from early pregnancy to post-partum, there was no significant difference between the groups concerning previous back pain, age, weight, height and cigarette smoking, irrespective of pregnancy. A similar pattern was shown between women with and without back pain with onset during present pregnancy at the third appointment in late pregnancy, except for no significant difference in back pain in previous pregnancy (data not shown).
Table 3. *Characteristics in early pregnancy among women in study I with and without persistent back pain 3 months post-partum.*

<table>
<thead>
<tr>
<th></th>
<th>Back pain group</th>
<th></th>
<th>No back-pain group</th>
<th></th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>n</strong></td>
<td><strong>Mean (SD)</strong></td>
<td><strong>N</strong></td>
<td><strong>Mean (SD)</strong></td>
<td><strong>p</strong>-value</td>
</tr>
<tr>
<td>AA in early pregnancy (°)</td>
<td>16</td>
<td>44.1 (6.3)</td>
<td>154</td>
<td>39.7 (7.0)</td>
<td>0.019</td>
</tr>
<tr>
<td>AA pp – AA early pregnancy (°)</td>
<td>16</td>
<td>1.0 (7.1)</td>
<td>150</td>
<td>1.8 (5.0)</td>
<td>0.69</td>
</tr>
<tr>
<td>Age (years)</td>
<td>16</td>
<td>29.1 (5.5)</td>
<td>155</td>
<td>27.7 (4.4)</td>
<td>0.25</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>16</td>
<td>67.0 (6.9)</td>
<td>154</td>
<td>63.4 (8.9)</td>
<td>0.12</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>16</td>
<td>166.1 (5.1)</td>
<td>153</td>
<td>166.3 (5.8)</td>
<td>0.86</td>
</tr>
<tr>
<td>Cigarette smoking (%)</td>
<td>16</td>
<td>12 (2/16)</td>
<td>155</td>
<td>23 (35/155)</td>
<td>0.18</td>
</tr>
<tr>
<td>No. of previous pregnancies</td>
<td>16</td>
<td>1.6 (1.1)</td>
<td>154</td>
<td>0.8 (0.8)</td>
<td>0.0006</td>
</tr>
<tr>
<td>No. of previous deliveries</td>
<td>16</td>
<td>1.0 (0.8)</td>
<td>154</td>
<td>0.46 (0.6)</td>
<td>0.002</td>
</tr>
<tr>
<td>Time since previous delivery (years)</td>
<td>11</td>
<td>3.5 (3.7)</td>
<td>60</td>
<td>3.3 (3.7)</td>
<td>0.88</td>
</tr>
<tr>
<td>Previous back pain except pregnancy (%)</td>
<td>16</td>
<td>44 (7/16)</td>
<td>155</td>
<td>57 (88/155)</td>
<td>0.13</td>
</tr>
<tr>
<td>Back pain in previous pregnancy (%)</td>
<td>13</td>
<td>77 (10/13)</td>
<td>89</td>
<td>34 (30/89)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

AA: passive abduction angle of the left fourth finger
pp: post-partum

*Continuous data t-test and categorical data $\chi^2$ or Fisher’s exact test.*
Factors measured in early pregnancy and the association with reported back pain with onset during present pregnancy and persistent post-partum were analysed with logistic regression and are displayed in Table 4. The abduction angle of the left fourth finger and the number of previous pregnancies were positively associated with reported back pain in a simple logistic regression analysis. At GW 36, similar associations were shown between the factors and back pain with onset during present pregnancy. A multiple logistic regression analysis with all factors measured in early pregnancy included as independent variables was performed to find determinants for reported back pain with onset during present pregnancy and persisting post-partum. The number of previous pregnancies and the abduction angle of the left fourth finger in early pregnancy were significantly and independently associated with the incidence of back pain. The agreement of the model was 83%. 
Table 4. Factors measured in early pregnancy and the association with reported back pain with onset during present pregnancy and persistent 3 months post-partum in several simple and one multiple logistic regression analyses (n=167).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Crude OR</th>
<th>95% CI</th>
<th>p-value</th>
<th>Adjusted OR</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA in early pregnancy</td>
<td>1.09</td>
<td>1.01-1.17</td>
<td>0.02</td>
<td>1.15</td>
<td>1.05-1.26</td>
<td>0.003</td>
</tr>
<tr>
<td>Age</td>
<td>1.07</td>
<td>0.96-1.19</td>
<td>0.25</td>
<td>1.02</td>
<td>0.89-1.17</td>
<td>0.81</td>
</tr>
<tr>
<td>Weight</td>
<td>1.04</td>
<td>0.99-1.10</td>
<td>0.13</td>
<td>1.06</td>
<td>0.99-1.13</td>
<td>0.07</td>
</tr>
<tr>
<td>Height</td>
<td>0.99</td>
<td>0.91-1.09</td>
<td>0.86</td>
<td>0.98</td>
<td>0.88-1.10</td>
<td>0.76</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>0.48</td>
<td>0.12-1.92</td>
<td>0.30</td>
<td>0.22</td>
<td>0.04-1.28</td>
<td>0.09</td>
</tr>
<tr>
<td>No. of previous pregnancies</td>
<td>2.34</td>
<td>1.37-3.98</td>
<td>&lt;0.0001</td>
<td>3.24</td>
<td>1.57-6.68</td>
<td>0.002</td>
</tr>
<tr>
<td>Previous back pain</td>
<td>0.59</td>
<td>0.21-1.67</td>
<td>0.32</td>
<td>0.68</td>
<td>0.21-2.20</td>
<td>0.52</td>
</tr>
</tbody>
</table>

AA, Passive abduction angle of the left fourth finger; OR; odds ratio; CI; 95% confidence interval. ORs are estimated by univariable and multivariable logistic regression analyses.
Using logistic regression, an estimation of mean back pain incidence was performed based on the passive abduction angle of the left fourth finger in early pregnancy and number of previous pregnancies (Figure 11.) The highest estimated incidence of back pain was among women with the greatest passive abduction angle of the left fourth finger in early pregnancy and highest numbers of previous pregnancies, and vice versa. In fact, the highest incidence of back pain was estimated to 94% and the lowest to 0.8% in the most extreme cases of combinations of passive abduction angle of the left fourth finger and number of previous pregnancies. To predict pregnancy-related back pain, we estimated the cut-off angle in early pregnancy to >40°.

![Proportion of back pain after delivery vs. Number of deliveries and Abduction angle](image)

*Figure 11.* Finger joint laxity, number of pregnancies and back pain persisting after childbirth. The association of finger joint laxity and number of previous pregnancies with pregnancy-related back pain incidence, persisting three months after delivery. The logistic regression model was used to compute expected mean incidence estimates of back pain.

**Study II**

Characteristics of the women in the triamcinolone and saline treatment groups are presented in Table 5. Baseline characteristics showed no significant differences between the groups, except for the higher number of previous pregnancies among women in the triamcinolone treatment group compared with women in the saline treatment group. In both treatment groups, the DRI was high; the self-reported median physical and mental health scores, median walk
distance and median time of isometric trunk extensor and flexor tests were low which, in total, indicated very low physical function.

Table 5. Baseline characteristics of participants in study II by treatment groups in medians and frequencies. The 25th to 75th percentile is shown in brackets.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Triamcinolone group n=18</th>
<th>Saline group n=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>32.3 (28.1 to 37.9)</td>
<td>32.2 (29.5 to 36.3)</td>
</tr>
<tr>
<td>No. of previous pregnancies</td>
<td>3 (2 to 4)</td>
<td>2 (2 to 3)</td>
</tr>
<tr>
<td>No. of previous deliveries</td>
<td>2 (2 to 3)</td>
<td>2 (2 to 2)</td>
</tr>
<tr>
<td>Time of PGP (years)</td>
<td>4.3 (2.3 to 6.5)</td>
<td>4.1 (2.7 to 6.4)</td>
</tr>
<tr>
<td>Time since latest delivery (years)</td>
<td>1.9 (1.0 to 2.5)</td>
<td>2.9 (1.1 to 3.9)</td>
</tr>
<tr>
<td>Non-smokers (n)</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Latest delivery as Caesarean section (n)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>LBP/PGP before pregnancy (n)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Ongoing sick leave for LBP/PGP(n)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Pain intensity at present (mm)</td>
<td>31.0 (27.0 to 49.0)</td>
<td>38.5 (30.0 to 51.0)</td>
</tr>
<tr>
<td>Pain intensity past week (mm)</td>
<td>69.5 (42.0 to 75.0)</td>
<td>55.0 (44.0 to 69.0)</td>
</tr>
<tr>
<td>Disability rating index (mm)</td>
<td>56.1 (46.1 to 63.6)</td>
<td>49 (36 to 69.7)</td>
</tr>
<tr>
<td>SF-36, Physical component score</td>
<td>31.4 (26.6 to 41.0)</td>
<td>32.0 (23.4 to 40.5)</td>
</tr>
<tr>
<td>SF-36, Mental component score</td>
<td>41.3 (33.7 to 54.1)</td>
<td>46.7 (37.5 to 59.2)</td>
</tr>
<tr>
<td>6MWT, Walk distance (m)</td>
<td>250 (136 to 324)</td>
<td>275 (131 to 350)</td>
</tr>
<tr>
<td>Isometric trunk extension (s)</td>
<td>35.5 (17 to 69)</td>
<td>42 (12 to 96)</td>
</tr>
<tr>
<td>Isometric trunk flexion (s)</td>
<td>15 (3 to 35)</td>
<td>31 (5 to 40)</td>
</tr>
</tbody>
</table>

Differences between treatment groups at follow-up are shown in Table 6. The DRI decreased 14.6 mm in the triamcinolone treatment group compared to 1 mm in the saline treatment group (p=0.046). The relative differences of 28% in the triamcinolone group and 3% in the saline group were not significant (Table 6). Within the triamcinolone treatment group, the decreased DRI was correlated with decreased pain intensity (Spearman’s ρ=0.48, p=0.045).
Table 6. Ability to perform daily activities according to the Disability Rating Index (DRI), walking distance at 6 Minute Walk Test (6MWT) and the time of isometric trunk extensor test, at baseline and at four weeks follow-up as well as absolute and relative change between follow-up and baseline, by the triamcinolone and saline treatment groups. The 25th to 75th percentile is shown in brackets.

<table>
<thead>
<tr>
<th></th>
<th>Triamcinolone group</th>
<th>Saline group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>DRI (mm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>56.1 (46.1 to 63.6)</td>
<td>49.0 (36.0 to 69.7)</td>
<td>0.96</td>
</tr>
<tr>
<td>Follow-up</td>
<td>38.0 (24.0 to 52.3)</td>
<td>50.9 (29.8 to 68.6)</td>
<td>0.29</td>
</tr>
<tr>
<td>Follow-up – baseline</td>
<td>-14.6 (-26.6 to -3.7)</td>
<td>-1.0 (-11.5 to 5.3)</td>
<td>0.046</td>
</tr>
<tr>
<td>(Follow-up – baseline)/baseline</td>
<td>-0.28 (-0.56 to -0.05)</td>
<td>-0.03 (-0.17 to 0.08)</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Walking distance (m)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>250 (136 to 324)</td>
<td>275 (131 to 350)</td>
<td>0.66</td>
</tr>
<tr>
<td>Follow-up</td>
<td>255.5 (191 to 389)</td>
<td>240 (73 to 368)</td>
<td>0.38</td>
</tr>
<tr>
<td>Follow-up – baseline</td>
<td>54.5 (-8 to 104)</td>
<td>-3.5 (-58 to 30)</td>
<td>0.016</td>
</tr>
<tr>
<td>(Follow-up – baseline)/baseline</td>
<td>0.24 (-0.07 to 0.42)</td>
<td>-0.01 (-0.44 to 0.20)</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Trunk extensor test (s)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>35.5 (17 to 69)</td>
<td>42 (12 to 96)</td>
<td>0.72</td>
</tr>
<tr>
<td>Follow-up</td>
<td>58.5 (42 to 97)</td>
<td>42.5 (18 to 65)</td>
<td>0.12</td>
</tr>
<tr>
<td>Follow-up – baseline</td>
<td>19.5 (3 to 38)</td>
<td>-3.5 (-28 to 9)</td>
<td>0.004</td>
</tr>
<tr>
<td>(Follow-up – baseline)/baseline</td>
<td>0.44 (-0.14 to 1.4)</td>
<td>-0.08 (-0.47 to 0.29)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

The SF-36 total score showed no difference between the treatment groups. However, in the triamcinolone treatment group, there was higher difference in SF-36 scores at follow-up compared with baseline in the median physical component summary (p=0.045), but not in the saline treatment group (data not shown).

In the triamcinolone treatment group, the median increase was 4.5 for physical component summary and 1.5 for mental component summary compared with 1.5 for physical component summary and 0.5 for mental component summary in the saline treatment group. The increased physical component summary in SF-36 for the triamcinolone treatment group was correlated to decreased pain intensity (Spearman’s ρ=-0.52, p=0.014).

In the 6MWT, the median walking distance between baseline and follow-up in the triamcinolone treatment group increased by 54.5 m with a median walking speed of 0.7 m/s. This was significantly different from the decrease in walking distance of 3.5 m shown in the saline treatment group (p=0.016), but the relative changes of 24% and 1% were not significant (Table 6). The
increased walking distance was significantly correlated (Spearman’s \( \rho = 0.82, \ p < 0.0001 \)) to decreased pain intensity in the triamcinolone treatment group (Figure 12).

\textbf{Figure 12.} The correlation between changes in walking distance and changes in pain intensity between baseline and follow-up in study II.

In the isometric trunk extensor test, the absolute difference in the triamcinolone treatment group increased the median time by 19.5 seconds, and the saline group decreased the median time by 3.5 seconds \((p=0.004)\). Also, there was a difference in the relative increase of median time in the isometric trunk extensor test of 44\% in the triamcinolone treatment group and the decrease of 8\% in the saline treatment group \((p=0.016)\) (Table 6).

There was no difference between the groups for the median time of the isometric trunk flexor test. The triamcinolone treatment group increased by 3.6 seconds and the saline treatment group by 5.6 seconds (data not shown).

The women did not report any serious adverse events one day after the injection treatment or at follow-up after four weeks. Four women reported minor events the day after treatment.
Discussion

In early pregnancy, peripheral joint extensibility was positively associated with the risk for back pain with onset during present pregnancy. Several years after childbirth, women with persistent pregnancy-related PGP, improved function after locally administrated corticosteroid injections.

Peripheral joint extensibility in early pregnancy and the number of previous pregnancies was associated with a substantial contribution to the incidence of pregnancy-related back pain, with onset during present pregnancy and reported in late pregnancy and three months after delivery. However, the change of joint extensibility throughout current pregnancy did not reflect the pregnancy-related back pain. The association between the number of previous pregnancies on back pain development was especially prominent in women with increased joint extensibility, which can be explained by genetic factors [153, 154]. These results may be used to identify women with higher risk for pregnancy-induced LBP already in early pregnancy, which opens the possibility for preventive actions. If they get treatment in early pregnancy, there is an opportunity to prevent pain development and dysfunction in late pregnancy and post-partum. To the best of our knowledge, there is no previous study on the association between PGP persisting after childbirth and finger joint laxity.

The corticosteroid injection to the pelvic ligament structures entailed improved function among severely disabled women with persistent PGP long after childbirth. Just one single injection treatment to the ischiadic spine bilaterally was enough to improve function on a short time follow-up among women with persistent PGP long time after pregnancy. Short-term efficacy of corticosteroid injection against tendinopathy in other locations is well documented [155], but based on our knowledge, physical functioning outcome measures after corticosteroid injection treatment to the insertion of the sacrospinous ligament on the ischiadic spine have not been studied before.

Study I

To reflect GJH, we used the passive abduction extensibility of the left fourth finger at the MetaCarpoPhalangeal (MCP) joint. The association between this specific and generalised joint mobility was not measured in the present study.
However, the use of the specific joint is to some extent justified by high correlations between laxity of the MCP joint and general joint measures shown in previous studies [115, 116].

The method we used to measure finger abduction is fast and easy to perform and has been used in pregnancy before [58], with a significant correlation between abduction angle of the left fourth finger and general joint mobility measured by Beighton score ($r=0.55$, $p<0.001$) [156].

One possible explanation for the demonstrated effects of pregnancy and joint mobility on pregnancy-induced back pain persisting after pregnancy could be a successively increased general extensibility with each additional pregnancy, in particular among women with constitutionally weak connective tissue [153, 157]. The concept that the degree of joint laxity of one individual is generalised throughout the body and that the majority of the stiffness of the MCP joints of the hand is a result of the capsule ligament complex and not the muscle-tendon units supports this view [158], as well as reported high correlations between finger joint laxity and general joint mobility measures [58, 159]. This may result in a corresponding subtle increase in joint susceptibility on the pelvic ligament system [160]. This point of view is supported by the strong association displayed between the number of previous deliveries and pelvic pain in pregnancy, demonstrated in a large epidemiological study [81]. The fact that the joint mobility in the MCP joint did not increase at the end of the pregnancy could be because of intraauricular edema, which many women suffer from in late pregnancy.

In contrast to our findings, an inverse association between joint mobility in early pregnancy and reported back pain in pregnancy has been reported in a previous similar study, although limited to women in their first pregnancy [58]. The same method of joint mobility measurement was used in that study, but no account was taken if the onset of back pain was before or during the present pregnancy, which might be one explanation for the different results. However, according to our results, in a questionnaire study, the women reporting joint hypermobility had a 1.5 times greater risk for LBP persisting six months after delivery [10].

The strengths of study I include: measurement of only the woman’s left hand finger joint laxity, performed by the same examiner at all time periods, the high participation rate, the low drop-out rate and inclusion of only Caucasian women. In addition, we controlled for possible confounding factors in the multiple regression analysis. Although an influence of the passive abduction angle of the left fourth finger was expected, the magnitude of the effect was surprising. However, various factors might have distorted the results in any direction. In addition, to study the potential sources of systematic errors, our finding of an association between joint extensibility and pregnancy-related back pain needs to be confirmed in a larger prospective study.
There were several limitations of study I. The validity of the used angle measurement device had limited evidence albeit satisfactory [46]. In the present study, the stability of the device in repeated angle measurement was established by intra-individual coefficient of variance between 7% and 8%. In two previous studies of finger joint mobility, they presented lower reliability coefficients of variance (1.5% and 3.6%) with tests within the same day [115, 116] compared to several months in study I.

At the post-partum assessment, the time since delivery had a wide dispersion from 4 to 29 weeks; thus, since recovery might have occurred 29 weeks after delivery and not always four weeks after, this might have distorted or underestimated the number of women with pain post-partum in study I. In addition, the number of women with persistent back pain after delivery was small. This could have reduced the sensitivity of the study to reveal only the strongest associations, which suggests that the possibility of a false positive in detecting the stated associations was small.

The first study showed that there was an association between pregnancy-related back and PGP and finger joint hypermobility, which could mirror changes of ligament laxity and ligament attachment in general, also in the pelvis. Also, our experience was that women with pregnancy-related PGP had great soreness at ligament attachments on the inside of the pelvis [161]. Therefore, in study II, we tried to treat PGP with corticosteroid injection bilaterally at the sacrospinous ligament attachments.

Study II

The effect of physical functioning by one single corticosteroid injection to a sacroiliac joint ligament suggests the ligament might be a possible cause of pain. To provide stability of the back and pelvis, a strong ligament system is needed [162]. This includes the weaker sacrospinous ligaments, which have low tensile strength with a merely proprioceptive role, as well as the very strong sacroiliac and interosseous ligaments [127, 162, 163]. Overload and creep because of changed biomechanical properties of the pelvic load transmission may be one hypothesis about the cause of pain. In other studies, as well as in the present study, this view is supported by the correlation between decreased pain intensity and increased function. For example, increased walking tolerance is achieved with use of pain relieving braces [164], and increased isometric lumbar extension strength is associated with decreased LBP [165].

The explanation is uncertain for the contradictory results of improved isometric trunk extensor test and virtually unchanged trunk flexor test between baseline and follow-up. There is, to our knowledge, no previous study regarding women with persistent pregnancy-related PGP and isometric trunk tests. In study II, the improved extensor endurance among women in the corticosteroid treatment group can be explained in terms of decreased pain after the
treatment. If the pain-relieving effect of the injection treatment did not engage the parts of the pelvis that are loaded during the trunk flexor test, this is perhaps a reason for the absence of improved endurance. Also, the trunk flexor test could be more sensitive to absence of exercise because trunk extensor muscles are postural to a higher extent than the trunk flexor muscles. Low endurance and muscle strength could be the case for many of the women in study II.

In a study on back pain and pregnancy [3], the pregnant women who reported the highest pain intensities reported similar result on DRI as the women in study II, which is low function and high disability. In study II, the 6MWT distance was 60% less than that of healthy women of the same ages and 48% less than patients with hip osteoarthritis [166-168]. The walking speed capacity of the women in study II was 0.7 m/s, and this was like the 0.8 m/s reported in a previous study of women with persistent PGP [169].

The improved function in the present study following a single corticosteroid injection to one ligament insertion bilaterally is, from this perspective, interesting. The result suggests that corticosteroid injection treatment makes it possible to improve function by physical exercise in this specific group of disabled women.

The strengths of the second study include the RCT design that included unsystematic allocation to the treatment groups, a strictly blinded assessment and treatment procedure, no drop-outs, the use of validated tests for inclusion criteria and follow-up assessments and clinically relevant outcome measures. The strict inclusion and exclusion criteria lead to a prolonged inclusion period but gave a homogenous study-population. To optimise the precision of the location of the injected solution, only one and the same person gave all the injections.

A limitation of study II was the small number of women included, which might influence generalisation of the results. A substantial limitation was the short follow-up time. The corticosteroid effect on short-term follow-up, with low frequency of adverse events is congruent with previous studies on tendinopathies. A reversed corticosteroid effect at longer term follow-up is known [155], but the long-term effect of the corticosteroid injection was not in focus in this study. The intention was to find a way to start physiotherapy exercises among women that before treatment had very low physical function and high pain intensity.

Clinical implications

The results of our studies have set focus on anatomical structures in the pelvis. Today, we always examine the joint mobility and take GJH into account during treatment options.
Corticosteroid treatment given systematically or locally at ligament insertions sometimes gives unwanted side effects, which has led us to a new study with low level laser therapy as the anti-inflammatory treatment.

The anti-inflammatory treatment has the intention to decrease pain and increase physical function, improves the possibility for supervised physiotherapy with successively increased exercises. A choice of treatment might be physical therapy, focusing on specific functional recovery as stabilisation exercises [170] with selective rest [171].

PGP is almost as common as endometriosis, coxarthrosis, diabetes and asthma, and must be considered a major health issue affecting women [6, 172-175]. The increased knowledge as a result of these studies has allowed us to help more women with PGP and made it possible to open a pelvic clinic at Sundsvall Hospital.
Conclusions

- The studies contribute to the understanding of pregnancy-related back and PGP, including possible factors for development of back pain induced in pregnancy, and an initial treatment for resistant PGP with locally administrated corticosteroid injections.

- The finger joint laxity as a reflection of GJH together with impact from previous pregnancies are suggested to be important factors for the development of back pain induced in pregnancy and persisting after childbirth.

- The corticosteroid injections provide improved function, positively correlated with reduced pain intensity.

- Together, these studies indicate that ligament structures can be one source of pregnancy-related LBP and PGP. It may contribute to the development of targeted preventions strategies for women at higher risk of persistent LBP and PGP after childbirth and of a new treatment strategy for this pain entity.

Trots att det är ett vanligt kvinnoproblem så är det inte klarlagt vilken eller vilka orsakerna är till att problemet uppstår under graviditeten och inte heller varför smärtan kvarstår för vissa kvinnor. Vissa riskfaktorer är kända men mer forskning behövs för att klargöra detta och i förloppningen förhoppningsvis kunna förebygga graviditetsrelaterad rygg- och bäckensmärta.

Det råder också oenighet kring hur rygg- och bäckensmärta ska behandlas dels under graviditeten men framför allt vid kvarstående smärta efter graviditeten. Drabbade kvinnor blir ofta inte tagna på allvar i hälso- och sjukvården och vårdgivare kan oftast inte erbjuda dem någon effektiv behandling.

Syfte: Att studera ifall fingerrörlighet som en spegling av generell överrörlighet har något samband med graviditetsrelaterad rygg och bäckensmärta samt utvärdera behandling med cortisoninjektioner mot ömmande ledbandsfästen vid bäckenskelettet.

Metod: I studie I följdes 200 kvinnor under graviditeten fram till 3 månader efter förlossningen. Deras fingerrörlighet i vänstra ringfingret jämfördes med rygg- och bäckensmärta som de fick rita på en smärtteckning och skatta med en visuell analog skala (0-100). De fick även skatta hur de klarade vardagsaktiviteter i ett frågeformulär (DRI).

I studie II lottades 36 kvinnor som haft ont ca 4 år efter graviditeten, till cortisoninjektioner eller lokalbedövning vid ett ledbandsfäste på båda sidorna inne i bäckenet. Före och en månad efter behandlingen undersökt kvinnorna och de fick samtidigt svara på enkäter om hur de klarade sina vardagsaktiviteter (DRI, SF-36). Deras gångförmåga (6 min gångtest) och deras muskler i rygg och mage testades.

Resultat: De kvinnor som hade rygg- och bäckensmärta 3 månader efter graviditeten hade de största fingervinklarna uppmätta tidigt i graviditeten. Ju större fingervinkel och ju fler antal graviditeter desto större var risken för kvarstående rygg- och bäckensmärta.
De kvinnor som fick cortisonsprutor hade ökad gångförmåga, de skattade sin fysiska förmåga högre och de var starkare i sina ryggmuskler jämfört med de som fick lokalbedövning.

**Slutsatser:** Stor fingervinkel tidigt i graviditeten kan vara en riskfaktor för rygg- och bäckensmärta, speciellt om kvinnan fött flera barn tidigare.

Cortisoninjektion mot ledbandsfästen inne i bäckenet ger ökad funktion vid långvarigt kvarstående bäckensmärta och skulle kunna vara en bra behandlingsmetod.
Appendices

Appendix 1:
Questionnaires and study protocols, Study I
Kodnummer: __________ ifylls av MVC

RYGG- OCH BÄCKENSMÄRTA VID GRAVIDITET
FRÅGEFORMULÄR, Relaxin-kohortstudien
(Ifylls även om du inte har rygg- eller bäckensmärta just nu.)
Personnummer____________________________
Namn____________________________________
Adress___________________________________
Tel______________________________________
Datum när du besvarar frågorna_______________
Graviditetsvecka___________________________
Antal veckor efter förlossningen_______________

TACK PÅ FÖRHAND! Vi är glada över att Du vill medverka till att öka kunskaperna om ryggbesvär under graviditet!

Cigarettrökning, antal/dag □ 0 □ mindre än 10 □ mer än 10
Snusning, antal/dag □ 0 □ mindre än 10 □ mer än 10

Är Din kroppsliga kondition sämre än vanligt? □ Nej □ Ja □ Vet ej
Yrsel/ostadig □ Nej □ Ja
Dålig matlust □ Nej □ Ja
Insomningsproblem pga smärta? □ Nej □ Ja
Vaknar Du pga smärta? □ Nej □ Ja
Har Du använt värkmedicin (Treo Magnecyl o liknande) hittills under graviditeten? □ Nej  □ Ja, i så fall vilken/vilka?__________________

Har Du urinläckage vid hosta el. lyft? □ Nej  □ Ja
Är Din psykiska kondition sämre än vanligt? □ Nej  □ Ja  □ Vet ej
□ Psykisk trötthet  □ Depression/nedstämdhet  □ Irriterad/otålig
□ Dåligt minne/koncentration

TA MED FORMULÄRET IN TILL LÄKAREN!
RYGG- OCH BÄCKENSMÄRTA VID GRAVIDITET,

RELAXINSTUDIE

LÄKARFORMULÄR

Kodnummer: ___________ Personnr: ______________________

Datum: __________________

Namn: ____________________________

Fullbordade graviditetsveckor: ________________

Fullbordade graviditetsveckor enligt UL: ___________

PM enligt SM: ___________

BP enligt UL: ___________

Ifylls vid första läkarbesöket

Antal tidigare graviditeter: 0 1 2 3 >3

Antal tidigare förlossningar: 0 1 2 3 >3

Datum för senaste förlossning: ______________________

Ryggsmärta vid tidigare graviditet? Ja vid □1:a □2:a □3:e □>3, □Nej


Ryggsmärta, förutom vid tidigare graviditet? □Nej □Ja

Som medförde sjukskrivning? □Nej □Ja

Känd bindvävssjukdom? □Nej □Ja

Behandling med hormoner i någon form, ex p-pillar? □Nej □Ja
Ifylls vid efterkontrollen

Sjukskriven under graviditet pga ryggbesvär? □ Nej □ Ja
Sjukskrivningslängd pga ryggbesvär under graviditeten?
□ ½________månader □ 1/1________månader
Sjukskriven pga ryggbesvär efter graviditeten? □ Nej □ Ja
Interkurrent sjd med ryggsmärta? □ Nej □ Ja

BRÖSTRYGGLIG
Scolios □ Nej □ Ja
□ Hö-konvex □ Vä-konvex
Rörelsesmärta □ Nej □ Ja
Palpationsömhet □ Nej □ Ja
Perkussionsömhet □ Nej □ Ja
Thoracal expansion □ Armar högt □ Armar hängande
(_____cm-_____cm=) _______cm

LÄNDRYGGLIG
Scolios □ Nej □ Ja
□ Hö-konvex □ Vä-konvex
Rörelsesmärta □ Nej □ Ja
Sidböjning □ ua sym □ Inskr sym □ Inskr hö asym □ Inskr vä asym
Palpationsömhet □ Nej □ Ja
Perkussionsömhet □ Nej □ Ja
Smärta vid kompression av foramina □ Nej □ Ja, hö □ Ja, vä
Hostsmärta □ Nej □ Ja

BENLYFT (SLR)
HÖGER;
SLR □ Neg □ Klart pos ______° □ Tveksamt pos ______°
Hamstringskontraktur □ Nej □ Ja □ Tveksamt
Femoralistest □ Nej □ Ja □ Tveksamt

VÄNSTER;
SLR □ Neg □ Klart pos ______° □ Tveksamt pos ______°
Hamstringskontraktur □ Nej □ Ja □ Tveksamt
Femoralistest □ Nej □ Ja □ Tveksamt
REFLEXER
Vä ben: □ Ua □ Svaga □ Hyperaktiva
Hö ben: □ Ua □ Svaga □ Hyperaktiva

BÄCKEN inkl SI-leder och höftleder
SACRO-ILIACA-LEDER
Separation □ Neg □ Tveks pos hö □ Tveks pos vä □ Tveks pos bil □ Klart pos bil □ Klart pos vä □ Klart pos bil
Kompression □ Neg □ Tveks pos hö □ Tveks pos vä □ Tveks pos bil □ Klart pos bil □ Klart pos vä □ Klart pos bil
Femurkompr. □ Neg □ Tveks pos hö □ Tveks pos vä □ Tveks pos bil □ Klart pos bil □ Klart pos vä □ Klart pos bil
Palp.-öm SIPS □ Neg □ Tveks pos hö □ Tveks pos vä □ Tveks pos bil □ Klart pos bil □ Klart pos vä □ Klart pos bil

SYMFYSEN
Kompression □ Neg □ Tveks pos □ Klart pos
Direkt tryck □ Neg □ Tveks pos □ Klart pos

HÖFTLEDER
Rörlighet □ Ua □ Inskränkt hö □ Inskränkt vä
Rörelsesmärta □ Nej □ Smärta hö □ Smärta vä
Palpationsömhet □ Nej □ Smärta hö □ Smärta vä

ELASTICITETSMÄTNING
i finger dig IV sin __________°
## Appendix 2.

**Study protocol, Study II**

### Undersökning vid studiestart och vid uppföljning efter injektion

<table>
<thead>
<tr>
<th>Studiedeltagare nummer:</th>
<th>________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datum:</td>
<td>________________</td>
</tr>
<tr>
<td>Tid vid status början:</td>
<td>________________</td>
</tr>
<tr>
<td>Namn:</td>
<td>________________</td>
</tr>
<tr>
<td>Personnr:</td>
<td>________________</td>
</tr>
<tr>
<td>Adress:</td>
<td>________________</td>
</tr>
<tr>
<td>Tel.:</td>
<td>________________</td>
</tr>
</tbody>
</table>

### Undersökningar i utförandeordning:

#### STÅENDE

<table>
<thead>
<tr>
<th>Lumbalt</th>
<th>Ja</th>
<th>Nej</th>
<th>Ja</th>
<th>Nej</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ext+sidovrid hö</td>
<td>nedsatt □ □</td>
<td>smärta □ □</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ext+sidovrid vä</td>
<td>nedsatt □ □</td>
<td>smärta □ □</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostsmärta</td>
<td>□ □</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### RYGGGLIGGANDE

<table>
<thead>
<tr>
<th>SLR + Q-test höger</th>
<th>______°</th>
<th>Pos □</th>
<th>Neg □</th>
<th>Q-tester Pos □</th>
<th>Neg □</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLR + Q-test vänster</td>
<td>______°</td>
<td>Pos □</td>
<td>Neg □</td>
<td>Q-tester Pos □</td>
<td>Neg □</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>inte alls</th>
<th>lite</th>
<th>något</th>
<th>måttligt</th>
<th>kraftigt</th>
<th>omöjligt</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLR höger</td>
<td>□ 0</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 4</td>
</tr>
<tr>
<td>ASLR vänster</td>
<td>□ 0</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neg</th>
<th>+</th>
<th>++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menell’s test Höger</td>
<td>□ □ □</td>
<td>Vänster □ □ □</td>
</tr>
<tr>
<td>Patrick’s FABER test Höger</td>
<td>□ □ □</td>
<td>Vänster □ □ □</td>
</tr>
<tr>
<td>Symfyspalpation</td>
<td>□ □ □</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neg, 10kg</th>
<th>5kg</th>
<th>1kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4 test höger</td>
<td>□ □ □</td>
<td>□</td>
</tr>
<tr>
<td>P4 test vänster</td>
<td>□ □ □</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pos</th>
<th>Neg</th>
<th>Odec</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASR Höger</td>
<td>□ □ □</td>
<td>Vänster □ □ □</td>
</tr>
<tr>
<td>PSR Höger</td>
<td>□ □ □</td>
<td>Vänster □ □ □</td>
</tr>
</tbody>
</table>
### Magliggandé

**Lumbalt**

<table>
<thead>
<tr>
<th>Ja</th>
<th>Nej</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palpömhet paravert höger</td>
<td>☐</td>
</tr>
<tr>
<td>Palpömhet paravert vänster</td>
<td>☐</td>
</tr>
<tr>
<td>Perk.ömhet spinalt</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Sacralt**

<table>
<thead>
<tr>
<th>Neg</th>
<th>+</th>
<th>++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Öm iliolumbale höger</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm iliolumbale vänster</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm sacral lateral crest hö</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm sacral lateral crest vä</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm sacrotuberale höger</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm sacrotuberale vänster</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm SIPS höger</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Öm SIPS vänster</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Funktionella test**

6 min gångtest; Hastighet: ________km/h, Sträcka: _______m, Avbröt efter _______min

Kommentar

<table>
<thead>
<tr>
<th>Isometrisk ryggresning:_______ sek (Max 3 min).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kommentar</td>
</tr>
<tr>
<td>Isometrisk sit-up:______________ sek (Max 90 sek).</td>
</tr>
<tr>
<td>Kommentar</td>
</tr>
<tr>
<td>Övriga comentarer</td>
</tr>
</tbody>
</table>

**9-poängs Beighton hypermobilitets score** (1 poäng/kryss)

<table>
<thead>
<tr>
<th></th>
<th>Hö</th>
<th>Vä</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Passiv dorsiflex av dig 5 MCP till ≥ 90 grader</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Opposition av tummen till underarmens volarsida</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Hyperextension armbåge &gt; 10 grader</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Hyperextension av knäleder &gt; 10 grader</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5. Komma ner med handflatorna i golvet utan att böja knäna</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Σ_____

---

*Endast vid studiestart:*
**Endast vid studiestart:**

**Vaginal palpation**

**Smärta**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neg</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
</tbody>
</table>

1. Os coecxyx

2. Fästet sacrospin/tub på sacrum  | Höger |

8.  | Vänster |

3. Ovanpå lig sacrospin/tub  | Höger |

9.  | Vänster |

4. Spina ischiadica  | Höger |

10.  | Vänster |

5. På corpus ossis ischii  | Höger |

11.  | Vänster |

6. Insidan på ramus sup. os pubis  | Höger |

12.  | Vänster |

7. På os pubis vid symfysen  | Höger |

13.  | Vänster |

**Endast vid uppföljning**

Eventuella biverkningar eller komplikationer efter injektionen eller testerna?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

Andra incidenter?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
Acknowledgements

We are grateful to all the women that have participated in the studies. Without their help, this work could not have been done.

To Per Kristiansson, my main supervisor at the Department of Public Health and Caring Sciences in Uppsala. Thank you for sharing of your vast knowledge, for inspiring discussions, patience and support. Without your inspiration, I would not have been able to perform this thesis.

To Thomas Torstensson, my co-supervisor and nearest colleague spatially. Thank you for your invaluable patience and for answering all of my questions, your clarity and warmth, and for laughter in the middle of everything. Your help has been invaluable.

To Pelle Allard, I am grateful to have you fill my life with joy, happiness, love and meaning, so I could add energy to my work with this thesis.

To my sons Axel and Björn, I am so proud and happy to be your mother. I love you so much and am so glad that you exist on this earth.

To all my dear colleagues at the physiotherapy department, thank you for listening to me talk about my research and all the discussions with valuable views. You have all been very understanding and positive.

To Erling Englund, thank you for always taking the time to answer questions about statistics and helping with statistical analyses in study II.

To all the women that have participated in the studies and helped me to understand more about PGP. Without your help, there would not have been any studies and thesis.

Great thanks to the pharmacist Elisabeth Pokosta for invaluable assistance with preparation and delivery of the blinded treatment involved in Study II.

To Anne Björk, my research fellow in Uppsala that invited me to stay at her place during my visits there. We have had long and interesting discussions about research and life’s big questions.
To my bosses, Gunilla Ruben, Thomas Torstensson, Anne Thelander, Sofie Lidehäll, Helen Eriksson and Anna Karin Zell who gave me the opportunity and encouraged me to continue my research studies.

To Felicia Wikman who designed a very nice book cover for this dissertation.

To Bosse Thorén, who inspired me and discussed different ways to write and express things.

To my mother Margit, my deceased father Bert and my sister Lena: for your love and immense support in so many ways.

To all my friends that always support me and bring me joy.

Thanks to the possibility of doing these studies and the help and support by all mentioned above, the in-depth knowledge in the field has led us to be able to open a pelvic clinic at Sundsvall Hospital in order to help affected women.
References


102. Niklas Rexelius, M., Anne Lindgren RPT, MSc 2, Thomas Torstensson, RPT, PhD2, Per Kristiansson MD, PhD2, Sahrhu Turkmen, MD, PhD1, *Sexuality and mood changes in women with persistent pelvic girdle pain after childbirth: a case-control study*. Submitted 2019.


