PELVIC FLOOR, PROLAPSE AND VAGINAL BIRTH

- A search in medical literature for anatomical repair descriptions of acute obstetrical tears and a study on primiparous women in the delivery room with focus on cysto- and/or rectoceles

Camilla Rosberg

Supervisor:
Ann-Kristin Örnö, Senior Consultant, MD, PhD,
Department of Obstetrics and Gynecology, Lund University

Master's thesis
May 2012

Department of Obstetrics and Gynecology, Sweden
Skåne University Hospital LUND
SE - 221 85 Lund

Abstract

BACKGROUND: It is well-known that pelvic organ prolapses and perineal tears can be a consequence of vaginal birth. Seven thousand women undergo surgery for pelvic organ prolapses in Sweden every year.

OBJECTIVE: To search for medical literature that describes the identification and repair of the anatomical structures present in obstetrical perineal tears. To make an attempt to understand how prolapses might originate by trying to provoke a protrusion of the rectum or the urinary bladder into the vagina thus forming an instability similar to a cysto- and/or a rectocele, in primiparas immediately after a vaginal birth and to describe their tears anatomically.

METHODS: A search in the Pub Med and in the Cochrane database was done and three textbooks for different staff categories of health care professionals were penetrated. Patients were recruited by telephone and seen when they came to deliver at the labor ward. A clinical examination was done immediately postpartum and the tears were described anatomically.

RESULTS: 17 women were examined and in 6 of them an instability similar to a rectocele could be provoked. In all of them a tear in the perineal membrane and in a thick fascia in the posterior vaginal wall was noted thus enlightening the importance of other structures besides muscles for stability of the pelvic floor. The possibility to provoke an instability similar to a rectocele could exist despite an intact sphincter or only a partly torn perineum. In this small population no protrusions of the urinary bladder similar to cystoceles were found.

CONCLUSION: Rectocele-like instabilities can be provoked immediately after a vaginal birth. Anatomical structures in an obstetrical tear are possible to identify and describe despite bleeding and edema postpartum. We found no comprehensive references in the literature on how to define and repair these structures in the postpartum period.

Sammanfattning

När en kvinna föder barn kan hon få skador i underlivet. Det kan göra att man senare behöver opereras för att t.ex. tarmen eller urinblåsan inte sitter helt fast på sin ursprungliga plats i magen utan istället buktar ut i slidan, något som kallas för framfall. Ca 7000 kvinnor opereras för sådana problem varje år i Sverige och det blir en stor kostnad för samhället. Även om man kan få framfall utan att ha fött barn så vet man att det är ökad risk att drabbas om man har varit med om en förlossning. Det har därför gjorts en studie där man undersökte kvinnor som inte fött barn på ”vanligt sätt” tidigare, d.v.s. där barnet kommer ut genom slidan. Man undersökte kvinnornas underliv direkt efter förlossningen och såg om man med hjälp av fingret i kvinnans ändtarm kunde trycka fram ett framfall. Kvinnan fick också hålla andan och trycka på neråt för att se om det p.g.a. ökat tryck i magen då började bukta. Studien visade att när en viss del av väggen mellan slidan och ändtarmen är sönder så kan man lätt framkalla framfall av ändtarmen. Man vet inte om väggsvagheten hade funnits kvar även om man inte försökt laga den direkt som man gjorde här utan det måste undersökas vidare, men eftersom man i studien letat i diverse medicinsk litteratur och kommit fram till att det i den inte finns en enda komplett instruktion till läkaren om hur man ska sy ihop alla delar som kan gå sönder vid en förlossning så var det viktigt att hitta sambandet mellan väggsvagheten och framfallet. Det verkar dock vara svårare att få urinblåsan att bukta och man vet fortfarande inte vilka delar som går sönder när urinblåseframfall uppkommer vid en förlossning, eller hur man ska undersöka för att hitta de framfallen.

Contents *page*

Background

The anatomy of the pelvic floor is complex. The arrangement of striated muscles, and especially fascias, together with smooth muscles brace the viscera, maintain continence and enable reproduction. During vaginal deliveries these structures can be torn or otherwise weakened and give rise to incontinence and a pelvic organ prolapse (POP), resulting in much discomfort for the afflicted women and a need for surgical procedures later in life (1).

The prolapses can be further divided depending on which structure that protrudes into the vagina, for example when the rectum bulges it is called a rectocele whereas when the urinary bladder is involved it is called a cystocele (2).

In Sweden, the prevalence of any kind of prolapse is around 30% and 8-15% suffer from symptomatic prolapse (3). The POP-prevalence increases with age, and worldwide more than 50% of parous woman over 50 years of age are estimated to have a prolapse. Caesarian sections might be protective (although further studies are needed to confirm this) whereas the risk is increased with the number of children delivered. The maternal age at first delivery is also important and a high maternal age increases the risk regardless of delivery mode, although this correlation has not been completely proved yet (1).

In recent years in Sweden much effort has been done to avoid tears by protecting the perineum and the sphincter during the second stage of labor, but despite this an increase in sphincter tears have been noticed over the years. Approximately 15-30% of primiparous women have tears in the levator ani muscle visible on transperineal ultrasound after their first delivery (3), 25% of primiparous women experience anal incontinence (mainly incontinence to flatus) and about 10% suffer from urinary incontinence (4), (5).

Apart from the sphincter and the perineum there are also other important structures to observe. One of them is the area between the vagina and the anal canal or the intestine, often called the rectovaginal septum or the urogenital diaphragm. The endopelvic fascia can be found in this septum and underneath this fascia the internal anal sphincter (IAS) and the external anal sphincter (EAS) can be seen in the anal canal part whereas the muscle layers of the intestine (for example the longitudinal muscle (LM)) can be seen underneath the fascia in the rectal part (6).

In classical anatomical atlases like Netter and Sobotta (7), (8), the anatomical structures creating the pelvic floor are described. But when reading descriptions in textbooks of

midwifery, obstetrics and gynecology of how to repair obstetrical tears no names or only a few (mostly muscles) are mentioned (9), (10), (11), (6). Thus, apart from the successful works of Sultan et al. in which they describe how to repair the anal sphincter complex, no detailed descriptions of how to repair all structures in a vaginal or a perineal tear can be found (12), (13). Such descriptions and thereby increased knowledge may help in the work of reducing POP and it is also known that for example medical students themselves feel like they have little knowledge in this area (14).

Aim

The aim of this study was to investigate if anatomical descriptions of how to repair acute obstetrical tears could be found in published articles and textbooks for midwives and medical students. Another aim was to make an attempt to understand how prolapses might originate by trying to provoke an instability similar to a cysto- and/or a rectocele in primiparous women in the delivery room after a vaginal birth and to describe their obstetrical tears with reference to the terms used in the literature mentioned. Taken together, this may help in the work of preventing POP.

Subjects and methods

The search for articles was done in the PubMed database using the words anatomy, perineal, vaginal, obstetric, tears, female, pelvic, delivery and repair, in different combinations (Table 1). We also read relevant Cochrane reports from the Cochrane Incontinence and the Cochrane Pregnancy and Childbirth group that can be found in the Cochrane database. In total three textbooks, one recommended for midwives and one for medical students in Sweden and one recommended for midwives in Norway, were also searched for similar descriptions (9), (10), (11).

The clinical part of the study started in January 2012. Swedish - speaking healthy women who had not delivered vaginally and who had reached at least week 37+0 of pregnancy were included. Exclusion criteria were duplex pregnancies, scheduled caesarian, a classified address or an address outside Scania, hospitalization due to pregnancy complications or pregnancies complicated by unhealthy fetuses.
From the KIKA electronic system (an obstetrical medical records system) lists of women who had undergone a second routine ultrasound examination around week 32 of pregnancy at the Obstetrics and Gynecology Department of Lund University Hospital

from the 17th of December until the 13th of March were received (Figure 1). By using the medical records system (MELIOR) the patients' medical files were compared with the inclusion and the exclusion criteria. CR contacted the women by telephone or talked to them in person (3 women) in the obstetrical outpatient clinic at the hospital. The aim with the phone call was to inform the women shortly about the study and to ask them if they would like to participate.

The delivery ward was closely supervised both during days and nights to make sure none of the included subjects were lost. When the women entered the labor ward they were seen again, given an information form (Appendix 1) and asked if they were still interested in taking part of the study. Every woman who still agreed gave her written consent on a form (Appendix 2). The study was a part of another bigger study which was approved by the local ethical committee and the information form (Appendix 1) belonged to the bigger study. Because only some parts of the study design from the bigger study were used and no new parts were added there was no need for a new ethical approval. The patients were thoroughly informed about the difference between the information form (Appendix 1) and the study design used, i.e. they only agreed to share their medical file regarding the delivery, undergo a clinical examination immediately postpartum and to do a follow-up about one month later (only if a deep tear was found). The follow-up included a questionnaire regarding symptoms of prolapse, a clinical examination and a perineal ultrasound examination. We ended the data-collection period on the 27th of April.

The clinical examination in the delivery room was done in the dorsal lithotomic position. A finger was inserted into the rectum and two fingers from the other hand were separating the labia and opening the vaginal introitus. The dorsal part of the vagina was palpated and an attempt to meet the rectal finger was done, thus getting a feeling of if the pelvic floor was still thick and stable and thereby well-preserved. At the same time we tried to push the finger ventrally to see if the dorsal part of the vagina bulged out thus showing an instability that might lead to a rectocele in the future. We also looked for wounds round the urethra and below the symphysis and inspected the cranial part of the vagina to see if a rupture could be found here. The patient was asked to push and we looked for signs of protrusion of the urinary bladder and the rectum into the vagina, thus forming an instability called a cysto- or a rectocele. These were the only

signs used to determine if the patient had a cysto- or a rectocele and no grading systems commonly approved to describe these kinds of conditions, like e.g. POP-Q for cystoceles, were used. During the whole clinical examination we paid special attention to tears exposing adipose tissue in the vagina thus giving signals of a deep tear.

On all patients, also the ones with shallower wounds, a form was filled out (Appendix 3) with information about the pregnancy, the woman, the delivery and the child. On the same sheet a description of the wounds was written in which it was noted if the patient had a tendency of a cysto- or a rectocele. The completion of the form was done mainly from the labor journal but sometimes we had to use MELIOR again.

Ethical considerations

The women in this study were recruited on telephone before arriving to the labor ward. During the phone call they were told that the study was only up and running during our working hours and that an examination postpartum therefore not could be asserted even if they agreed to participate. Contacting the patients in advance, i.e. before labor resulted in considerably fewer participants in the study. The first plan was to include the patients when they came to deliver but after a discussion with the midwives we agreed to contact them in advance because of the risk that the women are not capable of making well-grounded decisions on participation in studies when they are in active labor. Furthermore, there is also a risk of disturbing the linkage between the mother and the newborn child if more people than needed interfere directly postpartum and that was also important regarding the choice of recruitment method. Regarding the clinical examination itself it's only an advantage for the women with an extra examination and thereby a more attentive and closer check-up on the structures potentially torn. If POP can be prevented by this method a way of giving the mother a possibility to keep in contact with her child postpartum must be found. It is also possible that the surgery time can be shortened with more practice.

Results

In total, 165 articles were found in the PubMed database out of which 38 had titles of interest (Table 1). After reading the abstracts only two articles remained (15), (16), but none of them described all of the anatomical structures, especially some of the fascias and other vaginal parts were left out. Comprehensive descriptions of how to find and

repair all of the important structures of the pelvic floor after a vaginal birth couldn't be found in the Cochrane database either. In the searched textbooks (9), (10), (11) there was often a well-written anatomy chapter but in the chapter handling with repair there was nothing written about how to find the anatomical structures and which of them that are particularly important. They seemed to be more focused on the way of repairing, i.e. on the suture techniques and on the suture material used.

Out of the original 284 patients given to us from KIKA 149 were excluded after matching the patients' medical files with the inclusion and exclusion criteria (Figure 1). 117 patients were dialed out of which 85 agreed to participate and 6 declined (mostly because they were uncomfortable with gynecological examinations). 16 did not answer despite several efforts in trying to reach them. 3 withdrew their participation along the way, either pre- or postpartum. 27 of the 85 patients and 3 patients recruited face to face in the obstetrical outpatient clinic in Lund were given the information form (Appendix 1) and gave their written consent to take part of the study (Appendix 2). 5 of these 30 patients (27+3) were missed postpartum (due to delivery at certain hours). 25 patients remained and were included in the statistical part of the study. 17 of them were examined postpartum while 6 ended up with caesarian sections and 2 were missed because the midwives responsible for the labor did not contact us before they began to repair the tears.

A description of the clinical data is given in Table 2. The median age of the women at labor was 29 years (24 - 34) and they reached a median pregnancy length of 40+2 weeks (38+0 – 42+1). One of the patients had experienced a c-section before whereas the other 24 women were primigravida.

During the clinical examination, it was possible to identify the following anatomical structures (Figure 2 and Figure 3): the perineum (PN), the Colles fascia, the vaginal epithelium (VE) and the vaginal subepithelial fascia (VSF), the hymenal borders (HB), the labia majora incl. the round ligament (RL) and the bulbospongiosum muscle (BS), the perineal membrane (PNM), the superficial (sup.) and the profound (prof.) part of the transverse perineal muscles (TPM), the external anal sphincter (EAS), the longitudinal muscle (LM), the internal anal sphincter (IAS), the rectal mucous membrane (Rectal MM) / the anal mucous membrane (Anal MM) / the anal epithelium (AE), the levator

ani muscle (Lev ani) and the endopelvic fascia in the rectovaginal septum. The endopelvic fascia lies underneath the vaginal subepithelial fascia and above the longitudinal muscle and is considerably thicker than the vaginal subepithelial fascia. Because of its previously poorly described thickness, we have chosen to call it Denonvilliers fascia (DNV fascia) instead, a name often used to describe a similar structure in men (6).
During the examination, we discovered that this Denonvilliers fascia was surprisingly thick and well-developed in primiparas. We also found out that all muscles of the pelvic floor seem to be accompanied by fibrous tissues or fascias giving them a "skeleton". We could identify the perineal membrane together with the transverse perineal muscles and the round ligament together with the bulbospongiosum muscle. The involvement of the anatomical structures in a tear is described in Table 3.

The tears can be divided into three different groups: minor (yellow), medium-sized (orange) and large (red). Two minor tears could be seen (about 12% of the examined women) meaning that they were superficial with the hymenal borders as the deepest structures involved. The medium-sized injuries were defined as injuries that might include tears up until the perineal membrane and the transverse perineal muscles (superficial and profound part) but no deeper structures. About seven out of the seventeen examined women (approximately 41%) experienced this kind of injuries although the number is a bit vague because all of the structures were not marked as torn or intact in our protocols depending on the fact that when the study continued we gradually improved our knowledge in how to find the structures.
Eight out of the seventeen women had more severe and deeper tears (around 47%) out of which three had ruptures of the sphincter, defined as an EAS-rupture (approximately 18%).

In total, 4 vacuum extractions (VE) and 4 episiotomies were performed, distributed as follows: Two patients experienced both a VE and an episiotomy out of which one was a woman we did not examine postpartum (see Table 3). The other patient with both VE and episiotomy had a medium-sized tear with no involvement of the sphincter. Two patients did only experience an episiotomy and both of them had medium-sized tears without sphincter injuries. Two patients had only a VE out of which one had a medium-sized injury while the other had a severe tear including injury to the EAS. In the form

for tear description and statistical facts (Appendix 3) on this patient the sphincter injury was described as 25-75% of the EAS left and no injury to the IAS or to the LM (data not shown).Taken together, this means that the majority of the severe tears occurred despite no involvement of vacuum extractions or episiotomies.

In the women where an instability similar to a rectocele could be provoked all of the perineal structures together with the Denonvilliers fascia (our definition) were completely or partly torn. No major injury in the levator ani muscle was visible in these patients but that is not completely confirmed since no ultrasound examination was done. The possibility to provoke an instability called a rectocele could exist despite an intact sphincter or only a partly torn perineum. No cystocele tendencies (our definition) were seen.

Due to the limited amount of time for this project no follow-ups were done before writing this article.

Discussion

This study consisted of two major parts: one documentary research in medical literature and one clinical study. The literature for this study was chosen with focus on anatomical descriptions of how to repair acute obstetrical tears. PubMed and Cochrane are two large and global databases for medical articles often used by researchers when references are needed. The limited amount of time given for this study made it impossible to use more than these two databases in the search for articles. Concerning the textbooks we focused on recommended books for the specific staff categories of health care professionals that often deal with repair of acute obstetrical tears. Depending on the lack of time we used the books that were easiest for us to find in the library (the books recommended for the Swedish medical students and midwives, (9), (11)) or by personal contacts (the Norwegian book (10)).

Despite the fact that repair of acute obstetrical tears is one of the most common surgical procedures (16), we couldn’t find relevant descriptions and anatomy-focused instructions on how to repair all of the torn parts in obstetrical tears (mentioned in Table 3) in the literature analyzed in this study (9), (10), (11), (15), (16), (Table 1). The lack of this kind of information implies a risk that only the vaginal epithelium and the

vaginal subepithelial fascia is repaired resulting in an instability of the posterior vaginal wall which in the future may give rise to rectoceles.

Of course this is not a comprehensive documentary research and it might be possible to find the requested anatomical repair instructions in literature outside the databases and the textbooks used here. Anyhow, it is a problem worth noting that the descriptions can't be found in the literature used for this study, especially since this may be the only literature used by some of the health care professionals working with this kind of conditions (according to our own experience).

Since it is well-known that POP can be a consequence of vaginal birth and as many as 7000 women undergo surgery because of POP every year in Sweden (1), (3), it is important to study this area. As many as 15-30% of women with a history of vaginal deliveries have clinically detectable prolapses of the pelvic floor afterwards (3). This results in a huge cost for society and a lot of discomfort for the women and it would have been beneficial if this cost and discomfort could be reduced. It is also a question about where this cost should be put. It can be put either into the attempt of finding, repairing and hopefully preventing these signs of prolapses immediately postpartum or used to finance the rectifying surgery procedures many years later. Our opinion is that the immediate correction should be preferred and we think that the first step towards the goal of preventing some of these prolapses from originating might be this kind of studies where the anatomical structures of the pelvic floor are thoroughly looked for, defined, described and repaired. The second step might be an introduction of a rule that no injury described as severe in this article is allowed to be sutured in the delivery room. The severe injuries should be sutured at the operating theatre because better conditions regarding the lighting, the surgical instruments and the opportunity to supply adequate analgesia are given there (16).

During the clinical examination we succeeded in identifying most of the described anatomical structures in the obstetrical tears. One of the most important results in this study was the identification of the fascia that we call the Denonvilliers fascia and the instability that we found in patients where this fascia had been torn. (Figure 4) or detached from the perineum (perineocele) (Figure 5). This fascia can be difficult to find during rectifying surgical procedures many years postpartum because to be able to find

it one must lift the distended vaginal epithelium aside and stretch the tissues (Figure 4 and Figure 5). If the fascia is thinner or absent in women undergoing rectifying surgical procedures later in life (either because of age or because of previously experienced vaginal births), that might also explain why the Denonvilliers fascia is so poorly described in the literature and in the clinic.
No cystoceles (our definition) could be found and it is therefore still unclear which structures that are torn when a cystocele originates from a vaginal birth and how the obstetrician or the midwife should examine the women to be able to find them directly postpartum.

Only 17 patients were examined which is a small amount. Despite this, the incidence of the different injury groups seen in Table 3 correlated pretty well to numbers described by Samuelsson et al. (15). The quantity of women that experience only minor tears during a vaginal delivery is usually known to be around 6,6% (15), whereas the number in our study was around 12%. Medium-sized injuries are known to afflict almost 50% of the women after a vaginal delivery (15), whereas the number in this study was vaguely around 41% (see results above). The number of more severe injuries was 47% in this study, compared to 37% in the study by Samuelsson et al. (15). This difference might depend on our small amount of patients or on different classification methods. Furthermore, our percentage calculations were based only on the women examined and they would have been lower if all of the 25 patients in the study were included.

The quotas of VEs and episiotomies were 16% each in this study and the quota of caesarian sections was 24% (based on all 25 women included, see Table 2). Comparative numbers are around 20% for any kind of instrumental delivery in primiparas (1), 18,1% for episiotomies (15), and 17,7% for caesarean sections in 2008 (1). The mean age for primiparas in Sweden 2009 was 28 years (1). In our study we used the median instead of the mean value and found a median age of 29 (based on all 25 women). Since these are two different mathematical methods they can't be compared but at least, if all of this is taken together, it *looks like* we had a representative study population.

One strong point with this study was that we were able to do a thorough examination postpartum and to describe the tears in detail. Furthermore, we were also allowed to

sometimes take pictures of the tears. We could look at the pictures afterwards, when there was more time to study the tears in detail, and thus improve our knowledge about the pelvic floor anatomy and which anatomical structures that can be torn during a vaginal birth. Another strong point worth mentioning is that the extent of the vaginal parts of the tears was estimated in a good way during this study, something that hadn't been done before.

On the other hand, one big weak point with the study was the recruitment method. Out of the originally 135 potential patients that matched the inclusion criteria only 25 were included in the end. As discussed in the ethical part above there are some disadvantages with recruitment at the labor ward. One of them is that the women might not be capable of making well-grounded decisions when they are in active labor, but to recruit before admission is very time consuming and since only a few patients can be reached by our computer system so many potential candidates are being missed. Most examinations are done outside office hours so the process of recruitment needs to be more efficient to make it possible to get enough patients in a reasonable amount of time. We therefore think that, at least at a university hospital, it should be possible to recruit patients at the labor ward before delivery or immediately postpartum, as long as everything is taken care of with respect for the patients and their kindred.

The small amount of patients also resulted in an impossibility to make any reliable statistics out of the clinical data, for example the quotas of VEs and episiotomies. If we had been able to include more patients and to arrange the follow-ups we would also hopefully be able to show even stronger correlations between the instability of the posterior vaginal wall, the repair of it and the forming of a cysto- or a rectocele (our definition). Because of the altered study design with recruitment in advance there was no time to do follow-ups, but the patients with sphincter tears will be followed up later.

It is known that it takes time to develop a POP (1), and without a long-term follow-up it is impossible to say whether or not these patients would have developed a rectocele in the future. As mentioned, we think that it must be better to repair the torn structures immediately postpartum but the only way to confirm the possible correlation between the tear and a futural rectocele is to do studies like this with long-term follow-ups because it wouldn't have been ethically correct to do a study like this with a control

group of women in which the instability of the posterior vaginal wall is not being sutured. Apparently, there is a need for further research in this area.

If we could redo the study we would have made sure that we could include more patients and that the personnel at the labor ward was better informed about the study setup and their role in the process before we began.

Conclusion.

Anatomy-focused instructions on how to repair all of the torn parts in obstetrical tears (except for the tears of the anal sphincter complex) can't be found or are deficiently described in the medical articles and in the textbooks analyzed in this study. During the clinical examination we succeeded in identifying most of the described anatomical structures in the obstetrical tears. We tried to provoke an instability called a rectocele both by asking the patients to push and by trying to manually lift the dorsal vaginal wall ventrally with one finger inserted in rectum. This instability could only be seen in patients where a specific and thick fascia in the posterior vaginal wall was torn or detached from the perineum (perineocele).

We also looked for cystoceles defined as a protrusion of the urinary bladder into the vagina when the patients were asked to push (no global grading systems for cystoceles were used) and no such protrusions were found.

The only way to confirm the possible correlation between a tear and a futural rectocele is to do studies like this with long-term follow-ups. This was a small study and more and bigger studies are needed. In future studies it is recommended to recruit patients at the labor ward when they come to deliver and not before admission because otherwise many potential candidates will probably be missed.

Prolapses are common and if some of them can be prevented immediately postpartum lots of women worldwide will be spared from the associated discomfort.

References

1) Leijonhufvud, Åsa. Pelvic floor dysfunction depending on mode of delivery – clinical and epidemiological aspects. Stockholm: Karolinska Institutet, 2012.

2) Janson, P O (red.) & Landgren, B-M (red.). Gynekologi. Lund: Studentlitteratur, 2010.

3) Pakbaz, Mojgan. Vaginal prolapse – Clinical outcomes and patients' perspective. Umeå: Umeå University, 2011.
4) Pollack, J & Nordenstam, J & Brismar S, Lopez & Altman, D & Zetterstöm, J. Anal incontinence after vaginal delivery: a five-year prospective cohort study. Obstet Gynecol 2004; 104, 1397-402.
5) Altman, D & Ekström, A & Gustavsson, C & Lopez, A & Falconier, C & Zetterström, J. Risk of urinary incontinence after childbirth: a 10-year prospective cohort study. Obstet Gynecol. 2006; 108, 873-8.
6) Baert, A.L (red.) & Knauth, M (red.) & Stoker, J (red.) & Taylor, S.A (red) & DeLancey, J.O.L (red). Imaging Pelvic Floor Disorders. Berlin: Springer-Verlag Berlin Heidelberg, 2008.
7) Netter, F H. Atlas der Anatomie des Menschen. Stuttgart: Georg Thieme Verlag KG, 2006.
8) Putz, R (red.) & Pabst, R (red.). Sobotta Atlas of Human Anatomy. Munich: Elsevier GmbH, 2006.
9) Hagberg, H (red.) & Maršál, K (red.) & Westergren, M (red.). Obstetrik. Lund: Studentlitteratur, 2008.
10) Brunstad, Anne. Rifter, episiotomi og suturering. I: Tegnander, Eva (red), Jordmorboka. Oslo: Akribe AS, 2010, s. 456-467.
11) Henderson, Chris & Macdonald, Sue. Mayes' Midwifery A Textbook for Midwives. London: Bailliere Tindall, 2004.
12) Sultan, AH & Moga, AK & Kunmar, D & Stanton, SL. Primary repair of obstetric anal sphincter ruptures using the overlap technique. Br J Obstet Gynaecol 1999; 106, 318-23.
13) Kettle, Christine. The management of perineral trauma. I: Henderson, Christine (red) & Bick , Debra (red), Perineal Care: An international issue. Wiltshire: MA Healthcare Limited, 2005, s. 43-52.
14) Stepp, Kevin J & Siddiqui, Nazema Y & Emery, Stephen P & Barber, Matthew D. Textbook Recommendations for Preventing and Treating Perineal Injury at Vaginal Delivery. Obstet Gynecol 2006; 107 (2), 361-6.
15) Samuelsson, E & Ladfors, L & Lindholm, BG & Hagberg, H. A prospective observational study on tears during vaginal delivery: occurrence and risk factors. Acta Obstet Gynecol Scand. 2002; 81, 44-9.

16) Leeman, Lawrence & Spearman, Maridee & Rogers, Rebecca. Repair of Obstetric Perineal Lacerations. American Family Physician. 2003; 68 (8), 1585-90.

Legends to figures, tables and appendices

Figures

Figure 1. Flow chart of patient recruitment.

Following the green boxes and arrows shows the number of patients remaining after each step in the recruitment process.

Figure 2. The anatomy of the female pelvic floor.

Drawn picture of the anatomical structures identified in primiparous women in the delivery room immediately postpartum after a vaginal birth. Transverse section. Schematic picture, no layers can be seen.

Figure 3. The anatomy of the female urogential region and the rectum.

Drawn picture of the anatomical structures identified in primiparous women in the delivery room immediately postpartum after a vaginal birth. Sagittal section.

Figure 4. A deep tear.

Photo of a deep tear found in a primiparous woman in the delivery room immediately after a vaginal birth. With one finger inserted in rectum, the injured area can be seen. The stars mark the Denonvilliers fascia (DNV fascia), the arrows the longitudinal muscle (LM), the triangle the external anal sphincter (EAS) and the circle the urinary bladder with a catheter in the urethra.

Figure 5. A tendency of a rectocele

Photo of a tear found in a primiparous woman in the delivery room immediately after a vaginal birth. The examiner has one finger inserted in rectum and can easily provoke an instability of the posterior vaginal wall. The star marks the external anal sphincter (EAS), the triangle marks the internal anal sphincter (IAS) and shows the instability similar to a rectocele. The arrow marks the longitudinal muscle (LM).

Tables

Table 1. Search in the PubMed database.

Used words for a search in the PubMed database and the number of found and used articles. Following the "*Saved* – column" shows the number of articles remaining after each step.

Table 2. Clinical data.

Clinical data received from primiparous women, their labor and their newborn children. Median values of maternal age, pregnancy length, BMI (on registration, on labor, increase during pregnancy), total amount of bleeding during labor, length of stage one

of labor, length of stage two of labor (passive, active). The number of primiparous women who had experienced a c-section before, were induced or got Oxytocin stimulation during labor, had an epidural anesthesia during labor, experienced an episiotomy or a VE. The number of labors that started with ruptured or intact membranes and labors in which fundal pressure was used, The numbers of different birth positions (sitting, side, dorsal lithotomic), different labor presentations (occiput anterior, deep transverse, unknown) and labors in which compound presentation was seen. The median values of the newborn child's APGAR-score 5 minutes postpartum, the child's weight and length and the child's skull circumference.

Table 3. Torn structures immediately after a vaginal birth in primiparous women. Divided into different injury groups (small/yellow, medium-sized/orange and large/red injuries). Green color means that the delivery ended up in a caesarian section and the purple color means that the women were not examined by us. Torn structures are marked with Yes and intact structures are marked with No. In the Rectocele / Cystocele tendency (RC / CC tendency) column Yes means that the patient had a rectocele- or a cystocele tendency during provocation.

Appendices

Appendix 1. Information form

Given to the patients before inclusion in the study. This form belongs to a bigger study. The women were thoroughly informed about the difference between this information form and the study design used, i.e. they only agreed to share their medical file regarding the delivery, undergo a clinical examination immediately postpartum and to do a follow-up about one month later (only if a deep tear was found). The follow-up included a questionnaire regarding symptoms of prolapse, a clinical examination and a perineal ultrasound examination.

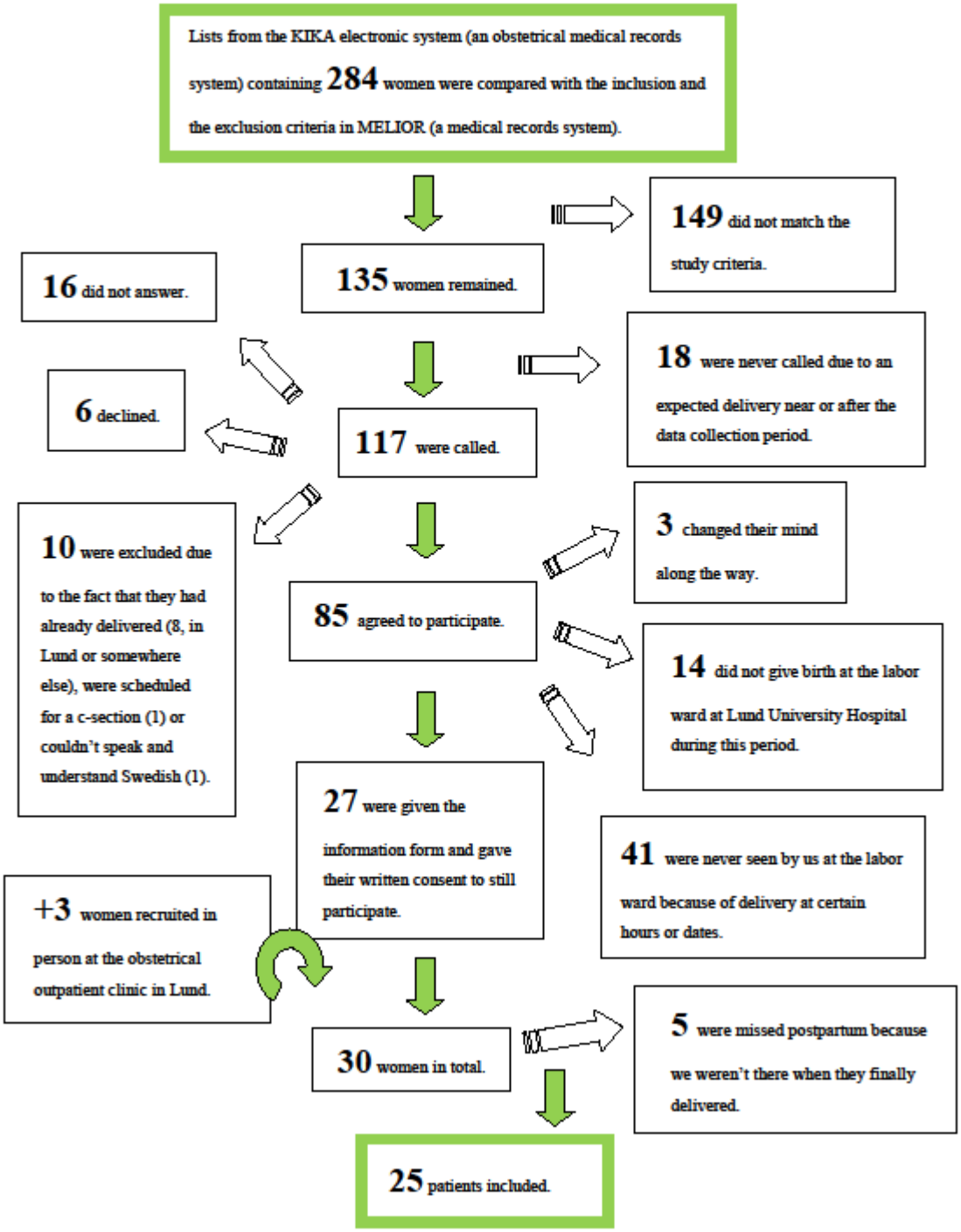
Appendix 2. Form for written consent

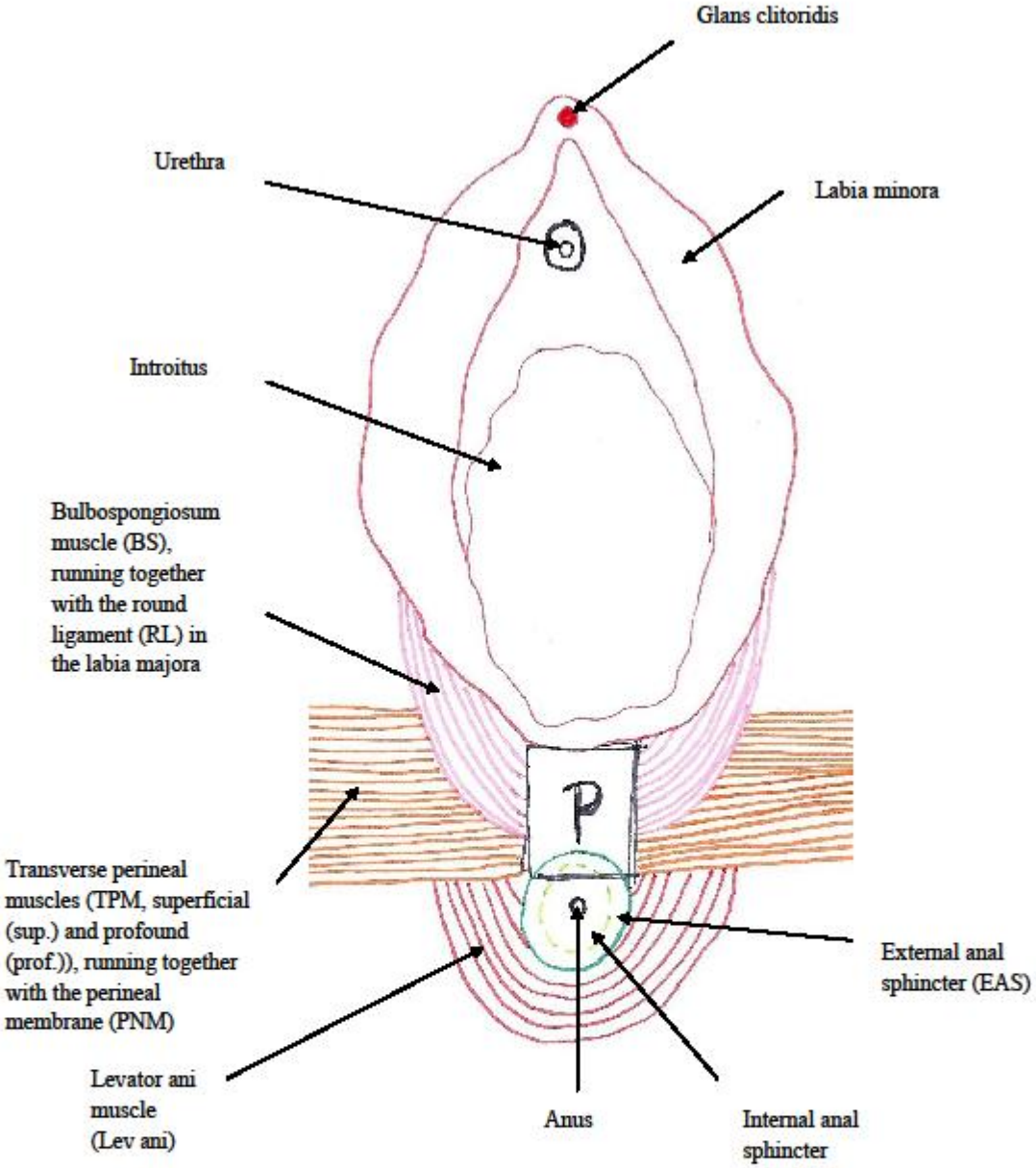
All women included gave their written consent on this form.

Appendix 3. Form for injury description and statistical facts.

Form used for describing the women, their delivery, their newborn child and their injuries.

Figure 1. Flow chart of patient recruitment.

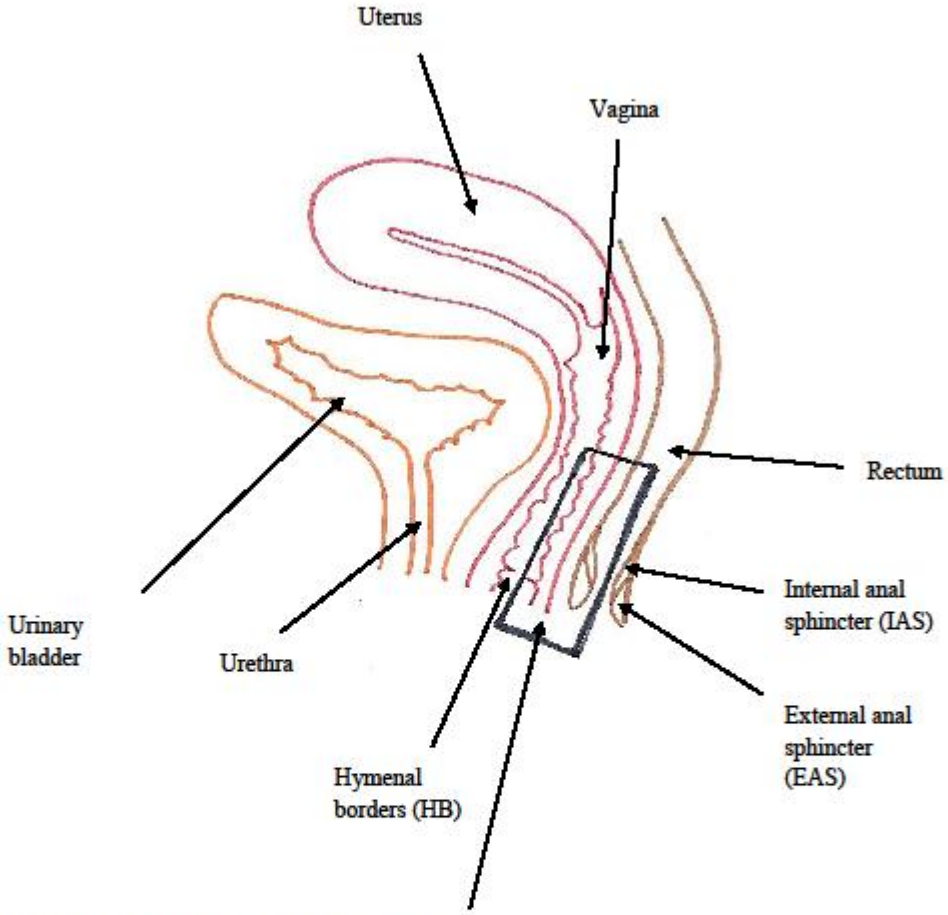




P = Perineum (PN). Sagittal section from outside of the body:

- Skin
- Colles fascia
- External anal sphincter (EAS)
- Longitudinal muscle (LM)
- Internal anal sphincter (IAS)

Figure 2. The anatomy of the female pelvic floor. Transverse section. Schematic picture, no layers can be seen.



Rectovaginal septum. Sagittal section from the vagina to the rectum:

- Vaginal epithelium (VE)
- Vaginal subepithelial fascia (VSF)
- Denonvilliers fascia (DNV fascia)
- Longitudinal muscle (LM)
- Rectal mucous membrane (Rectal MM)

Rectovaginal septum. Sagittal section from the vagina to the anal canal:

- Vaginal epithelium (VE)
- Vaginal subepithelial fascia (VSF)
- Denonvilliers fascia (DNV fascia)
- External anal sphincter (EAS)
- Longitudinal muscle (LM)
- Internal anal sphincter (IAS)
- Anal mucous membrane (Anal MM) / Anal epithelium (AE)

Figure 3. The anatomy of the female urogential region and the rectum. Sagittal section.

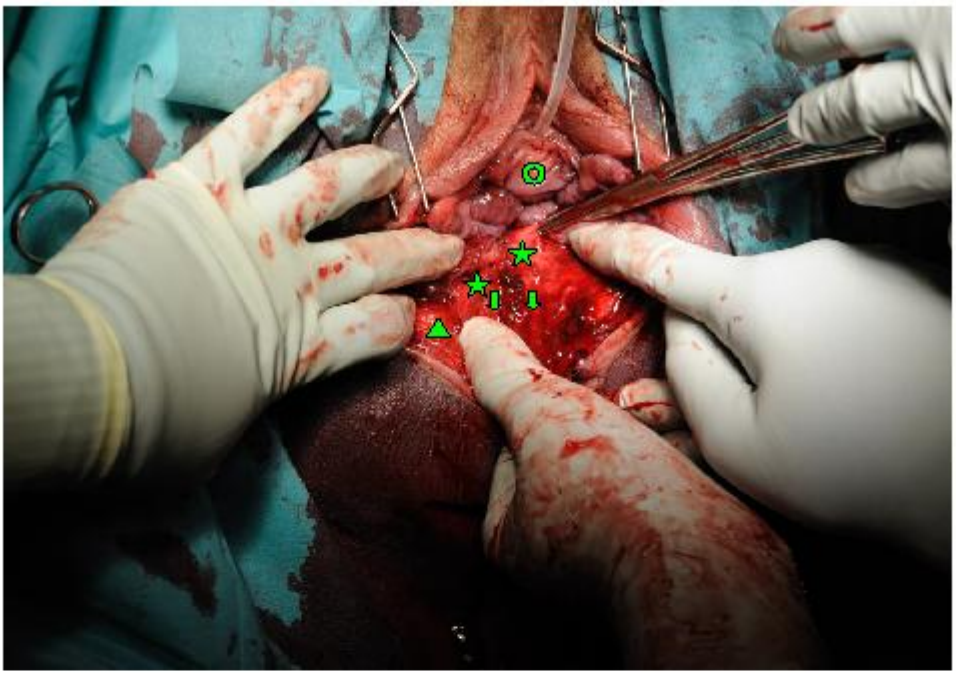


Figure 4. A deep tear. Photo of a deep tear found in a primiparous woman in the delivery room immediately after a vaginal birth. With one finger inserted in rectum, the injured area can be seen. The stars mark the Denonvilliers fascia (DNV fascia), the arrows the longitudinal muscle (LM), the triangle the external anal sphincter (EAS) and the circle the urinary bladder with a catheter in the urethra.

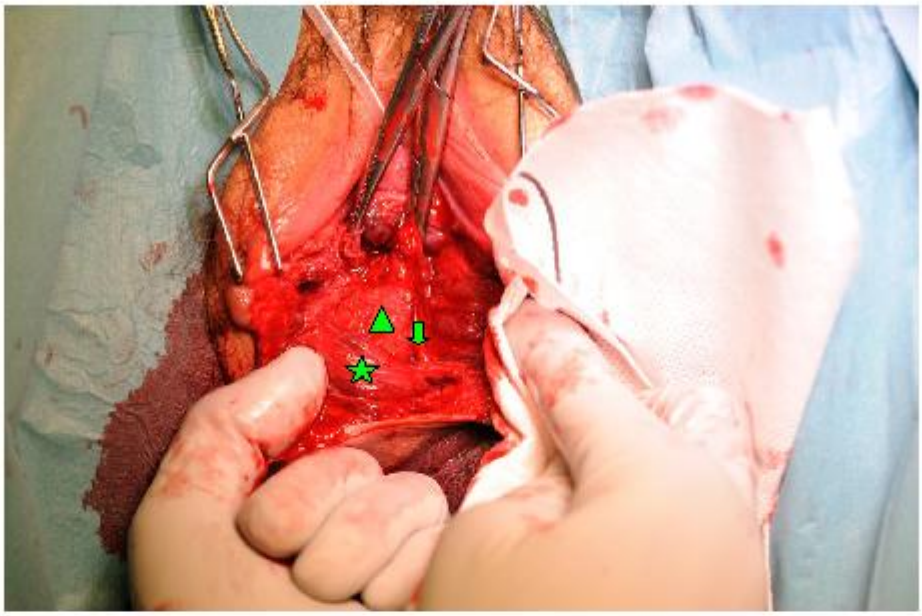


Figure 5. A tendency of a rectocele.

Photo o a tear found in a primiparous woman in the delivery room immediately after a vaginal birth. The examiner has one finger inserted in rectum and can easily provoke an instability of the posterior vaginal wall. The star marks the external anal sphincter (EAS), the triangle marks the internal anal sphincter (IAS) and shows the instability similar to a rectocele. The arrow marks the longitudinal muscle (LM).

Table 1. Search in the PubMed database. (No.)

Words	*Found*	*Saved*
Anatomy AND perineal AND tears:	33	17
Anatomy AND vaginal AND tears:	41	12
Anatomy AND obstetric AND tears:	40	6
Female AND pelvic AND anatomy AND delivery AND repair:	51	8
In total	= 165	= 43
Not written in English		-5
Articles left with titles of interest		= 38
Not available in fulltext versions		-9
Not of interest after reading the abstract		-23
Not written in English		-4
Articles used		= 2

Table 2. Clinical data.

Parameter		*Median range or number*
Maternal age (years)		29 (24-34)
Length of pregnancy at labor (weeks)		40+2 (38+0 – 42+1)
BMI	On registration (kg/m^2)	23,6 (19,0 – 29,3) [1]
	On labor (kg/m^2)	30,5 (23,9 – 40,0)
	Increase during pregnancy	6,3 (3,3 – 10,7)
C-section before (Yes / No)		1 / 24
Induction (Yes / No)		4 / 21
Labor start with ruptured / Intact membranes (n)		7 / 18
Oxytocin stimulation (Yes / No)		21 / 4
EDA (Yes / No)		20 / 5
Birth position (n) [2]		
	Sitting position	9
	Side position	4
	Dorsal lithotomic position	5
Fundal pressure (Yes / No)		4 / 21
Episiotomy (Yes / No)		4 / 21
Use of instruments (VE) (Yes / No)		4 / 21
Labor presentation		
	Occiput anterior	17
	Deep transverse	1
	Unknown (Birth at home)	1
Compound presentation (Yes / No)		1 / 23 [2]
Total amount of bleeding (ml)		500 (200 - ≈3000) [1]
Stage one of labour		8h, 15min (2h, 15 min – 15h) [3]
Stage two of labour		
	Passive	1h, 37,5min (0min - 4h,10min) [4]
	Active	47,5 min (20min – 2h, 2 min)[1]
APGAR score (points) [2]		
	5 min postpartum	10 (1 - 10)
Weight of child (g)		3755 (2800 – 4340)
Length of child (cm)		53 (50 – 56) [5]
Childs' skull circumference (cm)		35 (33cm – 37,5cm) [1]

[1] Two values missing, [2] One of the patients gave birth at home, [3] 5 values missing, [4] 3 values missing, [5] 1 value missing

Table 3. Torn structures immediately after a vaginal birth in primiparous women.

Patient	PN height, % left	Colles fascia	VE + VSF	HB	Labia majora incl. RL/BS	PNM + TPM sup. & prof.	EAS	LM	IAS	Rectal / Anal MM / AE	RC/ CC tend-ency [1]	DNV fascia [1]	Lev ani (cp) [2]	Note
11	100	No	Yes [3]	Yes	No	No	No	No	No	No	No/No	No	No	
19	100	No	No	Yes	No	No	No	No	No	No	No/No	No	No	
1	25	Yes	Yes [4]	Yes	Yes	Yes	No	No	No	No	No/No	?	No	
3	100	No	Yes [5]	Yes	Yes	No	No	No	No	No	No/No	No	No	
6	25	Yes	Yes [6]	Yes	Yes	?	No	?	No	No	?/No	?	No	[19]
9	100	Yes	Yes [7]	Yes	Yes	Yes	No	No	No	No	No/No	No	No	[20]
10	100	No	Yes [8]	Yes	Yes	Yes	No	No	No	No	No/No	No	No	[21]
12	75	Yes	Yes [9]	Yes	Yes	No	No	No	No	No	No/No	No	No	[22]
16	100	Yes	Yes [10]	Yes	Yes	No	No	No	No	No	No/No	No	No	[23]
2*	50	Yes	Yes [11]	Yes	Yes	Yes	No	No	No	No	No/No	?	Yes	[24]
5*	50	Yes	Yes [12]	Yes	Yes	Yes	No	Yes	No	No	Yes/No	Yes	No	
7	25	Yes	Yes [13]	Yes	Yes	Yes	No	Yes	No	No	No/No	Yes	Yes	[25]
13*	25	Yes	Yes [14]	Yes	Yes	Yes	Yes	?	?	No	Yes/No	Yes	No	[26]
17	25	Yes	Yes [15]	Yes	Yes	Yes	No	No	No	No	Yes/No	Yes	No	[27]
21*	25	Yes	Yes [16]	Yes	Yes	Yes	Yes	No	No	No	Yes/No	Yes	No	[28]
23*	0	Yes	Yes [17]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes/No	Yes	No	
25*	25	Yes	Yes [18]	Yes	Yes	Yes	Yes	No	No	No	Yes/No	Yes	No	
4	S	E	C	T	I	O	#	S	E	C	T	I	O	#
8	S	E	C	T	I	O	#	S	E	C	T	I	O	#
15	S	E	C	T	I	O	#	S	E	C	T	I	O	#
20	S	E	C	T	I	O	#	S	E	C	T	I	O	#
22	S	E	C	T	I	O	#	S	E	C	T	I	O	#
24	S	E	C	T	I	O	#	S	E	C	T	I	O	#
14	N	O	T	#	E	X	A	M	I	N	E	D	#	# [29]
18	N	O	T	#	E	X	A	M	I	N	E	D	#	#

PN height = perineum height, VE = vaginal epithelium, VSF = vaginal subepithelial fascia, HB = hymenal borders, RL = round ligament, BS = bulbospongiosum muscle, PNM = Perineal membrane, TPM = transverse perineal muscles, sup. = superficial, prof. = profound, EAS = external anal sphincter, LM = longitudinal muscle, IAS = internal anal sphincter, Rectal / Anal MM / AE = rectal / anal mucous membrane / anal epithelium, DNV fascia = Denonvilliers fascia, Lev ani (cp) = cranial part of the levator ani muscle. Yes = structure torn, No = structure intact. In the Rectocele / Cystocele tendency (RC / CC tendency) column Yes means that the patient had a rectocele- or a cystocele tendency during provocation. * = Repair at the operating theatre. Yellow = minor tears, Orange = medium-sized tears, Red = large tears, Green = caesarian sections, Purple = women not examined by us. Notes, see next page.

Notes from Table 3.

1 refers to our definition of these terms.

2 refers to the examination of this structure

3-18 refer to vaginal tears defined as short = 0-3cm, medium = 3-5cm, long = >5cm (estimated, not measured). dx = to the right, sin = to the left.

19-29 refer to other important information.

1) Our definition, see text.

2) Clinically estimated, no ultrasound examination performed.

3) Short dx.

4) Short dx.

5) Medium in the midline.

6) Dx.

7) Short sin.

8) Short dx.

9) Short dx.

10) No vaginal tear.

11) Short dx.

12) Long sin + Short dx.

13) Short dx + midline.

14) Short sin.

15) Long sin + Short dx.

16) Medium sin + dx.

17) Long dx + medium sin.

18) Long in the midline.

19) Sutured by another physician than my supervisor.

20) Episiotomy to the left, VE.

21) Episiotomy to the right, the urinary bladder had a crushing injury, looked like a cystocele at first but wasn't.

22) VE.

23) Episiotomy to the left.

24) Superficial vaginal hematoma.

25) Birth at home.

26) Sutured by another physician than my supervisor.

27) Tendency of a cystocele but the urinary bladder could not be moved.

28) VE, Returned with incisively pain later.

29) Episiotomy, VE.

Appendix 1. Information form.

Vill Du vara med i en studie om bäckenbottenskador vid första förlossningen?

Bakgrund och syfte
Nästan alla förstföderskor får skador i mellangården vid förlossningen. Vi vill undersöka vilka vävnader som oftast spricker med ultraljud, och om man kan minska långtidsbesvär som framfall och inkontinens genom en ny operationsmetod.

Vill Du vara med i denna studie?
Ditt namn har vi fått när vi letat efter kvinnor som skall genomgå rutinultraljud och skall föda sitt första barn.

Hur går studien till?
Om Du vill vara med skall Du fylla i fyra enkäter, en under graviditeten, en sju dagar efter förlossningen, en tre månader efter förlossningen och en 9-12 månader efter förlossningen. Vid den rutinmässiga kontrollen av bäckenbotten efter förlossningen undersöks dessutom studiedeltagarna med ett ultraljud som läggs mot slidans respektive ändtarmens mynning. Undersökningen är smärtfri och tar ca 4 minuter. Därefter lottas studiedeltagare till två grupper. En grupp får samma behandling som idag där de eventuella skadorna diagnostiseras och sys av en barnmorska eller vid djupare skador av läkare, och i den andra gruppen repareras skadorna med ledning av ultraljudsbilden av läkare. Sju dagar efter förlossningen kontaktas alla studiedeltagare via telefon och frågas om sårsmärta och förändrad funktion i bäckenbotten. Om det behövs kallas Du in för en undersökning efter samtalet. Sedan kallas Du till återbesök tre månader efter förlossningen då vi undersöker bäckenbotten med samma sorts ultraljud och gör en gynekologisk undersökning. Vi behöver Din tillåtelse att hämta uppgifter ur Din förlossningsjournal eftersom det är viktigt att veta om Du förlöstes med sugklocka, om klipp gjordes, hur länge Du fick krysta osv. Ultraljudsbilder och enkäter märks med kodnummer. Dina svar och bilder förvaras så att ingen obehörig kan ta del av resultaten. Vid publicering av studieresultaten är uppgifterna avidentifierade. Du erbjuds information om ultraljudsfynden vid återbesöket efter tre månader. Alla som behandlas på sjukhus omfattas av patientskadeförsäkringen. Det finns inga kända risker med att delta i denna studie.

Fördelar med att delta i studien
Om Du deltar får Du om det behövs uppföljning av läkare sju dagar efter förlossningen. Vid återbesöket efter tre månader instrueras Du i bäckenbottenträning genom att Du kan se på ultraljudsskärmen hur muskulaturen rör sig när Du kniper.

Deltagande i studier är frivilligt. Du kan när som helst avbryta ditt deltagande utan att detta påverkar det fortsatta omhändertagandet på Kvinnokliniken i Lund.

Ann-Kristin Örnö	Andreas Herbst	Karel Maršál
Studieansvarig läkare	Förlossningsöverläkare	Professor
Specialistläkare	Docent	Kvinnokliniken
KK, Lund	KK, Lund	KK, Lund

Ann-kristin.orno@med.lu.se, 046/17 25 51

Appendix 2. Form for written consent.

Samtyckesformulär Sfinkterstudie II

Jag vill delta i studien om bäckenbottenskador efter första förlossningen. mitt deltagande är frivilligt och jag vet att jag när som helst kan dra mig ur studien utan att detta påverkar mitt fortsatta omhändertagande på Kvinnokliniken i Lund.

Alla uppgifter som samlas in är sekretessbelagda. All information som inhämtas under försöket finns tillgänglig enligt bestämmelserna i PUL-lagen. Britt Lagerlund, tel 046-173213, är PUL ansvarig i Region Skåne.

Personnummer..... Beräknat förlossningsdatum .....

Mobiltelefonnummer.....

Lund den .....

.....
Underskrift

.....
Namnförtydligande

.....	.....	.....
Ann-Kristin Örnö,	Petur Reynisson.	Andreas Herbst,
Specialistläkare	Specialistläkare	Förlossningsöverläkare
Ann-kristin.ornoe@med.lu.se		
046/ 17 25 51		

Appendix 3. Form for injury description and statistical facts.

Patient nr:

Kvinnan:
Grav.längd vid förlossning:
BMI vid inskrivning/partus:
Tidigare sectio: JA/NEJ
Tidigare op. i bäckenbotten:
Tidigare sjd:

Förlossningen:
Induktion: JA/NEJ
med:
p.g.a:
Värkstart med: Vtn.avg./Hela hinnor
Syntocinon: JA/NEJ
Laktat/värde: JA: /NEJ
EDA: JA/NEJ
Förlossningsställning:
Yttre press: JA/NEJ
Perineotomi: JA/NEJ
med: Medialklipp/Mediolateralklipp
Instrumentellt: JA/NEJ
med: Tång/Klocka
Bjudning:
Compound present: JA/NEJ
Skulderdystoci: JA/NEJ
Blödningsmängd:
Faslängder:
Öppning:
Utdrivning:
Passiv:
Aktiv:
Efterbörd:

Barnet: Pojke/Flicka
APGAR:
Vikt:
Längd:
Huvudomfång:

Lottad till: Oss/Bm
Sydd av:

OP:
Vaginalbristning: JA/NEJ
Längd: Kort/medellång/lång
Läge: Mitt/Dx/Sin/Dx+Sin
Bedömd som grad:
Fettväv synlig: JA/NEJ
Urinblåsa buktande vid krystning: JA/NEJ
Urinblåsa synlig vid påfyllnad av kateter: JA/NEJ
Bristning under symfysen, labialt: JA/NEJ
Sfinkterskada: JA: IAS/EAS/IAS+EAS /NEJ
Hur?: IAS: Prox/Dist/Prox+Dist
EAS: <25%/25-75%/>75% kvar
Hel perineumhud: JA/NEJ:
25%/50%/75% kvar

Ultraljud:
Levatorskada: JA: Dx/Sin/Dx+Sin /NEJ
Cystocele: JA/NEJ
Krystning: JA/NEJ
Cystocele vid krystning: JA/NEJ

Uppföljning:
Rapporterar urinvägsbesvär: JA/NEJ

Studien:
Foto taget: JA/NEJ
Utgått pga:

Beskrivning av skadan: