UMEÅ UNIVERSITY

TO TEAR AND TO HEAL

Pelvic floor dysfunction and childbirth

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Till min pappa

”Non rien de rien, non je ne regrette rien”

Edith Piaf

Content

Abstract

Background
Up to 80% of women are affected by a perineal laceration after their first vaginal birth. An estimated 40–50% of lacerations involve the perineal muscles, and up to 7% are obstetric anal sphincter injuries (OASI). There is a lack of knowledge about the extent of short-term complications such as pelvic floor dysfunction (PFD) following spontaneous or iatrogenic pelvic floor trauma. Women's experiences of daily life after childbirth complicated by OASI is poorly understood. Three-dimensional endoanal ultrasonography (3D-EAUS) is a well-documented method for evaluating damage to the anal sphincter in other contexts. Adding ultrasonography to standard clinical examination has revealed injuries previously missed, and research evaluating diagnostic methods for the routine screening of OASI has been called for.

Aim
This thesis aims to evaluate the diagnostics of OASI, determine if the degree of perineal injury or anal sphincter defects after childbirth are associated with pelvic dysfunction, and explore women's experiences of OASI.

Methods
Studies I and IV were prospective cohort-studies to evaluate any association between perineal tear or sphincter defect to PFD. Study II was an interview study addressing women's experiences of OASI by qualitative content analysis. Study III was a cross-sectional study designed to examine the utility of endoanal ultrasound to detect OASI. Participants were clinically examined after birth and 3D-EAUS was performed immediately after giving birth and 3 months postpartum. PFD was evaluated using a web-based questionnaire one year after delivery.

Results
A total of 511 women completed the one-year questionnaire (Study I) and a purposive sample of 11 women were invited to take part in Study II. In Study III, 680 women underwent a clinical examination and 3D-EAUS recording immediately after birth. In Study IV, 239 women who attended all follow-ups were included. PFD was experienced by women with a perineal laceration of any grade, but also those with an intact perineum. Dyspareunia and urinary incontinence were the most common problems. Women with OASI had a higher risk for developing

symptoms of prolapse, urinary urge incontinence, dyspareunia, and pain as well as experiencing a negative impact on their daily life. Elements that negatively influenced women's experiences of OASI were pain and symptoms of PFD, normalisation of symptoms by healthcare providers, and unrealistic expectations about this period in life. 3D-EAUS immediately after delivery had poor sensitivity and specificity in detecting clinically diagnosed OASI. Postpartum anal sphincter defects were associated with genital pain and dyspareunia.

Conclusion
OASI is an evident risk factor for pelvic floor dysfunction after childbirth, but symptoms of pelvic floor disorder were found to be common, even in women with mild to moderate perineal laceration. OASI has a negative impact on how a woman experiences relationships, social contact, and sexuality. Using 3D-EAUS in a maternity ward to diagnose OASI is demanding. Staff generally have little experience in 3D-EAUS. There are also difficulties in obtaining good image quality, due to local oedema, bleeding, positioning of the woman, and unintentional movements. These factors all complicate the interpretation of images.

Abbreviations

3D-EUAS	Three dimensional endoanal ultrasound
3D-TPUS	Three dimensional transperineal ultrasound
AI	Anal incontinence
aOR/OR	Adjusted odds ratio/ Odds ratio
BMI	Body mass index
CI	Confidence Interval
EAS	External anal sphincter
IAS	Internal anal sphincter
ICD10	International Classification of Disease
LAM	Levator ani muscle
OASI	Obstetric anal sphincter injury
PFD	Pelvic floor dysfunction
PFMT	Pelvic floor muscular training
POP	Pelvic organ prolapse
QCA	Qualitative content analysis
RCT	Randomised control trial
TPUS	Transperineal ultrasound
TUI	Tomographic ultrasound imaging
UI	Urinary incontinence
WHO	World Health Organisation

List of Papers

This dissertation is based on the following papers, referred to in the text by their roman numerals:

I. Pelvic floor dysfunction one year after first childbirth in relation to perineal tear severity
Huber M, Malers E, Tunón K
June 2021 *Scientific Reports* 11(1)

II. “From hell to healed” – a qualitative study on women´s experience of recovery, relationships, and sexuality after severe obstetric perineal injury
Huber M, Tunón K, Lindqvist M
May 2022 *Sexual & reproductive healthcare:official journal of the Swedish Association of Midwives* 33(2):100736

III. Use of endoanal ultrasound in detecting obstetric anal sphincter injury immediately after birth
Huber M, Larsson C, Harrysson M, Strigård K, Lehmann J-P, Nordin P, Tunón K
January 2023, *Acta Obstet Gynecol Scand*. 2023;00:1–7.

IV. The prevalence of postpartum anal sphincter defects and the association with perineal pain and dyspareunia
Huber M, Larsson C, Lehmann J-P, Strigård K, Lindam A, Tunón K
Submitted

Thesis at a glance

	Study I	Study II	Study III	Study IV
Type of study	Prospective cohort study	Qualitative study	Cross-sectional study of diagnostic accuracy	Prospective cohort study
Population Sample Setting	776 primiparas giving birth (vaginally or by caesarean section) at Östersund Hospital January 2016- January 2018	11 primiparas with OASI at their first vaginal delivery at Östersund Hospital January 2016- January 2018	680 primiparas giving birth vaginally at Östersund Hospital January 2016- January 2018	239 primiparas giving birth vaginally at Östersund Hospital January 2016- January 2018 and attending follow up 3D-EAUS and questionnaire
Intervention Exposure	Questionnaire regarding symptoms of pelvic floor dysfunction one year after delivery	In-depth semi structured interviews 1-2 years after first vaginal delivery	3D-EAUS of anal sphincters performed immediately after delivery	3D-EAUS three months postpartum to assess sphincter defect and questionnaire regarding symptoms of pelvic floor dysfunction one year after delivery
Comparison Statistical analyses	Logistic regression Odds ratios for symptoms of prolapse, urinary incontinence, anal incontinence, sexual function, pain and influence on quality of life	Inductive qualitative content analysis	Sensitivity Specificity Positive and negative predictive value Likelihood ratios Comments on the examination	Logistic regression Odds ratios for symptoms of pelvic floor dysfunction Risk factors for endosonographic sphincter defect

	Study I	Study II	Study III	Study IV
Outcome	Self-reported prevalence of pelvic floor dysfunction in relation to severity of tear and comparison of vaginal delivery to caesarean section	Experiences related to recovery, sexual function, relationships, and coping strategies among women affected by OASI.	Diagnostic accuracy of 3D-EAUS to find clinically detected OASI	Self-reported prevalence of pelvic floor dysfunction in women with endosonographic sphincter defect compared to women without defect
Results	OASI was a risk factor for: Prolapse (OR 7.7) Urinary urge incontinence (OR 4.8) Pain (OR 3.3) Dyspareunia (OR 3.1) Second degree tear was a risk factor for urinary stress incontinence (OR 2.6) Caesarean section was protective against urinary stress incontinence (OR 0,2)	The overall theme was: "From hell to healed" Subcategories included: Imprisoned by physical limitations. Breaking apart and coming back. Burdened by normality. Requesting answers. Facing childbirth again. Appraising relations. Scarred and scared.	Sphincter defect on 3D-EAUS was observed in 12.8% of assessable recordings. With clinical examination set as a reference, ultrasound sensitivity in the diagnosis of OASI was 30.4%, specificity was 87.9%. The negative predictive value was 96.7%, Positive predictive value was 9.9%.	Three months postpartum, 48/239 (20%) patients had anal sphincter defects on 3D-EAUS. Patients with defects had higher foetal weight than those without defects, and a perineum <2 cm before sutruring was a risk factor for defects (OR 6.9) Patients with defects had a higher frequency of dyspareunia (OR, 2.4), and perineal pain (OR, 2.3) than those without defects.

	Study I	Study II	Study III	Study IV
Conclusions	Symptoms of pelvic floor disorders were common in primiparas one year after birth. The risk for PFD was greater after larger injuries in this study, and women with OASI reported that the symptoms had a significant impact of on their quality of life.	OASI has a negative impact on how women experience relationships, social contacts, and sexuality. Some women reported that OASI negatively affected everyday life-long after delivery, causing guilt due to lack of focus on their child. Others heal and cope quite quickly	Obtaining optimal 3D-EAUS images immediately after delivery is a challenge. Poor image quality makes interpretation difficult. When 3D-EAUS is added to clinical examination in the screening setting, it adds very little to the diagnosis of OASI.	There is an association between anal sphincter defect detected by postpartum endosonography and perineal pain, and dyspareunia. Ultrasonographic imaging may be beneficial during postnatal follow-up.

Table 1. Summary of the thesis.

Sammanfattning på svenska

Bakgrund

Upp till 80% av födande kvinnor får någon form av bristning vid sin första förlossning, majoriteten är av lindrigare art men uppåt 40% får en mellanstor bristning eller episiotomi (klipp) som innebär inverkan på bäckenbottens muskulatur. Den allvarligaste formen, sfinkterskada, uppkommer hos ca 6% av förstföderskor i Sverige[1]. Sfinkterskador, mellanstora bristningar, och episiotomi i samband med förlossning, kan ge upphov till smärta, påverkan på sexuell funktion samt bidra till framfall och anal- samt urininkontinens. Förlossningsbristningar åtgärdas vanligen inom några timmar efter förlossningen genom att man kirurgisk suturerar ihop de skadade strukturerna. Denna kirurgi kan försvåras av lokala ödem, blödning och smärta.

Förlossningsbristningar har under de senaste åren fått ökad uppmärksamhet såväl i professionen som i media. Ämnet har gått från att ha varit tabubelagd till att lyftas fram i olika sammanhang och man har börjat diskutera öppet vilka följder en förlossningsbristning kan ge, särskilt om den inte diagnosticeras och åtgärdas i samband med förlossningen. Man har också konstaterat att vården på många sätt fortfarande är bristfällig och det finns stor potential för förbättringar, både i preventivt arbete, diagnostik, behandling och uppföljning. Förlossningsbristningar innebär stora kostnader för både hälso- och sjukvården och samhället i stort. Flera studier visar på att många kvinnor får betala med en försämrad livskvalitet, en kostnad som knappast är mätbar.

Syfte

Statens beredning för medicinsk och social utvärdering (SBU) har publicerat tre rapporter inom ämnet förlossningsbristningar 2016, 2018 och 2021[2-4]. Mer kunskap om diagnostik av förlossningsbristningar var bland de högst prioriterade frågorna. En tillförlitlig diagnostik och tidig behandling av bristningar menade gruppen skulle kunna göra att senare komplikationer inte uppkommer i lika stor grad. Man efterfrågar också ökad kännedom om diagnostik, besvär och behandling av mellanstora bristningar (grad 2 och klipp) samt att man följer upp även dessa en längre tid. De ansåg det även viktigt att hitta diagnostiska verktyg som fungerar vid besvär lång tid efter förlossningen (upp till månader eller år efter förlossningen). Enligt rapporten lyftes att samlagssmärta är ett negligerat problem och man noterar att det "i diskussionerna framhölls att den kvinnliga lusten är lika viktig som den manliga men det upplevdes att den ofta nedvärderas idag". En ytterligare fråga som lyftes var vikten av forskning på psykologiska effekter av förlossningsbristningar.

Sammanfattning av syften/mål och relevans:

- Projektets mål var att förbättra kunskapsläget i diagnostik, prevention och omhändertagande av förlossningsbristningar och knyter an till de punkter som lyfts fram i SBU rapporterna.
- Delstudie I och IV syftade till att ge en ökad förståelse för sambandet mellan bäckenbottendysfunktion och graden av förlossningsbristning.
- Delstudie I, II och IV syftade till att öka kunskapen om hur komplikationer till förlossningsbristningar påverkar sexuallivet.
- Delstudie II syftade till att belysa hur en sfinkterskada påverkar relationen, den egna kroppsbilden och familjelivet, samt att undersöka psykologiska effekter av förlossningsbristningar.
- Delstudie III syftade till att förbättra diagnostiken av svåra förlossningsbristningar och därmed minska antalet missade förlossningsbristningar.
- Delstudie IV syftade till att öka förståelsen av sambandet mellan ultraljudsverifierad skada på analsfinktern tre månader efter förlossningen och senare symtom av bäckenbottendysfunktion.

Metod och studiedeltagare

Övergripande projekt
Delstudierna i avhandlingen ingick i ett samarbetsprojekt mellan förlossningsvården och kirurgkliniken i Östersund. Samtliga förstföderskor som beräknades föda mellan januari 2016 och januari 2018 erbjöds att delta i studien i samband med rutinultraljud i graviditetsvecka 18-20. Till Östersunds förlossningsavdelning kommer ca 500 förstföderskor varje år och 98% av kvinnor i upptagnings-området föder på Östersunds sjukhus.

Delstudie I
I denna delstudie erbjöds alla deltagare en uppföljning med ett webbaserat frågeformulär ett år efter förlossningen. Frågorna avsåg att utvärdera bäckenbottenfunktionen genom självrapporterade symtom på framfall, smärtor, sexuell funktion och avförings- och urininkontinens. Enkäten bestod av 15 frågor (Appendix 1). De rapporterade besvären har

sedan jämförts med de klassificerade bristningarna, hypotesen var att bäckenbottenfunktion påverkas mycket av sfinkterskador, men även i viss mån av mellanstora bristningar.

Delstudie II
I denna studie har de som drabbats av svårare bristningar följts upp i en djupintervju för att öka kunskapen om hur kvinnan upplevt att hennes relation och samliv påverkats efter en förlossning med sfinkterskada. Data analyserades med kvalitativ innehållsanalys.

Delstudie III
I denna studie utvärderades tredimensionellt endoanalt ultraljud (3D-EAUS) som metod för att diagnosticera sfinkterskador efter förlossning. Utvärderingen omfattade om metoden identifierar kliniskt diagnosticerade sfinkterskador, samt beskrev bildkvalitet och förekomst av svårigheter i samband med undersökningen.

Delstudie IV
I fjärde delstudien undersöks symtomen hos de kvinnor som vid uppföljande ultraljud 3 mån efter förlossningen visar sig ha kvarvarande (missad el felaktigt läkt) skada på analsfinktern. Resultaten från ettårs enkäten (Delstudie I) hos dem med kvarvarande skada jämfördes med dem utan några synliga skador på ultraljudsundersökningen.

Resultat och slutsats

Delstudie I
Av 776 tillfrågade kvinnor svarade 511 på enkäten, vilket motsvarar en svarsfrekvens på 66%. Av dessa uteslöts 74 på grund av ny pågående graviditet vid svarstillfället. Tolv enkäter var inkompletta och uteslöts. Det var ingen skillnad i prevalens av förlossningsbristningar i svarsgruppen jämfört med de som inte svarade. De som svarade var något äldre. Vid jämförelse av de tre bristningsgrupperna (ingen eller liten bristning/mellanstor bristning/sfinkterskada) och gruppen som förlösts med kejsarsnitt fann man att krystfasen var längre för de med mellanstora bristningar och sfinkterskador samt att födelsevikten på fostret var störst hos dem med sfinkterskada. Utav mellanstora bristningar var 45% iatrogena genom så kallat klipp.

Symtom på framfall fanns hos 8% av alla kvinnor i studien. Sfinkterskada var associerat med högre risk att rapportera symtom på framfall och ökade risken för att rapportera symtom på trängningsinkontinens. Mellanstora bristningar var associerade med ökad risk för symtom på ansträngningsinkontinens. Att förlösas med kejsarsnitt var associerat med minskad risk för ansträngningsinkontinens. Totalt uppgav 38% av kvinnorna att de hade besvär med samlagssmärta och risken var ökad nästan trefaldigt om man hade haft en sfinkterskada. Kvinnor med sfinkterskada angav att symtom från skadan påverkade deras vardagsliv. Sammantaget var symtom på olika former av dysfunktion i bäckenbottenbotten vanligt ett år efter förlossningen men risken för sådana symtom var mest utbredd hos dem som haft en sfinkterskada.

Delstudie II
Elva kvinnor som haft sfinkterskada i samband med sin första förlossning intervjuades ett till två år efter förlossningen genom semi-strukturerad djupintervju. Medelåldern på kvinnorna var 29 år. Fyra av kvinnorna hade fött barn igen och en kvinna var gravid.

De övergripande tema som uppstod ur analysen av kvinnornas berättelser var" From hell to healed" (direkt översatt" Från helvete till läkt") Kvinnorna beskriver ett stort lidande och påverkan på livskvalitet, relationer och samliv efter förlossning med sfinkterskada. De skildrar också att vårdens attityder till besvären och kvaliteten i den medicinska bedömning de får varierar. De återger en utbredd tendens från vården att normalisera de svårigheter och kroppsliga besvär som fortfarande kvarstår flera månader upp till år efter bristningen. I konstrast till dessa skildringar är det några av kvinnorna som inte framställer upplevelsen av sfinkterskada som svår, utan att de läkt och återhämtat sig ganska snabbt och utan påverkan på vardagsliv eller samliv.

Delstudie III
Totalt genomgick 680 förstföderskor endoanalt ultraljud av analsfinktern direkt efter förlossningen, innan eventuell suturering. Av dessa 680 bildvolymer var 18,5% av så dålig kvalitet att bedömning av eventuell skada ej kunde ske. Bland kvarvarande 554 bildvolymer fanns 23 kvinnor med kliniskt diagnosticerad sfinkterskada (4,2%) samt 71 med sfinkterskada enligt ultraljud (12,8%). Med den kliniska undersökningen som referens så var sensitiviteten för ultraljudet 30,4% och specificiteten 87,9%. Negativt prediktivt värde var 96,7% men positivt prediktivt värde var endast 9,9%.

Konklusionen är att endoanalt ultraljud som en generell åtgärd för att diagnosticera sfinkterskada direkt efter förlossningen inte tillför så mycket i diagnostiken. Detta på grund av svårigheter med bildkvalitet orsakat av förlossningspersonalens ovana att hantera endoanalt ultraljud samt problem med blödning, svullnad och rörelseartefakter. Dessa faktorer resulterar i låg tillförlitlighet för att hitta kliniskt diagnosticerade skador med endoanalt ultraljud. Endoanalt ultraljud har dock en viktig plats i uppföljningen av förlossningsbristningar inom specialiserade mottagningar. Framtida forskning får avgöra om andra ultraljudsmodaliteter, till exempel transperinealt ultraljud passar bättre för att diagnosticera sfinkterskada direkt efter födseln.

Delstudie IV
Totalt medverkade 239 vaginalförlösta (fom. 34 veckor) kvinnor på både uppföljande ultraljud och enkät. Av dessa hade 14 (6%) sfinkterskada, 109 (45%) andra gradens bristning i mellangården och resterande 116 (49%) liten eller ingen bristning. Vid ultraljudsundersökningen 3 månader postpartum hade 48 (20%) en defekt på sfinktern. Av dessa hade 45 en isolerad defekt på externa sfinktern och 3 en kombinerad defekt av både interna och externa sfinktern. De som hade en defekt födde tyngre barn och hade lägre mellangård innan suturering än de utan defekt. Bland kvinnor med defekt på sfinktern var det vanligare med samlagssmärta och värk i underlivet ett år efter förlossningen. Av alla kvinnor var det 13% som inte hade ett aktivt samliv ett år efter förlossningen, och det var vanligare bland kvinnor med defekt. Sammanfattningsvis är låg perineum ($\leq$ 2cm) innan sutur av bristning en riskfaktor för att ha en ultraljudsdefekt på analsfinktern tre månader efter förlossning. Att ha en defekt på sfinktern förefaller påverka samlivet negativt. Det finns ett samband mellan ultraljudsdefekt på sfinktern tre månader efter förlossning och senare samlagssmärta och smärta i underlivet.

Introduction

"Silence is the enemy" - Awareness of delivery-related pelvic floor trauma and pelvic floor dysfunction (PFD) in women is spreading like wildfire in the public media. Supportive associations, newspapers, blogs, social media, awareness campaigns and FemTech companies are sounding the alarm on signs and symptoms of PFD, increasing public awareness of this common health problem. Pelvic floor dysfunction (PFD) refers to signs and symptoms of pelvic organ prolapse, lower urinary tract dysfunction, anorectal dysfunction, sexual dysfunction and pelvic/perineal pain[5]. PFD is highly prevalent in a primary care setting[6] and presents a substantial and increasing economic burden to the society[7]. PFD encompasses conditions that affect women physically, socially, emotionally, and sexually and influences the lives of many women including physical activities, daily activities, employment, and intimate relationships, thereby significantly impacting their quality of life.

Despite increasing public awareness, many women with sequalae after childbirth still struggle to find a way through the healthcare system and retain the feeling of stigmatisation. There is much to learn about the natural course of healing after childbirth, especially regarding trauma after vaginal delivery other than anal sphincter injury. Over the last decade, the Swedish Agency for Health Technology Assessment of Social Services (SBU) has published several reports charting the true issues[2, 4, 8]. In one of these, women with delivery-related injuries and obstetric personnel were invited to collaborate in prioritising relevant research questions. They concluded that one of the most important fields of research was the reliability of diagnostic methods and equipment for detecting delivery-related injuries, and whether a more detailed standard examination at the follow-up appointment could lead to better diagnosis and management. Results from these reports also indicate that the healthcare system has a lot to learn regarding the experiences of women suffering from trauma after delivery, how the system responds to the predicament of these women, and which questions should be posed when evaluating postnatal function and quality-of-life.

This thesis aims to fill some of the gaps that exist in our knowledge of delivery-related pelvic floor trauma and pelvic floor dysfunction after childbirth, thereby contributing to this anticipated part of women's health empowerment.

Functional anatomy of the pelvic floor

The pelvic floor consists of muscles and connective tissue that support the internal organs located in the pelvis (bladder, intestines, reproductive organs) while at the same time providing the flexibility of assisting in bodily processes (urination, defecation, sexual activity, childbirth) as well as maintaining continence and resisting

intraabdominal pressure. The pelvic floor, abdominal muscles, back muscles, and the diaphragm compromises the core muscles of the body.

The pelvic floor is surrounded by and attached to the diamond-shaped bony pelvis. The bony pelvis consists of bilateral pelvic bones that articulate anteriorly at the pubic symphysis and are attached posteriorly to the sacrum by the sacroiliac ligaments. The sacrum is the lowest part of the vertebral column before joining with the coccyx inferiorly. The sacrospinous and sacrotuberous ligaments cross the pelvis in the posteroanterior direction.

The somatic innervation of the pelvic floor muscles comes from the pudendal nerve arising from the second to fourth sacral segments (S2-S4) and direct branches from S4 (nerve to the levator ani). The superior hypogastric plexus (sacral splanchnic nerves) constitutes the sympathetic nerve supply to the pelvic floor and its organs. The pelvic splanchnic nerves serves the parasympathetic innervation[9]. Branches of the internal iliac artery provide blood supply[10].

The anatomy of ligaments and muscles in the pelvic floor is complex, and their terminology, topography, and function remain controversial[11-13]. As the nomenclature of various pelvic floor muscles, innervation, function and precise anatomy is still a matter of debate, this thesis will only provide an outline of the topic[13].

Pelvic diaphragm – “The pelvic floor hammock”

The pelvic diaphragm consists of the coccygeus muscle and the levator ani forming a hammock-like structure with the endopelvic fascia, nerves, and connective tissue. The endopelvic fascia is a strong yet elastic sheath that attaches the vaginal walls and uterine cervix to the ligaments and bony structures of the pelvis. The pelvic floor has two openings, the urogenital hiatus which allows passage of urethra and vagina and the rectal hiatus allowing passage of the anal canal.

The muscles of the levator ani differ from most other skeletal muscles in that they

- maintain constant tone, except during voiding and defecation.
- can contract quickly during acute stress (for example sneezing) to maintain continence.
- distend considerably during vaginal delivery to allow the passage of the foetus and then reform after delivery to resume normal function.
- contributes to sexual function[14]

Coccygeus muscle

The coccygeus muscle forms the most posterior part of the “hammock”. The coccygeus muscle originates at the ischial spines and attaches to the inferior end of the sacrum/coccyx.

Levator ani muscle

There are differences in the nomenclature of the levator ani muscle (LAM). However, here it will be referred to as a unit with three muscle sections, divided into three parts according to their probable attachments:

Ileococcygeus – attaches to the tendinous arch of levator ani muscle and runs posteriorly. Most fibres of iliococcygeus meet with fibres of the contralateral half of the muscle to form a midline raphe. The raphe, where the two halves of the muscle unite, is continuous with the anococcygeal ligament and provides a strong posterior attachment for the pelvic floor.

Pubococcygeus (or pubovisceralis) - attaches anteriorly to the body of the pubis, passes posteriorly, and converges medially to form the levator raphe that is attached posteriorly via the anococcygeal ligament. Some of the fibres of the pubococcygeus attach to the perineal body. Pubococcygeus can be further separated into pubovaginalis, puboperinealis and puboanalis depending on how and where the fibres converge towards the midline[15].

- *Puboperinealis* – muscle fibres that attach to the perineal body.
- *Pubovaginalis*- muscle fibres that descend on the side of the vagina and attach to the vaginal wall.
- *Puboanalis* – some muscle fibres blend with fibres of longitudinal rectal muscles and fascia.

Puborectalis – originates from the posterior surface of the pubic bones and runs like a sling back to its origin, rounding the anorectal junction. The puborectalis pulls the anorectal junction anteriorly, forming an angle of 90° between the rectum and the anus, preventing faecal matter from flowing freely from the rectum to the anal canal. For defecation to occur, the muscle must be relaxed (Fig 1)[15].

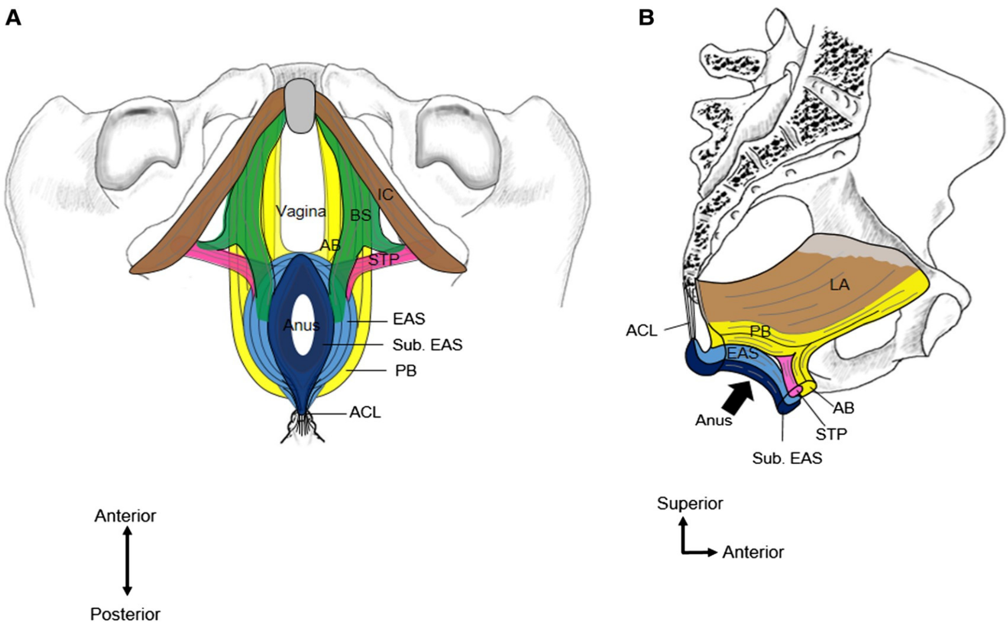


Fig 1. A: Schematic representation of the muscle slings in the pelvic floor shown from inferior aspect. B The anterior muscular wall of the anal canal from medial aspect. LA: Levator ani AB: anterior bundle of LA BS: Bulpospongiousus IC: Ischiocavernosus STP: superficial transverse perineal EAS: external anal sphincter PB: posterior bundle of LA (puborectalis) ACL: anococcygeal ligament. Reprinted with the permission of Keiichi Akita [16].

Perineal body – “The perineal pinecone”

The perineal body is an essential fibromuscular structure forming the midline, or the hub of the pelvic floor. It is generally accepted that most of the perineal skeletal muscles and parts of muscles from the deeper layer (LA) and the external sphincter (EAS) are attached to the perineal body, forming a pinecone like structure. The perineal body lies between the two openings of the pelvic floor and joins and stabilises the deeper layer with the superficial layer (Fig 2)[10].

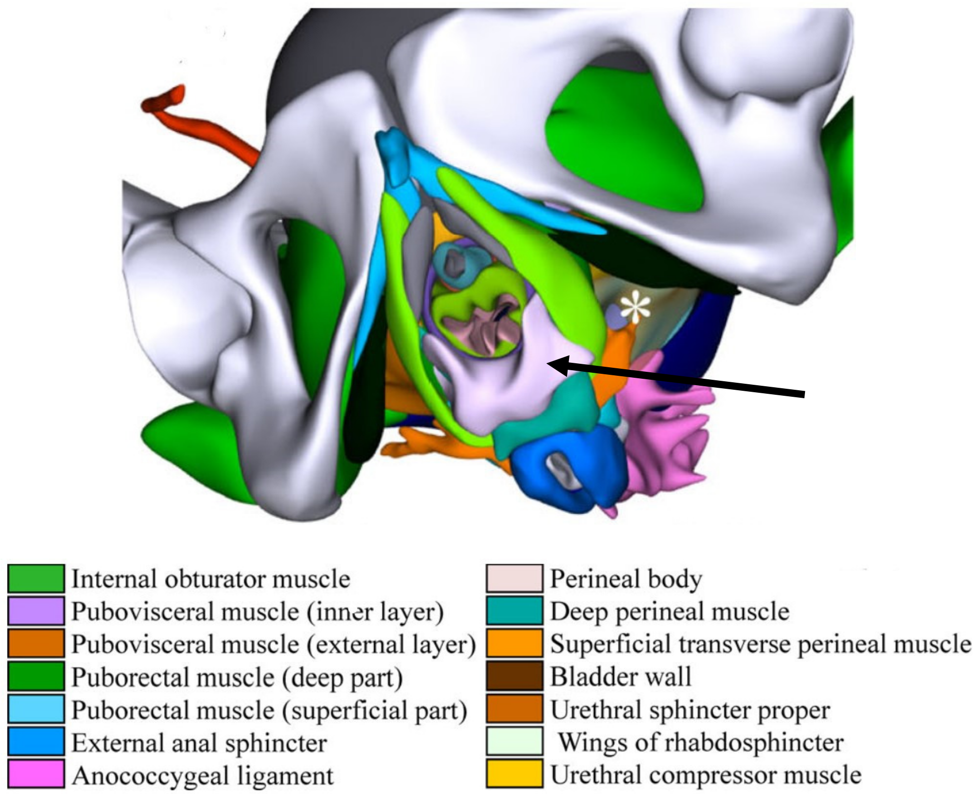


*Fig 2. The pelvic floor in females with the perineal body in the centre. This image is reprinted to illustrate the perineal body´s location and importance as a pelvic floor hub. The arrow points to the perineal body. *Muscular hiatus between the puborectalis muscle and the ischial bone. Reprinted with permission from Wout Lamers[12].*

Urogenital diaphragm and Perineum

The urogenital diaphragm is inferior to the pelvic diaphragm and comprises the perineal membrane, urethral muscles, and the deep traversal perineal muscle. The perineum is the continuation of the urogenital diaphragm posteriorly and of the LA inferiorly. Here lies the ischiocavernosus, bulbocavernosus, superficial transverse perineal muscle and the anal sphincters. Lateral to the anal canal and inferior to the pelvic diaphragm lies the ischioanal fossa filled with fat tissue, fibrous bands, nerves, and vessels[10].

Anal sphincter complex

The anal sphincter complex as a functional unit, consists of overlapping internal anal sphincter (IAS), external anal sphincter (EAS) and puborectalis muscle (Fig 3)[11, 17].

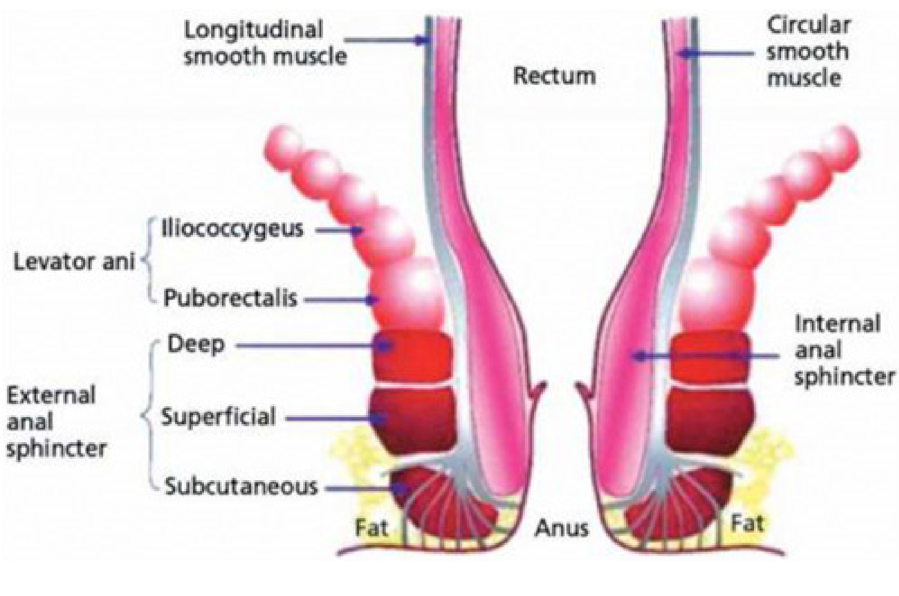


Fig 3. Anatomy of the anal sphincters and anal canal. Reprinted from The Surgeon, 15, Kumar and Emmanuel, Internal anal sphincter: Clinical perspective p 211-226, 2017 Reprinted with permission from Elsevier.

Internal anal sphincter

The IAS is composed of a 2.5-4 cm long and 2-3 mm thick smooth muscle. It is an involuntarily controlled muscle that stays contracted to prevent involuntary loss of faeces and gas. The IAS is continuous with the circular smooth muscle of the rectum. During defaecation, it relaxes, allowing the expulsion of stool. The IAS plays a significant role in the maintenance of faecal continence since it is responsible for the majority of resting anal pressure.

External anal sphincter

The EAS is a tube-shaped skeletal muscle surrounding the anal canal. It inserts anteriorly to the perineal body and posteriorly to the anococcygeal ligament (Fig 2). The EAS has classically been described as comprising three indistinct parts: the deep, the superficial, and the subcutaneous part. However, as mentioned before, the detailed anatomy is subject of debate[13]. Some muscle fibres blend with puboanalis posteriorly and superficial transverse perineal anteriorly in the deep part of the EAS. Proximally it is in close relationship with the puborectalis muscle (LA). The EAS ends slightly more inferiorly than the IAS and is thinner anteriorly (towards the perineal body) in women. EAS contributes to the resting tone and provides voluntary control of defaecation.

It is important to identify the tissue layers accurately at clinical examination of perineal tears after birth and when repairing OASI. When teaching this subject the sphincter muscles are usually described as follows: the IAS appear pale (like raw fish), while the striated EAS is red (similar to raw red meat)[18].

Pelvic floor trauma after delivery

Perineal tears and obstetric anal sphincter injury

Approximately 80% of primiparas suffer from a perineal tear during childbirth[19]. Prevalence rates of first- and second- degree tears are often estimated by clinical experiences since historically, data have seldom been recorded in patient notes or registers. An estimated 40-50% of tears involve the perineal muscles. Recent OASI prevalence figures in Sweden have been around 3% for spontaneous delivery and 10% for instrumental delivery, and higher rates in primiparas , with up to 7% in spontaneous deliveries[20]. In a large study from Denmark, the prevalence in primiparas was similar (6,5%)[21], while a review of French and English journals from 2018 found prevalence ranging between 1,6 and 6%[22].

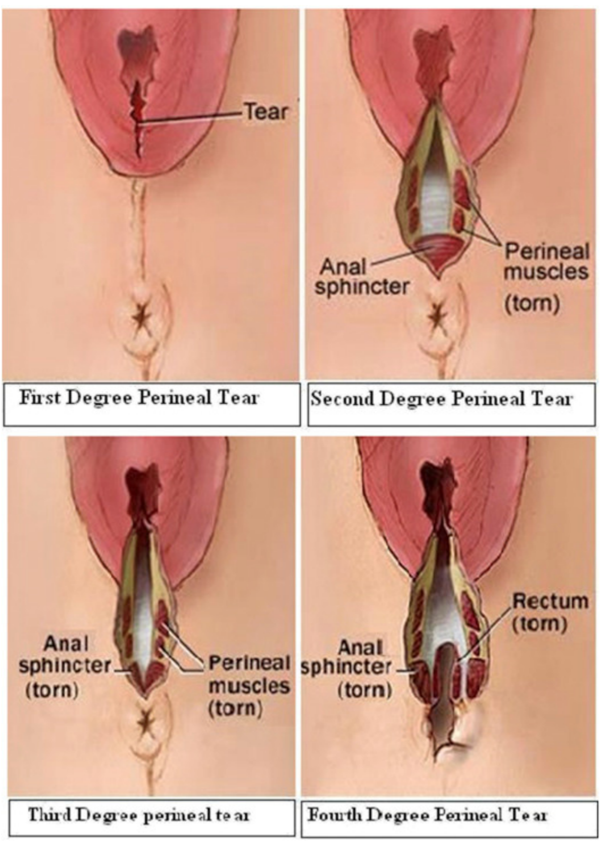


Fig 4. Classification of perineal tears. reprinted from The Surgeon, 15, Kumar and Emmanuel, Internal Anal Sphincter: Clinical Perspective 2017, with permission from Elsevier.

Perineal tears are classified according to WHO ICD-10 (Table 2, Fig 4)[23].

Degree of tear	**Perineal injury**
1	Perineal skin and vaginal mucosa
2	Beyond perineal skin into muscles of perineal body
3	A. External anal sphincter (less than 50%)
	B. External anal sphincter (more than 50%)
	C. External and internal anal sphincter
4	External and internal anal sphincter; anal mucosa

Table 2. WHO classification of perineal tears. Grade 3-4 is OASI.

A subdivision in the severity of second-degree tears was recently suggested to improve the specificity of the injury, and thereby enabling better evaluation of short- and long-term consequences of second-degree perineal tears[24].

Second degree tear	**Perineal injury**
A	Second degree perineal tear involving ‹50% of the perineal body (but not the anal sphincters) and/or a vaginal tear depth <2 cm.
B	Second degree perineal tear involving ›50% of the perineal body (but not the anal sphincters). May include a vaginal tear depth <2 cm
C	Second degree perineal tear involving the entire perineal body (but not the anal sphincters) and/or a vaginal tear depth > 2cm Vaginal tear extending >4cm in length from the second-degree tear: YES/NO

Table 3. Simplified subclassification of second-degree perineal tears adapted from Swedish ICD-10[24]

There are many factors associated with severe perineal tears. The principal risk factors associated with OASI are nulliparity and instrumental delivery. Others are age, ethnicity (Asian/Indian), mutilation, higher foetal weight or macrosomia, prolonged second stage (>1h), occiput posterior position, induction of labour, augmentation of labour, fundal press, shoulder dystocia, previous OASI, previous caesarean section, and low pre-pregnancy BMI[21, 22, 25]. Episiotomy as well as epidural analgesia have been shown to be both risk- and protective factors for OASI[21, 25, 26]. Obese women have a decreased risk for OASI compared to women with a normal BMI[27].

Levator trauma

The levator ani muscle (LAM) is the pelvic organs' main support (see above). After vaginal delivery, the levator hiatus increases in size but usually reverses somewhat from its enormous stretching during the first 6 months postpartum[28]. There is no universal definition of LAM trauma nor is there consensus on the classification of LAM tears[29]. LAM injury is often occult[30] and studies have shown LAM tears following vaginal delivery in 20% of women when assessed with MR[31] and 14-32% with TPUS[32-34]. However, LAM abnormalities have also been shown in nulliparas. LAM tears can be diagnosed immediately postpartum by inspection and palpation, where there is an association with large vaginal tears[35], but there is no established technique or evidence for primary repair. Risk factors for LAM tears are prolonged secondary stage of labour, forceps delivery, foetal birth weight and possibly foetal head circumference[36, 37]. OASI is associated with levator trauma[38, 39], while epidural analgesia is associated with a lower risk of LAM trauma[36]. LAM trauma is a major risk factor for prolapse as well as an increased risk for recurrence after prolapse surgery[40]. There is a relationship between the component that is damaged and the symptoms the woman experience, for instance puborectalis damage predisposes to rectocele and pubovaginalis to stress incontinence[15].

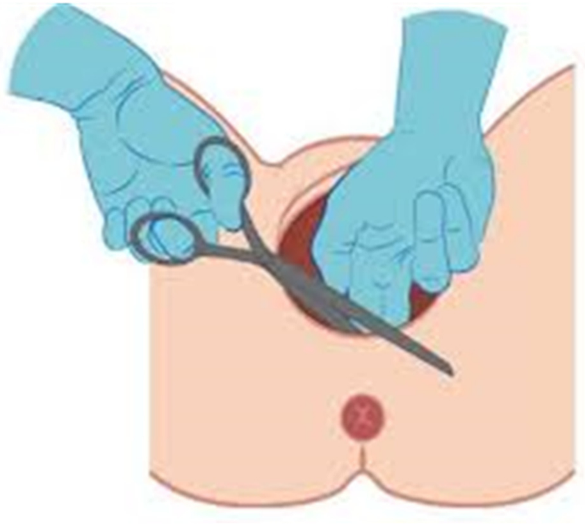


Fig 5. Performance of mediolateral episiotomy. Used with permission from Region Norrbotten.

Episiotomy

Perineal trauma can also be iatrogenic during episiotomy (Fig 5). An episiotomy usually involves the same structures as a second-degree tear.

The use of episiotomy differs widely between different countries, from around 10% or less in Sweden[20] and Denmark to over 60% in Poland and Cyprus41. In Sweden, where episiotomy is seldom used (the restrictive approach), the only indication in non-instrumental delivery is when there is a need for immediate vaginal delivery due to fetal distress. Used routinely, episiotomy is believed to prevent severe perineal tears. WHO states that routine or liberal use of episiotomy is not recommended for women undergoing spontaneous vaginal delivery, but that it is difficult to determine an "acceptable" episiotomy rate. If used, a mediolateral or lateral technique is recommended[42]. As with many other topics regarding the female pelvic floor, the advantage of episiotomy, especially routine episiotomy has been a hot topic in obstetric communities. In France, episiotomy rates have declined after the implementation of new guidelines that recommend restrictive use, without any rise in the rate of severe perineal tears[43.] In the latest Cochrane review from 2017, authors conclude that when an unassisted vaginal delivery is anticipated, a selective use (only if necessary) could result in fewer women with severe pelvic floor trauma without harming the infant, however the level of evidence is low. Nevertheless they concluded that current evidence does not support the routine use of episiotomy to reduce perineal/vaginal trauma, and that further research regarding instrumental delivery is warranted[44].

Preventive and Protective factors

Many projects and studies have been performed to evaluate different preventive measures during labour to prevent perineal tears, but the evidence level is still too low[45, 46]. There is, however, high-quality evidence from a Swedish randomised trial on the benefit of two midwives during the second stage of labour in spontaneous vaginal delivery. OR for severe perineal trauma was 0.69 in the intervention group[47]. Otherwise, only warm perineal compresses and perineal massage have been shown to affect the incidence of OASI. The effect on the rate of minor to moderate tears is unclear or inconsistent[46]. Despite the lack of high-quality evidence, the Swedish recommendation based on clinical experience is to delay pushing and use manual perineal protection. This is adhered to by most midwifes and obstetricians. It is also generally recommended to use a delivery position where the midwife has a good view of the perineum during the final stage. Part of manual protection is to slow the crowning of the foetal head, preventing the head from exiting with too much force, thus giving time for pelvic floor tissues to stretch.

Pelvic floor dysfunction

The term PFD comprises lower urinary tract dysfunction (urinary incontinence, overactive bladder) pelvic organ prolapse, anorectal dysfunction (anal incontinence, obstructed defaecation), sexual dysfunction and pelvic/genital/perineal pain. Different pelvic floor disorders may coincide[48]. In a cross-sectional study based on self-reported data the overall prevalence of any pelvic floor disorders was 37% in women aged 25-84 years[49]. A campaign in the US estimates that 60 million women in the US will suffer from PFD in 2050, due to longer life expectancy and increase in obesity.

The mechanism behind PFD is multifactorial. Theories include disruption of structural elements of support and denervation of the pelvic floor system[50]. The prevalence of these disorders is high and increases significantly with age and parity. Vaginal childbirth is associated with an elevated risk for PFD compared to women delivered exclusively by caesarean section. Other delivery-related risk factors include operative vaginal delivery, prolonged second stage of labour, foetal macrosomia, perineal tears, and episiotomy[50].

Childbirth is not the only contributor to the development of PFD. Epidemiological data indicate an impact of biological factors such as ethnicity, family history of PFD, BMI, intercurrent disease, and age at first childbirth[51].

Urinary incontinence

Urinary incontinence is a very common disorder in women. Stress incontinence is defined as a complaint of involuntary loss of urine on effort or physical exertion, sneezing or coughing[5]. Urge incontinence is defined as a complaint of involuntary loss of urine associated with urgency[5]. Urge can occur with or without involuntary loss of urine, for example in an overactive bladder, often accompanied by nocturia and frequency. Stress and urge urinary incontinence may occur together, usually referred to as mixed incontinence. There are also other kinds of incontinence such as postural and coital incontinence that are less prevalent. Urinary incontinence exists among nulliparous women and the prevalence increases with age[52]. Vaginal delivery and instrumental delivery are well-known risk factors for stress incontinence[50, 53]. Compared with spontaneous vaginal delivery, caesarean section has been reported to be associated with a significantly lower risk for stress incontinence and overactive bladder[54].

Anal incontinence

Anal incontinence compromises involuntary leakage of gas, liquid or solid stool and is a socially inconvenient condition. Faecal incontinence occurs in around 2% of adults, more commonly in women. Anal incontinence is a multifactorial condition involving pelvic floor musculature, fascia, pelvic nerves, and bowel function. One of the major causes of anal incontinence in women is OASI. Other risk factors for anal incontinence are vaginal delivery, maternal age, birthweight, and instrumental delivery[55-59]. Anal incontinence severity is usually recorded by validated scores, such as the Wexner Score or St Mark's score[60]. Bowel urgency and gas incontinence are common in the first few months after vaginal delivery. One study reported a faecal incontinence prevalence of 3% and involuntary gas leakage of 25% three months after delivery in a mixed cohort[61]. In another study assessing residual sphincter defects at 6 months postpartum, a correlation was seen between severity of tear and Starck's score (see below) as well as severity of anal incontinence symptoms[62]. However, another study found no direct relationship between residual sphincter damage, anal sphincter tone and faecal incontinence severity, indicating that multiple mechanism are involved in maintaining continence[63].

Pelvic organ prolapse

Pelvic organ prolapse (POP) is defined as the descent of one or more of; the anterior vaginal wall, posterior vaginal wall, the uterus (cervix), or the apex of the vagina, combined with the presence of symptoms of prolapse. Common symptoms are the feeling of a "bulge" or "something coming down" towards or through the vaginal introitus and sensations of increased heaviness or dragging in the suprapubic area and/or pelvis[5]. Pelvic organ prolapse can be assessed by clinical examination with valuable help of ultrasound. POP is one of the most common reasons for gynaecological surgery[64]. LAM injury increases the risk for POP[65].

Sexual function and dyspareunia

Sexual function after childbirth is influenced by a number of physical and psychological factors such as family structure, altered sleep patterns, breastfeeding, perineal trauma, hormonal changes, and changes in libido[66]. Dyspareunia is persistent or recurrent pain or discomfort associated with attempted or complete vaginal penetration[5].

The incidence of postpartum dyspareunia is high. Breastfeeding and perineal pain are risk factors for dyspareunia[67]. Compared to women with an intact perineum, those who had an episiotomy, sutured perineal tear, assisted delivery or caesarean section delayed their resumption of vaginal sexual activity[68].

Pelvic and perineal pain

Pelvic pain is an umbrella term for pain in the lower part of the abdomen and nearby structures. Pelvic pain can result from a variety of conditions with gastroenterological, urological, protological, neurological or gynaecological origin.

According to the International Continence Society, perineal pain is defined as pain between the posterior fourchette (posterior lip of the introitus) and the anus. In our study, the question about pain is formed to refer to pain located in the region of the vulva, vagina and perineum, but not deeper. The term perineal pain indicates that the symptom could originate from a local process such as a scar, but the pain can also be referred and originate from nearby locations, such as muscles in the pelvic floor[69]. Perineal pain is common after vaginal delivery, and can be experienced regardless of perineal trauma, but the reported incidence is higher in women affected by pelvic floor trauma after delivery. According to a review from 2019 it is more likely for pain to be long-term after a second-degree tear or an episiotomy. The incidence of perineal pain is reported to be lower after using a continuous suture[70].

Impact on daily life and encountering healthcare

The feeling of lack of support and information following childbirth, especially after trauma such as perineal tear, have been described in previous studies[71, 72]. Women's self-related health can be negatively affected by pregnancy and motherhood, especially with coexisting pain and lack of support from their partner[73]. Previous studies regarding women's experiences after perineal tear indicate a vulnerability affecting motherhood and relationships[74]. When reaching out for help, the healthcare system is described as "a patchwork", lacking consistency and standard care, and that it is crucial to find a key person with the correct competence[74-76]. Taboos and shame coupled with physical symptoms such as incontinence still prevail and changes in body image affect self-esteem[77, 78].

Diagnosis of pelvic floor trauma after childbirth

Clinical examination

Clinical examination of perineal trauma is performed with informed consent for vaginal and rectal examination. Ideally the patient should be in a lithotomy position with adequate analgesia and lighting.

The findings should be described as: location of the tear/tears using a clockwise indicator; the depth of the tear from the fourchette to the greatest depth of the perineal body; and the length of the tear from the fourchette to the apex of the tear in the vaginal wall and along the perineal skin towards the anus. After the vaginal examination a bidigital examination is performed with one finger in the rectum to assess the thickness of the perineum, the occurrence of buttonhole tears (isolated tear of the anal epithelium) and assessment of the anal sphincters. Awareness of the possibility of deep tears behind an intact skin in the perineum must be considered[79].

Clinical examination is also an essential part in the assessment of the pelvic floor later postpartum, both at the postpartum follow-up about three months after giving birth (a standard control performed by the midwife in primary care offered to all women giving birth in Sweden) and when the woman seeks help for any troublesome symptoms. During this examination pelvic floor muscles are palpated in the relaxed state and during contraction to assess resting tone and muscle strength.

Ultrasound Imaging of the pelvic floor

Endoanal ultrasound

Three dimensional endoanal ultrasound (3D-EAUS) is a well-documented method for evaluating damages to the anal sphincter[80] and it is regarded as the gold standard in the pelvic floor clinic[81]. The examination is usually well tolerated with little or no discomfort. Assessable pictures of good quality have been obtained in the late puerperium and studies have shown a good level of intra- and interobserver agreement[82]. Several scales for assessing the severity of endosonographic tears of the anal sphincters have been developed and are in use[82, 83]. Using Starck's score the extent of endosonographic defects are described using defect scores ranging from 0 (no defect) to 16 (maximal defect, Table 3). The score considers the defect's location and the longitudinal and circumferential extent. Although the 3D- EUAS is regarded as the gold standard for evaluating the sphincter complex, and is commonly used by colorectal surgeons, it is more expensive and generally not easily accessible to obstetricians and gynaecologists. Consequently, many use exoanal ultrasound with either vaginal or abdominal probes.[84-86]

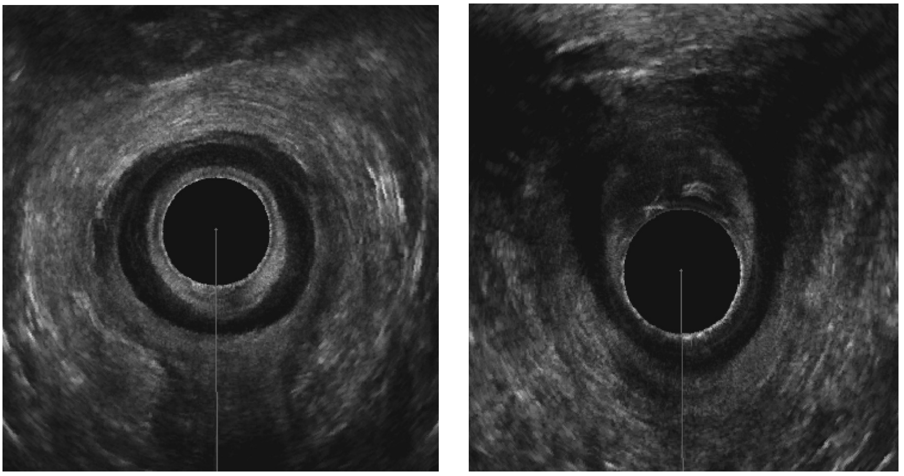


Fig 6. Postpartum images of anal sphincter with endoanal ultrasound. To the left is an intact sphincter and to the right a total sphincter rupture of both EAS and IAS.

Defect characteristic	**Score**			
	0	**1**	**2**	**3**
External sphincter				
Length of defect	None	Half or less	More than half	Whole
Depth of defect	None	Partial	Total	—
Size of defect	None	≤ 90°	91–180°	> 180°
Internal sphincter				
Length of defect	None	Half or less	More than half	Whole
Depth of defect	None	Partial	Total	—
Size of defect	None	≤ 90°	91–180°	> 180°

Table 4. Starck's scoring system for endosonographic sphincter defects.

Transperineal/translabial ultrasound

The use of transperineal ultrasound with an abdominal probe (TPUS) is rapidly gaining popularity among obstetricians and gynecologists. It is less expensive, more accessible, and more comfortable for the patient. According to a study comparing the sensitivity and specificity of transperineal and transvaginal ultrasound with 3D-EAUS, 3D-TPUS shows good agreement with 3D-EAUS and high sensitivity in detecting residual anal sphincter defects, with good intra- and interobserver agreement[87]. Few studies have examined the applicability of 3D-TPUS in the diagnosis of OASI immediately after delivery[88] and its potential role as a screening aid needs further evaluation. Furthermore, research has suggested that early sonographic signs of an anal sphincter tear disappear in up to 50% of patients, and it is recommended that the examination should be performed later in the postpartum period[55].

TPUS can be used in two dimensions for pelvic floor assessment, to visualise midline structures[89]. At rest, the pubic symphysis, the urethra with the bladder, vaginal walls, perineal muscles, rectum and anal canal and anorectal angle can be visualised. With dynamic examination by contraction and Valsalva manoeuvre, organ descent and urethra mobility can be assessed. TPUS can also be used as a tool to evaluate pelvic floor muscle contraction objectively and reliably[90].

The 3D technique is recommended to examine the levator plane[91]. The technique and interpretation learning curve for 3D-TPUS is long. As with 2D the pelvic floor should be assessed gyboth resting, while contracting and with high intrabdominal pressure. The 3D volume is usually acquired with the woman in lithotomy position, with the bladder empty, and using "high quality" settings, wide acquisition angle (70-85°), and the transducer placed on the midsagittal plane. The measured parameters include levator hiatal area, transverse diameters, and visible pelvic organ descent. It is also possible to obtain "slices" through tomographic ultrasound slicing (TUI), where measurement of LAM defects can be made[92]. Studies have shown good correlation between prolapse quantification and ultrasound measurement of prolapse in the anterior/middle compartment, but not in the posterior compartment[93].

Transperineal/endovaginal ultrasound

Transvaginal ultrasound (TVUS) is universally accessible to obstetricians and gynaecologists and can be used transperineally to image the sphincter plane (Fig 7). However, it remains controversial whether TPUS with a vaginal probe is an accurate modality for assessment of the anal sphincter after repair[85, 87, 94, 95]. Endovaginal 3D ultrasound with a rotational probe (the same as in 3D-EAUS) is also a potential way to assess pelvic floor anatomy, diagnosing LAM injuries and visualizing the anal canal[96, 97]. However, as with the 3D-EAUS, the method is not easily accessible.

Fig 7. Image of anal sphincters with vaginal probe. Measurement shows anovaginal distance. With permission from Sophia Pihl [85].

Functional testing

Functional testing is performed to assess the possible impact of pelvic floor trauma on voiding[98].

Anorectal manometry

This device evaluates the function of the anal sphincter by measuring the pressures of the anal sphincter muscles (resting and squeeze pressures), the sensation in the rectum, and the neural reflexes that are needed for normal defaecation[13].

Urodynamic investigations

Urodynamic testing refers to procedures that assess how well the lower urinary tract stores and releases urine. This includes post voiding residual volume measurement, cytometric testing and uroflowmetry/pressure flow studies.[5]

Treatment pelvic floor trauma and pelvic floor dysfunction

Management of perineal lacerations and episiotomy

Primary Repair

Women afflicted with obstetric pelvic floor traumas in Östersund are treated according to guidelines from the Swedish Society of Obstetrics and Gynecology (SFOG) and the Swedish Association of Midwives[99]. Perineal tears are surgically treated by suturing of the anatomical defect[79]. It is of utmost importance that primary repair is adequate to prevent future sequelae[100].

In Sweden, first- or second-degree and episiotomies are generally repaired by the midwife. OASI and complicated vaginal or perineal tears of lower grade are sutured by the obstetrician, with the help of a senior colleague if needed. Minor to moderate tears are usually sutured in the delivery ward, whereas it is recommended that OASI or complicated tears are repaired in the operating theater, where there is adequate lightning, assistance, and access to anaesthesia. The procedure includes re-apposition of injured muscles, reconstruction of the perineal body and skin closure. There are guidelines on suture technique and material[98, 99].

Secondary Repair

Previous studies have seen that primary repair of OASI can fail in up to 30%[101, 102]. The reasons for this include failure to diagnose the extent of the injury or the muscular lesion, wound rupture, and infection. Traditionally, secondary repair has been performed at the earliest 3-6 month after delivery. Newer studies, however, suggest that an early secondary repair in the first month is plausible but increases the risk for fistulas[103].

Follow-up

At the beginning of this project (in 2015), the only standard follow-up of women with a perineal tear was as follows:

- Second-degree tears/episiotomy: Written information (regarding voiding, diet, pelvic floor exercises and contact information if complications) and clinical examination before leaving the delivery ward to check for infection or wound dehiscence.
- OASI: As above plus telephone call 2-3 weeks postpartum and questionnaires from national quality registers[104].

National guidelines for pelvic floor trauma

There are no conclusive or binding national guidelines regarding pelvic floor trauma after delivery in Sweden. Since 2017, national recommendations for prevention, assessment and management of pelvic floor trauma are published online at bäckenbottenutbildningen.se ("pelvicflooreducation.se")[99]. This educational venture originates from Safe Delivery Care, a collaboration project between Swedish obstetricians, midwives, paediatricians/neonatologists via their professional associations, and the Swedish National Patient Insurance Company (LÖF). In parallel, and partly within this national project, systematic reviews of the literature have been conducted under the direction of the Swedish Agency for Health Technology Assessment and Assessment of Social services[2, 4].

All women with OASI and some with a second-degree tear (depending on whether the health care unit is affiliated with the register or not) are followed by a national quality register called the Tear Register[104]. Our unit in Östersund adheres to the recommended follow-up of OASI but not yet for second-degree tears. The register provides direct feedback to the midwife or doctor responsible, thus identifying women in need of further evaluation. It can also be used for follow-up as well as for comparing the results of delivery units over time or with other units nationwide.

There are national quality target values and data for OASI (see below) plus many other obstetric outcomes in the national Pregnancy Register. Data from the Births Register and the National Patient Register are merged. In 2019, data from over 90% of all pregnancies and births were collected[20]

National target values for birth trauma	
OASI in non-instrumental delivery	≤1.5%
OASI in instrumental delivery	≤6.9%

Overview of management of pelvic floor dysfunction

Conservative therapy

Conservative treatment of pelvic floor dysfunction is based on an interprofessional approach.

Counseling
Prevention strategies are targeted towards modifiable risk factors such as preventing, or at least recognising and adequately repairing delivery trauma and advice on future pregnancy.

Pelvic floor muscle training – physiotherapy
Pelvic floor muscle training (PFMT) is the foundation of conservative treatment of PFD. There is evidence of its efficacy regarding prevention and treatment of postpartum urinary incontinence, while effects on anorectal dysfunction remain disappointing[105-107]. It seems to be beneficial in the treatment of sexual dysfunction, but evidence is still scarce[108]. There are few studies on POP prevention in the postpartum period, and results are inconclusive[109, 110]. In summary, there is currently little evidence supporting postpartum PFMT and long-term pelvic floor function, and further research is warranted[110].

Urotherapy
Urotherapy focuses on re-education and rehabilitation of bladder-bowel function. Urotherapists work with diagnostics (such as urodynamics), education, personal counselling, catheter instructions, counselling for continence products and biofeedback/nerve stimulation (see below)[111].

Devices
Pessaries are variously shaped devices that are inserted into the vagina to provide structural support to one or more of the descending vaginal compartments in women with POP. There are also pessaries aimed to support the urethra to prevent stress incontinence as well as special devices coupled to an app to assist pelvic floor training.

Soft tissue therapy
This can include various forms of soft tissue therapy, such as scar massage or desensitisation therapy and myofascial release techniques, aimed to reduce local pain.

Dietary Changes
Evidence that dietary changes improve PFD is scarce. To limit strain at defaecation, a diet that prevents constipation is important for a healthy pelvic floor. This includes good hydration and plenty of fibre such as in flax seeds or psyllium husk. Fermented foods (probiotics,) and fruits, such as pears, kiwi and plum can also improve constipation symptoms. In patients with AI, and problems with looser stool, restrictions should target elimination of irritants such as caffein, beans and gluten, depending on the individual's response to food.

Local treatment
Urethral bulking can be used for mild stress incontinence. It involves injecting natural or synthetic bulk agents around the urethra to build up thickness[112]. Local therapy with oestrogen is often recommended to women with local pain or dyspareunia, especially when breastfeeding. Local injections with cortisone and/or local anesthetic and hyaluronidase are treatment options for chronic pain[113].

Biofeedback
Biofeedback is a safe technique to augment the normal sensory feedback and allow better control of bodily processes that are considered involuntary, such as voiding[114]. Biofeedback can be used in the treatment of UI and AI, constipation, and pain. It requires motivation and participation from the patient and a qualified therapist. Biofeedback uses different modalities to measure physiologic activity, for example muscle activity measured by electromyography, aimed at pelvic floor muscles for treatment of incontinence. With this technique patients can learn to control and exercise the right muscles of the pelvic floor. Biofeedback can also be targeted towards stress and anxiety. Trials that have evaluated biofeedback for incontinence are few, and level of evidence is low[115].

Surgical therapy

Among possible surgical treatments for PFD are reconstructive surgery of anal sphincters or perineum, sacral nerve stimulation[116], prolapse surgery and transvaginal tape for urinary stress incontinence (TVT). The lifetime risk of a woman requiring surgery for UI or POP has been estimated to be 20%[117]. Results of TVT are often successful and long-lasting[118], but for POP surgery there is a high-risk of recurrence[119, 120], and surgery for AI has not been entirely satisfactory[103]. Acceptable continence has been reported in 60-90% of those receiving reconstructive surgery for AI, but deterioration of continence is common with time[121]. Women with PFD must realise that surgical treatment is associated with morbidity and may not be totally satisfactory. A recent Swedish study concluded that surgical treatment was superior to pelvic floor muscle therapy in providing symptom relief in women with a poorly healed second-degree perineal tear[122].

Rationale for this thesis

In the above-mentioned national report on pelvic floor trauma from 2021[2], two major aspects of pelvic floor birth trauma are evaluated.

The first regarded ways to improve detection of perineal tears. One conclusion, based on two studies[123, 124], was that the addition of endoanal ultrasonography to standard clinical examination of the perineum immediately after vaginal delivery might decrease the risk for severe faecal incontinence 3 to 12 months after delivery (low degree evidence). The authors discussed the fact that there are problems with the usability of anal ultrasound due to practical difficulties in its execution and interpretation. They conclude that methods of examination should be simple, reliable, and sensitive and that there is a need for more knowledge on methods of examination that are suitable for routine use after delivery.

The second part discussed women's views and experiences of healthcare providers after sustaining a perineal tear. Most conclusions regarding women's experiences had a low level of certainty, except for conclusions regarding inadequate care and information that had moderate certainty. Negative experiences after birth trauma have appeared a lot recently, on television, radio, in newspapers and in social media. One example is the famous Instagram initiative #alltserfintut (#everythinglooksfine), with over 15000 followers, where women share their experiences of birth trauma, including physical, social and phycological aspects. Another large initiative is the Facebook site VVF -Våga Vägra Förlossningsskador (”dare to refuse birth trauma”) that was created as a forum for women to ask questions in a safe community, and to raise awareness to this topic. The site now has over 3000 members.

Fig 8. Screenshot from Facebook community "dare to refuse birth trauma". From Meta©.

These initiatives, and many others, together with evidence from a few published papers[73-75] and conclusions from the national report[2], led us to believe that more research into women's experiences after a perineal tear was warranted.

Furthermore, through clinical experiences and literature reviews we have seen that research on consequences of minor and moderate perineal tears as well as the natural healing of the pelvic floor in the first years after delivery, are scarce.

It is somewhat mind-blowing, and certainly alarming, that scientist could put a human on the moon already in 1969, while in the 21st century, there are still major gaps in our knowledge on what is considered to be the most natural thing in the world, giving birth.

Aims

The general aim of the thesis is to increase the knowledge of perineal trauma and its consequences, and to improve and simplify the diagnostics and follow-up of perineal trauma.

I

To determine whether degree of perineal injury at first delivery correlates with self-reported pelvic floor dysfunction one year later.

II

To explore experiences of women affected by OASI, related to recovery, sexual function, relationships, and coping strategies 1-2 years after delivery.

III

To determine if the use of three-dimensional endoanal ultrasonography (3D-EAUS) can improve the diagnosis of OASI immediately after delivery.

IV

The determine the prevalence of endosonographically visible anal sphincter defects three months postpartum, and if these defects are associated with later symptoms of pelvic floor dysfunction including perineal pain and dyspareunia.

Materials and Methods

The project in large and the setting

All studies in this thesis were part of a regional interdisciplinary project involving birth-related perineal injuries, endoanal ultrasound and postpartum pelvic floor disorders.

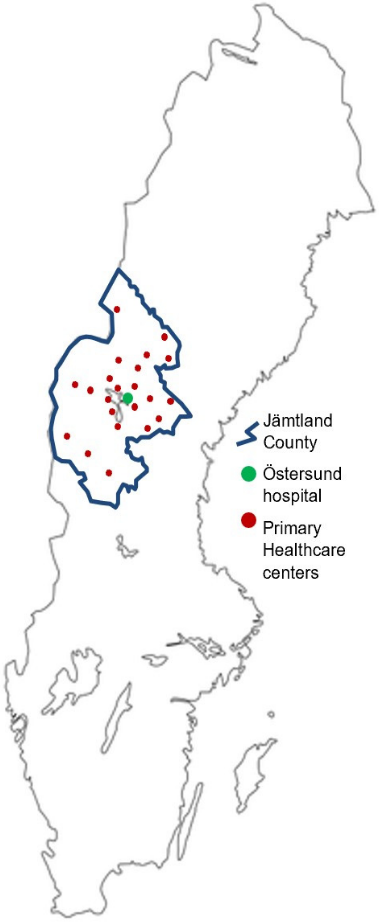


Fig 9. County of Jämtland-Härjedalen

The county of Jämtland-Härjedalen is a vast rural inland area (~49000 km^2), sparsely populated with about 130 000 inhabitants, of which about a third lives in the regional capital Östersund. Östersund Hospital is the only secondary care provider and has the only delivery ward in the region. Approximately 98% of pregnant women residing in the region give birth at this hospital. The birth rate was between 1050-1300 deliveries/year during the period of this project, with a caesarean section rate around 15%. Overall OASI rate ranged from 2.3-3.3% and OASI rate in primiparas from 4.1-6.8%. In Sweden, antenatal care of normal pregnancies and spontaneous cephalic deliveries are managed by midwifes. The antenatal and obstetric care services are public and free of charge. Antenatal standard care is provided by primary care providers that are interspersed throughout the region. Specialist obstetric care and foetal scans are carried out at the hospital.

Procedures

Written consent to participate in the project was obtained during the hospital visit for routine foetal anomaly scanning at 18–20 weeks ‘gestation. Women who agreed to be included in the study were assessed by clinical examination after delivery to diagnose any perineal injury. The clinical examination was performed by a midwife or, in eligible cases, by a doctor. The examination consisted of inspection and bidigital palpation in the lithotomy position. The laceration grade was documented by the midwife or doctor according to the ICD-10 WHO guidelines (Fig 4, Table 2). A 3D-EAUS recording was then performed in lithotomy position by a trained midwife, prior to suturing of any perineal or vaginal laceration. Only mediolateral episiotomy was used. The findings were documented in a study protocol. Data on maternal, obstetric, and neonatal characteristics were obtained from medical records (Obstetrix). Women were then invited to a complimentary 3D-EAUS recording in a specialised outpatient clinic, performed by a specially trained midwife. A Wexner anal incontinence score was obtained three months after delivery. Self-reported symptoms of perineal floor dysfunction were assessed one year postpartum by a web-based questionnaire with 15 questions (Appendices 1 and 2). Women who incurred OASI at their first childbirth were purposively invited to interviews after 1-2 years.

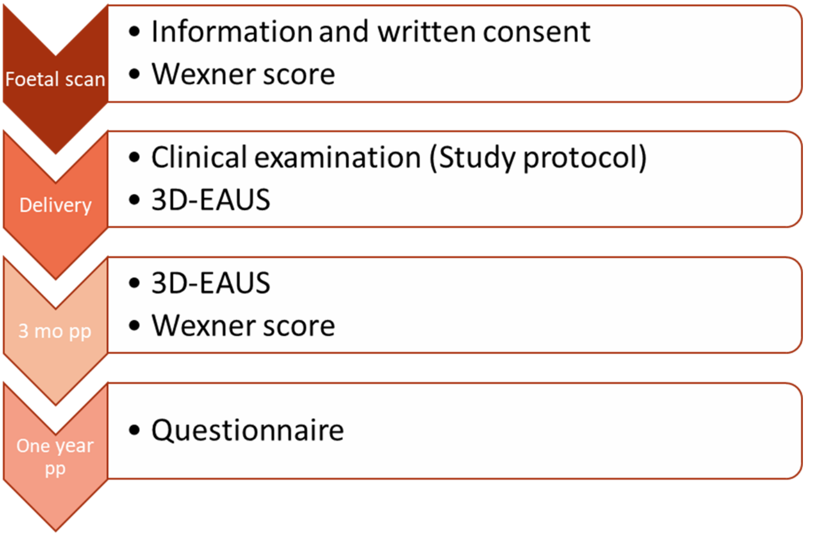


Fig 10. Schematic flowchart of study procedures. pp=postpartum.

Questionnaire

Approximately 12 months postpartum, each participant received an invitation to respond to a questionnaire by mail. Included in the letter was an information sheet explaining the purpose of the study, security standards, data storage, and consent process, as well as contact information of the investigators responsible. The participants were asked to complete a web-based questionnaire regarding symptoms of prolapse, urinary incontinence, anal incontinence, perineal pain, and sexual function. The questionnaire consisted of 15 questions and contained the most important parts for the postoperative evaluation of perineal injury provided by the Swedish Society of Obstetrics and Gynecology's register of perineal tears (Bristningsregistret)[104]. OASI has been registered since 2014 and is constantly followed and evaluated. In 2020, the coverage of OASI was 98%[2]. The parts of the questionnaire that are scored have been validated. The questionnaire was only available in Swedish. All questions had "no" or "never" as response options, and for questions regarding sexual function, patients had the option of not answering, without being excluded from the analysis. Adaptive questioning processes were used in cases where supplementary questions addressed further specifications regarding the occurrence of symptoms such as dyspareunia. The survey was conducted voluntarily, and the patient provided consent by logging in using their project code and submitting their answers. The participants received two reminders via text messages and/or a telephone call. The web-based questionnaire had been pilot-tested on 15 participants with different socioeconomic and educational backgrounds, to see that the questions were understandable, and to check how long it took to complete. The following definitions were applied:

- Prolapse was defined as a feeling of something bulging out of the vagina or pressing against the posterior vaginal wall to empty the bowel once or more per month.
- Stress urinary incontinence was defined as leakage of urine once a week up to every day. Urge incontinence as leakage once a month to daily.
- Anal incontinence was defined as involuntary flatus or leakage of stool once a month or more.
- Obstructed defaecation was defined as difficulties of emptying the bowels once a month up to every day.
- Sexually active was defined as intercourse within the last three months.

- Perineal pain was defined as pain in the vulvar-vaginal-perineal area (not related to sexual activity) that could not be ignored, affecting their concentration on daily tasks and activities. Severe perineal pain was defined as pain that prevented most activities or worse.
- Complications were defined as self-reported issues or complications related to the tear during the period from two months after childbirth until the day of filling in the questionnaire.

Study population

The project lasted between January 2016 to January 2018 at Östersund Hospital, Sweden. Eligible participants were nulliparas planning to deliver at Östersund Hospital during the study period. Exclusion criteria was prior anal surgery. An overall flowchart of study procedures is presented in Fig10 and participants in the different parts of the project are presented in Fig 11.

Power analysis

A sample size calculation was made at baseline for the project (for study III and a study performed to compare grade of tear to endosonographic results.) The sample size calculation was made by our regional statistician using Jeffreys Confidence Interval for One-Sample Proportion, in a stepwise manner. Based on an estimated prevalence of 15% for endosonographically detected OASI, and a confidence interval (CI) of +/- 0.0325 and the probability of achieving a power of ≥80 %, sample size was calculated to 500 individuals (exact power was 82.7%).

Equator guidelines

The EQUATOR (Enhancing the QUAlity and Transparency Of health Research) Network is an international initiative that seeks to improve the reliability and value of published health research literature. (equator-network.org). One way of accomplishing that is by reporting guidelines/checklists. There are different guidelines depending on the type of study. In this thesis the following guidelines were used; Study II COREQ (qualitative research, Study III STARD (diagnostic studies), and Study I and IV STROBE (observational studies).

Statistical analyses

All Statistical analyses were performed using SPSS software (version 26,27 or 28; IBM). Continuous variables were tested for normal distribution. To identify differences between continuous variables in different groups non-normally distributed variables were analysed using the Mann–Whitney U test, normally distributed Student's t-test and in the case of more than two groups ANOVA (analysis of variance), respectively. For categorical variables the Chi-square test or Fischer's exact test was used. $P>0.05$ was considered statistically significant. Odds ratios (ORs) were calculated using binary logistic regression and 95% confidence intervals (CIs). Based on results of previous studies and clinical experience, we selected age, BMI, and foetal weight as possible confounders for PFD, and in the sub analyses of episiotomy we also included instrumental delivery by vacuum. For intra-rater reliability we used κ statistics. Values of κ were defined as: less than 0.20, slight agreement; 0.21–0.40, fair agreement; 0.41–0.60, moderate agreement; .61–0.80, substantial agreement; and 0.81–0.99, almost perfect agreement.

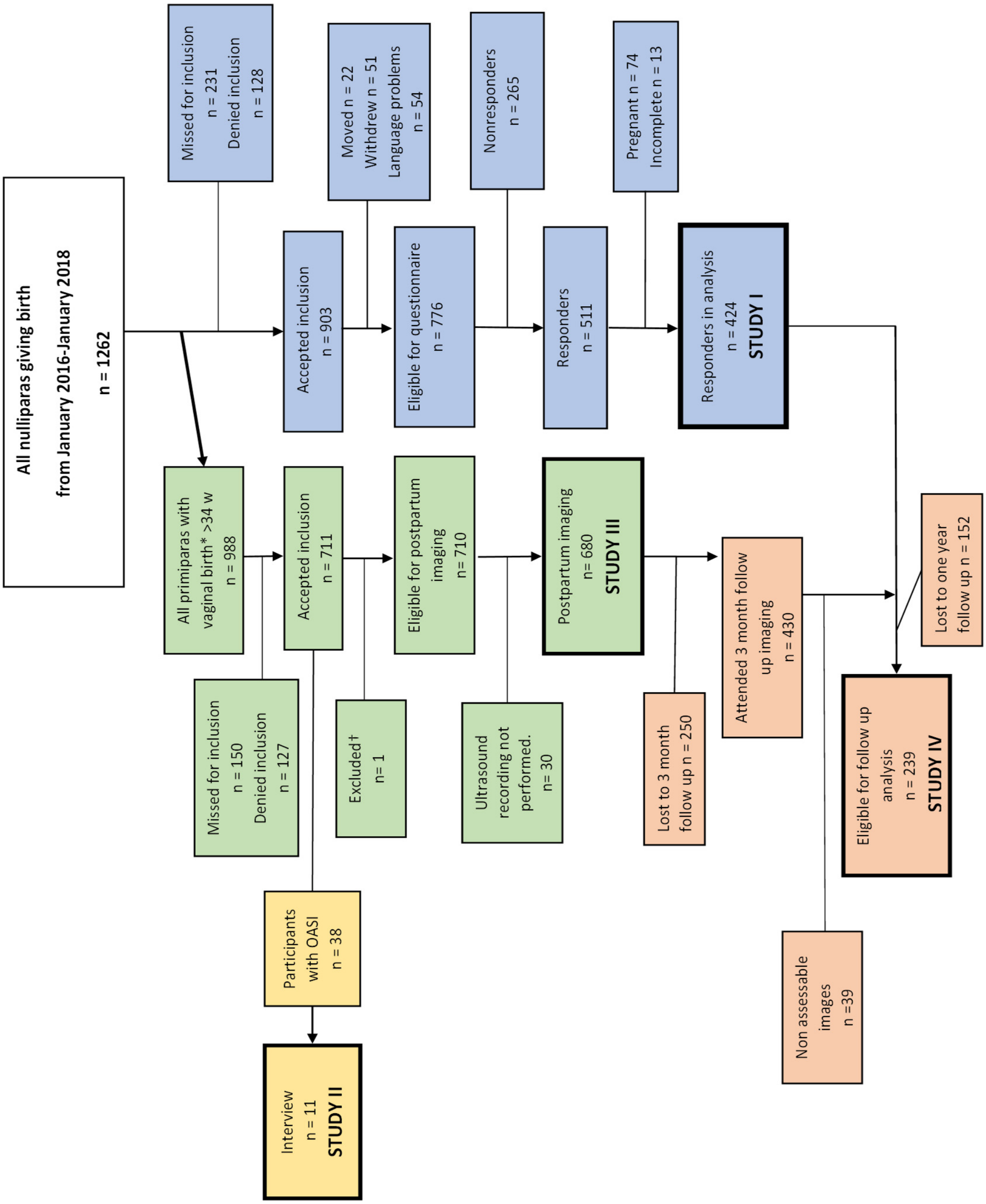


Fig 11. Flow chart of the study population for the project in large. Colors represent study inclusion flow chart; blue = Study I, yellow = Study II, green =Study III, Orange = Study IV. In Study I, women who gave birth by caesarean were included.

Schematic overview of methods

	Study I	Study II	Study III	Study IV
Type of study	Prospective cohort study	Qualitative study	Cross-sectional study of diagnostic accuracy	Prospective cohort study
Population Sample Setting	776 primiparas giving birth (vaginally or by cesarean section) at Östersund Hospital January 2016-January 2018	11 primiparas with OASI at their first vaginal delivery at Östersund Hospital January 2016-January 2018	680 primiparas giving birth vaginally at Östersund Hospital January 2016-January 2018	239 primiparas giving birth vaginally at Östersund Hospital January 2016-January 2018 and attending follow up 3D-EAUS and questionnaire
Intervention Exposure	Questionnaire regarding symptoms of pelvic floor dysfunction one year after delivery	In-depth semi structured interviews 1-2 years after first vaginal delivery	3D-EAUS of anal sphincters performed immediately after delivery	3D-EAUS three months postpartum to assess sphincter defect and questionnaire one year after delivery
Comparison Statistical analyses	Logistic regression Odds ratios for symptoms of prolapse, urinary incontinence, anal incontinence, sexual function, pain and influence on quality of life	Inductive qualitative content analysis	Sensitivity Specificity Positive and negative predictive value Likelihood ratios Comments on the examination	Logistic regression Odds ratios for symptoms of pelvic floor dysfunction Risk factors for endosonographic sphincter defect
Outcome	Self-reported prevalence of pelvic floor dysfunction in relation to severity of tear and comparison of vaginal delivery to cesarean section	Experiences related to recovery, sexual function, relationships, and coping strategies among women affected by OASI.	Diagnostic accuracy of 3D-EAUS to find clinically detected OASI	Self-reported prevalence of pelvic floor dysfunction in women with endosonographic sphincter defect compared to women without defect

Table 5. Methodological summary of the included papers in the thesis

Study I

Summary

An epidemiological, prospective cohort study of pelvic floor dysfunction related to severity of tear one year after first childbirth.

Subjects and methods

A prospective cohort of 774 primiparas received a questionnaire regarding symptoms of pelvic floor dysfunction (prolapse, urinary incontinence, anal incontinence, dyspareunia, pain). The prevalence of self-reported symptoms of pelvic floor dysfunction was assessed and compared between the categories of perineal traumas. Women that gave birth by caesarean section were also included. See flowchart of inclusion and dropouts (Fig 11).

Materials

Self-reported symptoms of perineal floor dysfunction were assessed using a web- based questionnaire with 15 questions (Appendices 1 and 2, details above). This questionnaire was based on the questionnaire for the postoperative evaluation of perineal injury provided by the National Swedish Society of Obstetrics and Gynecology[104].

Statistics

Associations between grade of perineal tear and self-reported symptoms of pelvic floor dysfunction were assessed by the Chi-square test or Fischer´s exact test and logistic regression analyses. Odds ratios were adjusted for age, BMI, and foetal weight when appropriate, and CI set at 95%. Patients with no/first-degree injuries were compared with patients with second-degree injuries and OASI. Vaginal delivery was compared with participants giving birth by caesarean section. Descriptive statistics were presented as mean or median and range.

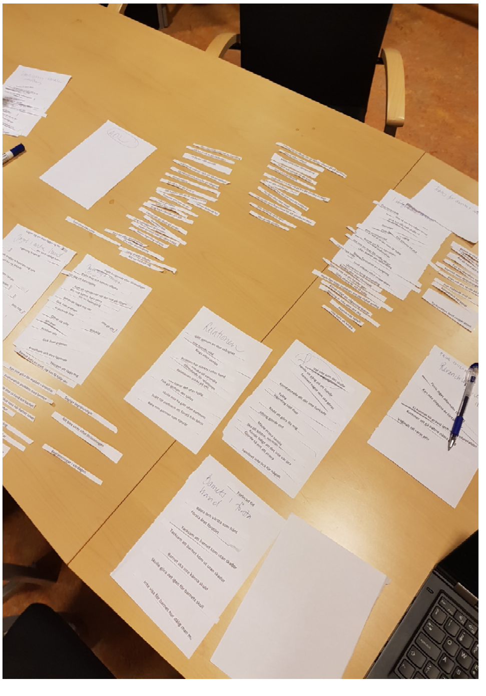
Study II

Summary

A qualitative study with semi-structured in-dept interviews of women where childbirth was complicated by OASI. The aim was to explore their experiences of the first years after delivery, focusing on recovery, relationships, coping and sexuality.

Subjects and methods
An interview guide (Appendix III) was created based on the literature and on the authors' experience. Two pilot interviews were performed and included in the analysis, which resulted in only minor changes in the interview guide. The topics of the guide were experiences of delivery and their perineal trauma, relationships, sexual function, experiences, and contact with healthcare services and the media. Interviews were conducted with eleven purposively sampled women who had incurred OASI at their first childbirth and was carried out 1-2 years after delivery to gain as much information as possible of the research study questions. The selection of these women was based on the population of the project. All women were interviewed in a secluded room at the hospital, except one who was interviewed at home.

Analysis
Inductive content analysis was applied. In inductive content analysis, analyses are made at the same time as data are collected, which entails that data collected from interviews influence subsequent data collection. The analysis included both the obvious, or manifest content as well as the latent, or underlying meaning. In short, it was performed as follows:



1. Women where individually interviewed by one or two of the authors in convenient setting chosen by themselves.
2. All interviews were recorded and transcribed verbatim.
3. Transcripts were read multiple times by two of the authors to achieve a sense of the entity.
4. Meaning units *i.e.*, sentences relating to the aim where identified, condensed and coded.
5. Codes were grouped into categories to reflect the underlying latent meaning (Fig 12).
6. All authors discussed the finding, and a theme emerged.

Fig 12. Part of the analysis process in Study II. Picture by the author.

Study III

Summary
A diagnostic cross-sectional study of the utility of 3D-EAUS to diagnose OASI in the immediate postpartum.

Subjects and methods
A total of 680 primiparas (with vaginal delivery ≥ 34 weeks) underwent examination with 3D-EAUS immediately after delivery, before suturing. Clinical examination to detect perineal tears (vaginal and rectal) and suturing was performed according to standard care. Results were noted in a study protocol. The definition of an endosonographically diagnosed sphincter defect was a discontinuity in the endosonographic image of the internal anal sphincter (IAS, hypoechoic ring) or external anal sphincter (EAS, mixed echoic ring), and/or characterised by the loss of the normal architecture in the appearance of the IAS and/or EAS. Outcome of endosonography with regards to sphincter defect was dichotomous (defect/no defect). Volumes regarded as "non-assessable" were excluded from final analyses, but reasons for not being able to assess the sphincter integrity were recorded and described.

Materials
Endoanal ultrasound was performed using a Flex focus 500 Ultrasound scanner (BK Medical) with an 8838 axial endoscopic probe at 12 MHz. Recordings were standardised by following easy step-by-step instructions. The scanner was pre-set and ready to use. Prior to the start of the study, all midwifes and some assistant nurses working at the delivery ward were given repeated education on how to perform the examination. The education consisted of lectures, demonstrating the machine, hands-on training on how to use the machine with the presets, and hands-on training on how to perform the examination on a rectal examination dummy. All recorded volumes were independently assessed by a colorectal surgeon who was blinded to all clinical, demographic, and delivery data. Archived 3D-EAUS volume data sets were analysed using proprietary software (BK viewer) on a computer. To test intra-reliability, a random set of 30 volumes was repeatedly assessed without the knowledge of the inspector.

Fig 13. High-4 multifrequency (12-4 MHz), 360° rotational mechanical probe (type 8838, BK Medical, Herlev, Denmark) Used in Study III and IV.

Statistics
Clinical diagnosis of OASI was set as the reference standard. The sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios of immediate postpartum 3D-EAUS to detect OASI were calculated. An intra-observer agreement test for the assessment of 3D-EAUS volumes was done using κ statistics.

Study IV

Subjects and methods
A total of 239 women participated in this follow-up. Requirements were vaginal delivery ≥ 34w, attendance in all parts of the project and assessable follow up ultrasonography images at 3 months postpartum.

Materials
For details regarding the questionnaire, see above and under Study I. Three months after delivery. participants were invited to an outpatient clinic, where 3D-EAUS was performed by a trained midwife. The same scanner and probe were used as in Study III. Participants also provided an actual Wexner score. Archived 3D-EAUS volume datasets were analysed using proprietary software (BK viewer) on a personal computer by one of the authors who was blinded to all clinical, demographic, and delivery data.

The extent of the anal sphincter defect identified by ultrasound examination was described by Starck's score, based on the depth (none, partial, or total depth), longitudinal involvement (≤50% , >50%, total), and radial angle of the defect (≤90°, 90–180, ≥180°) of the EAS and IAS (see above).

Statistics
Descriptive statistics of the patients with and without defects were presented and compared using Chi-square test or Fischer's exact test. Associations between endosonographically detected sphincter defects and self-reported symptoms of pelvic floor dysfunction were assessed by logistic regression analyses. Odds ratios were adjusted for age, BMI and foetal weight when appropriate, and CI set at 95%. Descriptive statistics were presented as mean or median plus range.

Ethical considerations

When collecting data from patients in a health-care situation, where they depend on their care provider for proper care and as researchers, clinicians must adhere to a certain code of conduct. The main purpose of health care for the newly delivered mother is to promote her and her child's health. To achieve this, delivery wards aim to offer a supportive and relaxing environment. This includes keeping the mother and baby together, skin-to-skin contact and avoiding medicalisation while maintaining patient safety[125]. If research intrudes this unique moment in life, thorough ethical considerations are required. Participation must be voluntary, confidential, well-informed, and safe for both mother and child.

On the other hand, it is essential that women (even pregnant or in the postnatal period) are recruited and involved in research. Historically, pregnant women enrolled into trials have been regarded as "vulnerable". After a workshop in 2010, US national guidelines recommend the term "scientifically complex "instead[126]. To gain insight into this complexity and into postnatal care, researchers must be present on the spot and consider and strive for the essential bond between mother and child.

In this project, we have adhered to general ethical principles regarding handling of data and informed consent, by allowing women to recall their consent or opt out of the study at any time, and by not pursuing intervention in the event of a very adverse outcome, such as intrauterine foetal death. In the questionnaire, questions about sexual function had the option of choosing "not willing to answer" without the woman being excluded due to "incomplete or missing data". The results of these studies could benefit the women who participated and future mothers.

Before beginning data collection, a research proposal was submitted to the Regional Institutional Review Board. All four studies in this thesis were reviewed and approved by Umeå Regional Ethics Board.

- Study I: Dnr. 2016–458-31M
- Study II: Dnr. 2016–458-31M and 2018–240-32M
- Study III: Dnr. 2015-183-31M
- Study IV: Dnr. 2016–458-31M

Participants received both written and verbal information about the study from the attending midwife following foetal scanning at the maternity care ward and/or at the delivery ward. All women participating in this study had given written consent to participate in the project and accepted that additional data would be drawn from their antenatal clinic and delivery ward notes. Participants were informed that they could withdraw their consent at any time, without any consequences regarding care during pregnancy, delivery, or the postnatal period. Women who declined participation were naturally treated according to routine practice. All data were handled according to GDPR regulations and Swedish law. Data were anonymised, confidential and only handled by the principal investigators. Results from all studies in this thesis are presented at an aggregated level whereby no individual study participant can be identified. Regarding interviews in Study II, we were aware that the topics that we addressed could be regarded as sensitive, which is why secluded in-depth interviews were chosen instead of, for example, group discussion. From the quotes presented, it is not possible to derive any information that could lead to identification of a participant.

Results

Study I

Participant characteristics
In total, 511 women (66%) responded. There were no differences in most characteristics between women who participated in the follow-up and the non-responders, apart from that the respondents were older, and more likely to have had a vacuum assisted delivery, while epidural use was more common among non-responders. There were no differences between the three injury categories regarding maternal age, body mass index, infant head circumference, gestational age at delivery, induction rate, labour augmentation or epidural use. The duration of the active secondary stage of labour was longer for patients with a second-degree injury and an OASI than for those with minor injury. Women suffering an OASI had the highest foetal birthweight. Occiput posterior presentation was more common in the OASI group, but the difference was not significant after post-hoc testing.

Outcomes
Prevalence of prolapse, urinary incontinence, anal incontinence, dyspareunia, and perineal pain one year after delivery is presented in Fig 15. OASI was a risk factor for developing symptoms of prolapse (aOR 7.7 CI 2.1–29). Second degree trauma was a risk factor for stress incontinence (aOR 2.6 CI 1.3–5.1) and delivery by caesarean section was protective against stress incontinence (aOR 0.2, CI 0.1-0.9). OASI was a risk factor for reporting symptoms of urge incontinence (aOR 4.8 CI 1.6–15). and 12% stated that urinary incontinence had an impact on their daily life. Women with OASI was more prone to report that they had urinary incontinence that affected their lifestyle (cOR 4.6 CI 1.5–14).

Thirty-eight percent of the women who were sexually active suffered from dyspareunia. The risk for dyspareunia was higher among women with OASI (cOR 3.1 CI 1.1–9.0). More women who had incurred OASI reported pain that was severe enough to prevent most activities over the previous 3 months (cOR 3.3 CI 1.1–10). OASI was also a risk factor for reporting that symptoms originating from their injury still had an impact on daily activity, and they reported the highest rate of complications. Women who underwent caesarean section generally had a low dysfunction rate apart from dyspareunia (31%), where the prevalence was in line with that in women with an intact perineum (Fig 15).

As spontaneous second-degree tears were analysed together with episiotomy, a sub-analysis was performed by logistic regression to reveal any association between episiotomy and PFD outcomes. Analysis showed that episiotomy itself was a risk factor for stress incontinence (aOR 1.9 CI 1.1-3.3), but not for other PFDs. These analyses were adjusted for age, BMI, foetal weight, and instrumental delivery.

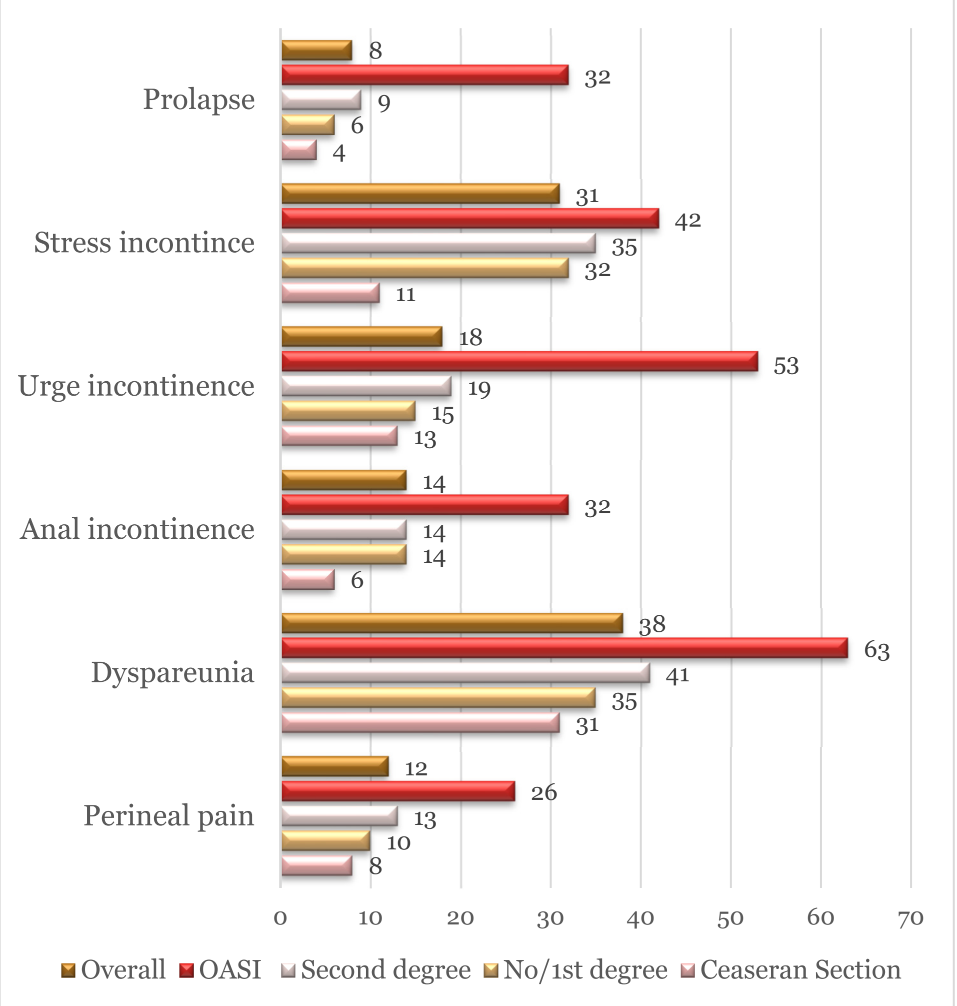


Fig 15. Prevalence of self-reported PFDs, one year after delivery in the study population, overall, per group of perineal tears and for caesarean section. Presented as % of total and in each group.

Study II

Participant characteristics

Of the 54 women that had given their consent to the project, and incurred an OASI, eleven were purposively included to participate in the interviews. All women were of Swedish origin, with Swedish as their native language, but showed variation in age, BMI, level of education and occupation (Table 5).

Inform. No	Age (range)	BMI (range)	Profession	Level of education	Origin	No of children	Degree of tear
1	30-35	30-35	Health care	University	Sweden	2	3c
2	25-30	30-35	Student	University	Sweden	2	3a
3	30-35	30-35	Agroforestry	High School	Sweden	1	3c
4	30-35	25-30	Health care	University	Sweden	1	3b
5	35-40	25-30	Store manager	High School	Sweden	1	3b
6	25-30	25-30	Craftswoman	High School	Sweden	1	3b
7	25-30	25-30	Office work	University	Sweden	2	3a
8	30-35	25-30	Health care	University	Sweden	1	3a
9	25-30	20-25	Student	University	Sweden	1	3a
10	30-35	20-25	Office work	University	Sweden	1	3b
11	30-35	20-25	Agroforestry	High School	Sweden	1	4

Table 6. Overview of participant characteristics in Study II.

Outcomes

The core theme that evolved from the analysis of women's experience of daily life, relations, and sexuality after OASI was "From hell to healed". Women described a panorama of outcomes, from having healed and coping well, to a situation where every day had been a struggle. Care of the infant was perceived as the primary concern during the first months after delivery, and mothers put their own concerns aside. Some women seemed to heal well and to cope with changes in their body and daily routines, whereas others depended on their partner or relatives to manage daily tasks. Women revealed issues related to their tear and sexuality, such as pain, fear and changed body image related to the scar. Women stressed the need for more information and a more humble approach from healthcare providers when they finally dared to seek help with their problems. Many described that they encountered a strong will on the part of the caregiver to normalise whatever symptoms they described and that healthcare providers often focused on how their pelvic floor looked instead of how it functioned.

Study III

Participant characteristics

Of the 680 scans performed, 126 (18.5%) were not assessable. Among the 554 scans remaining, 23 (4.2%) of women had clinically detected OASI and 71 (12.8%) had sphincter defect on 3D-EAUS. Demographic characteristic means (standard deviations) were as follows; age 28 (±5) years, gestational age 279 (±10) days, BMI 25 (±4) kg/m2, foetal weight 3471 (±472). In all, 17% had induction of labour, 66% epidural analgesia, 68% augmentation of labour, and the episiotomy rate was 23%. Instrumental delivery with vacuum occurred in 11%, no forceps deliveries.

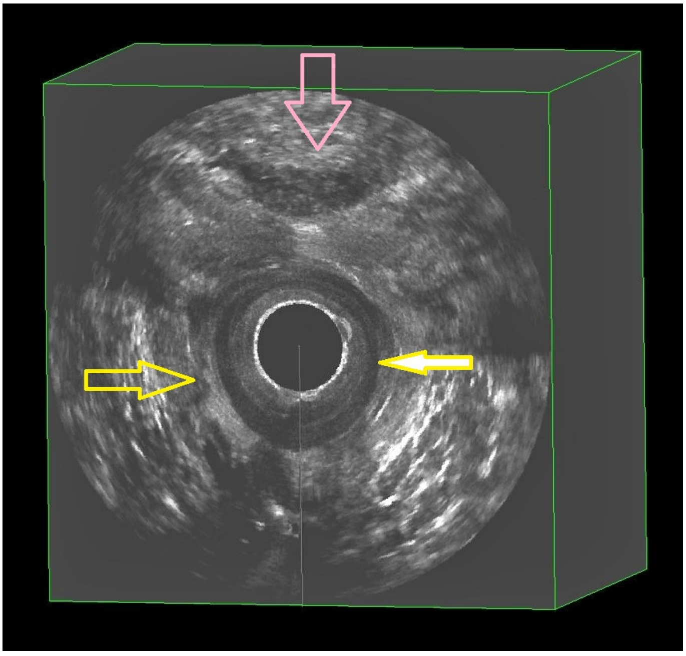


Fig 16. Immediate postpartum image of an intact sphincter. Yellow arrow pointing at EAS (with edema and some minor bleeding), yellow/white arrow pointing at edematous IAS, rose arrow pointing at bleeding above the sphincter plane.

Outcomes

With clinical examination set as a reference, the standard ultrasound sensitivity in the diagnosis of OASI was 30.4%, whereas the specificity was 87.9%. The negative predictive value was 96.7%, but the positive predictive value was only 9.9%. Comments were left on 175 recordings, outlined in Fig 17.

Results Study III	n and/or %
Performed scans	680
Illegible scans	126
Assessable scans	554
Scans with comments (Fig 15)	175
Prevalence of OASI, clinical	23 (4.2%)
Prevalence of endosonographic sphincter defects	71 (12.8%)
Sensitivity	30.4%
Specificity	87.9%
Negative predictive value	96.7%
Positive predictive value	9.9%

Table 7. Summary of results in Paper III.

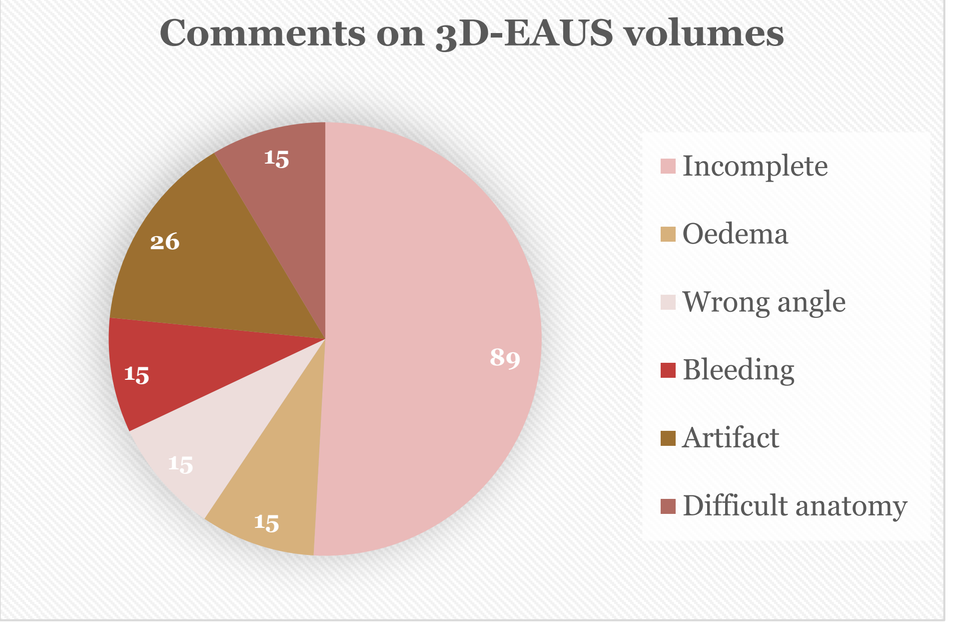


Fig 17. Summary of comments on 3D-EAUS volumes in Study III.

Study IV

Participant characteristics
A total of 239 women participated in this follow-up study. Requirements were vaginal delivery at ≥ 34w, attendance in all parts of the project, and assessable follow up ultrasonography images at 3 months postpartum.

Outcomes
Sphincter defect was a risk factor for dyspareunia (cOR 2.4, CI 1.2-4.9), and these women also had a greater risk for not being sexually active (cOR 3.4, CI 1.4-8.0). Having a defect was also a risk factor for perineal pain (cOR 2.3, CI 1.0-5.1) and severe perineal pain (cOR 3.3, CI 1.1-9.9). There were no statistical differences between women with or without defect regarding perineal tear rate. It was more common with a postpartum Wexner score ≥ 5 and a perineal height at birth before suturing ≤2cm, among women with a defect.

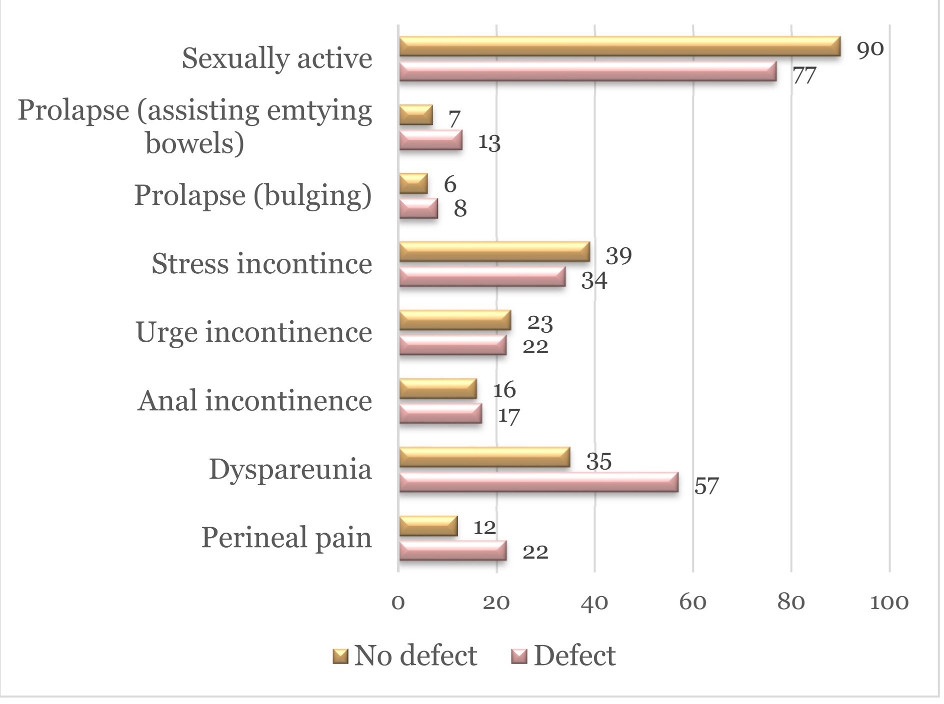


Fig 18. Prevalence of self-reported PFDs in the study population of women with endosonographic defect of the anal sphincter (rose) and without defect (yellow). Presented as % in each group.

Discussion

General discussion

Mode of delivery and the pelvic floor

PFD caused by birth trauma could theoretically be prevented by caesarean section. So why not?

Caesarean section rates have been steadily increasing in the last decades and they continue to raise worldwide[127]. It has become more common with caesarean section on maternal request and without medical indication. Despite this, research shows that most women would prefer vaginal delivery. In studies of both healthy nulliparas and mixed cohorts, over 90% expressed a preference for vaginal delivery[128, 129]. The section rate in Sweden was 18.6% in 2021, which is low compared to other more developed countries (average 27.2% in 2018)[127]. With rising caesarean section rates comes increased maternal mortality, maternal and infant morbidity, increased risk for complications in subsequent deliveries, as well as increased cost to the healthcare system[3]. Over the last 5 years, the section rate in the County of Jämtland-Härjedalen has been stable at 15-16%.

A common concern for women when considering mode of delivery is the function of the pelvic floor postnatally. It is well-known that vaginal delivery entails a higher risk for future prolapse, urinary incontinence, and anal incontinence, especially after instrumental vaginal delivery.[50, 53, 130-134] Some of the women in Study III described a strong will to try vaginal delivery again, despite their severe tear and traumatic experience. This was because they wanted to "set the record straight" and replace their negative experience with a positive one.

In a large observational study with data from the Swedish Medical Birth Register, the risk for AI was greater in women with vaginal delivery (OR 2.15) and women who delivered by caesarean (OR 1.31) compared to nulliparous women. This reinforces the observation that pregnancy itself has an impact on the development of AI[57]. The majority of women delivered vaginally do not develop PFD and the estimated number to treat *i.e.,* by caesarean section instead of vaginal delivery, to prevent one PFD is seven[49].

Instead of simply denying a woman's wish to have a section, modern guidelines emphasise the importance of information and informed consent regarding the mode of delivery[135, 136]. This is a complicated debate, and we as healthcare providers, must approach the question with a motivated spirit whilst showing sensitivity to all parties involved.

When counselling women on mode of delivery and how to limit the strain on their pelvic floor, there are modifiable risk factors to consider and, if possible, take out of the equation. Working towards reducing risk factors in vaginal delivery includes avoiding high birthweight, prolonged labour and instrumental delivery, and to have adequate support in the second stage of labour[47].

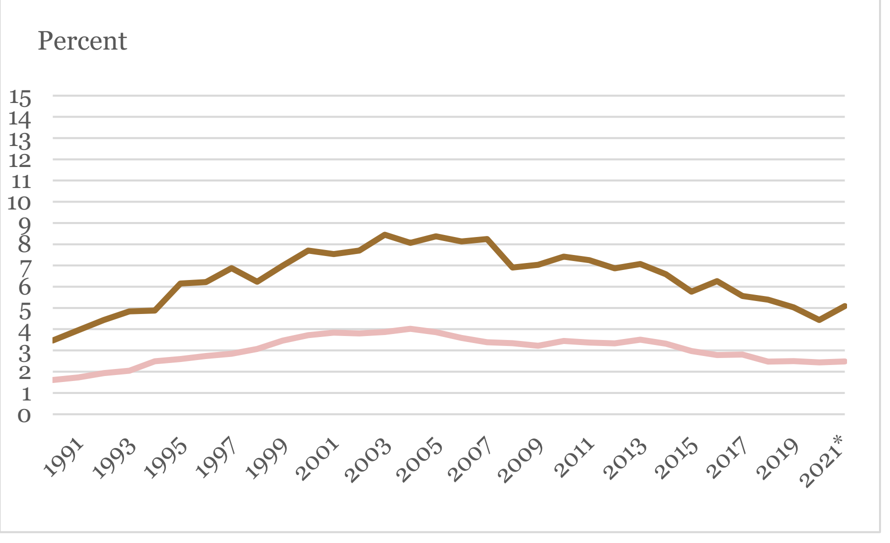


Fig 19. Prevalence of OASI 1990-2021 in Sweden in women who gave birth to infants with fetal weight ≤4449 g (rose line) and ≥4500g (brown line). Data and illustration from Swedish medical birth registry[1].

Obesity is a major health issue, and Sweden is no exception to the growing worldwide problem. Rates of overweight (BMI>25) and obesity (BMI>30) continue to grow in adults and children. In Sweden 51% of adults (16-84 years) are overweight or obese[137]. Unusually large gestational weight gain is associated with increased risk of large for gestational age infants and macrosomia[138]. High BMI and gestational diabetes are predisposing factors for macrosomia and macrosomia and high fetal weight are associated with increased risks trauma to the birth canal[21, 139]. Obesity is also a risk factor for PFD, especially UI[140]. Thus, nationwide initiatives to reduce the prevalence of obesity could have positive effects on birth trauma and PFD. On the other hand, results from studies suggest that women with higher BMI have a lower risk for severe perineal tear[27, 141], and contrary to the researcher's hypothesis, lower risk for AI two months after an OASI[142].

Prediction models for OASI has been tested but the reproducibility has not been good enough to apply them in counseling[22, 25]. This leaves us with an individualised approach, that includes informed consent between the care provider and mother, as being the only option.

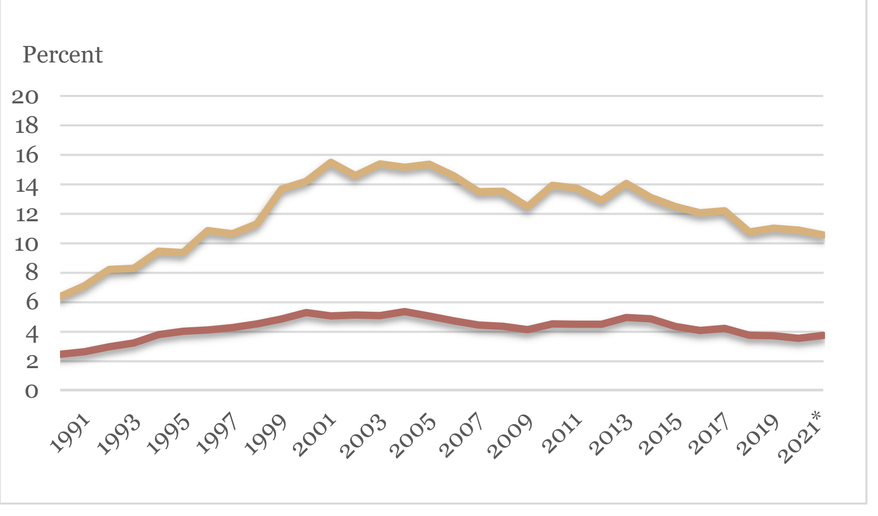


Fig 20. OASI in Sweden 1990-2021 for non-instrumental deliveries (red) and instrumental deliveries (orange). Data and illustration from Swedish medical birth registry.

Ultrasonography and birth trauma

As seen in study III, there is an ongoing debate on under and overdiagnosis of perineal tears, particularly OASI. In the beginning of this debate, the term "occult OASI" was frequently used, describing an OASI diagnosed later postpartum by second opinion or ultrasonography. More recently the term "undiagnosed OASI" is preferred as true "occult" OASI are rare, the majority being simply missed OASI[143]. Table 8 presents an overview of a selection of studies showing under or overdiagnosis of OASI when comparing clinical findings to ultrasonography findings[59, 81, 123, 144-153]. As can be seen, prevalence ranges from 7-44% for overdiagnosis and 1-56% for underdiagnosis.

In one of the above-mentioned retrospective study of women who attended a specialised clinic for follow-up 3 months after delivery, only 79% of clinically diagnosed OASI were confirmed by 3D-EAUS, *i.e.,* 21% overdiagnosis. This was further confirmed by significantly lower anal manometry pressures in the "true" OASI and a higher prevalence of flatus incontinence[144]. In another retrospective study, where TPUS was performed within a week after delivery, 56% undiagnosed IES defects were detected, and 19% of clinically diagnosed IES defect that were not confirmed by ultrasonography[145].

In our study the prevalence of a defect sphincter was 12.8% immediately after birth and 20% at the 3-month follow-up. Sphincter defect was defined as a discontinuity in the endosonographic image of the internal anal sphincter (IAS, hypoechoic ring) or external anal sphincter (EAS, mixed echoic ring), and/or characterised by the loss of the normal architecture of the IAS and/or EAS on ultrasonography. This definition is in line with others[81, 87, 123, 124, 154, 155], while some are more specific on the degree of hypogenecity/discontinuity, using a cut-off at 30° or "1hour"[156]. Others define injuries as a scar if ≤30° and as a defect if >30° in an axial image[157]. There are also studies that lack a definition of defect[123, 143]. For TUI the diagnosis of a defect requires ≥4/6 slices to show a defect ≥30°[59, 158]. The cut-off angle has empirically been set at 30° but has not been validated[159]. A standardised method for documenting sphincter injury diagnosed by endoanal ultrasonography using a pictorial chart has been proposed and validated in 2008 (EAS defects only)[160] . There are validated scores[82, 161, 162], but none of these are uniformly used which makes comparison between countries and centres difficult.

Study	Country	Over diagnosis	Under diagnosis	Ultrasound modality	Study design	Population Clinical diagnosis	Timing	Definition for defect/OASI
Jones et al. 2022[144]	UK	21%		EAUS	retrospective	1135 with OASI	12 w pp.	none
Capanna et al. 2020[145]	Switzerland	19% IAS	56% IAS	TUI	retrospective	119 with OASI	3–7 d pp.	4/6 slices> 30°
Guzman Rojas et al 2013[59]	Australia		24%	TUI	retrospective	247 without OASI	5 m pp.	4/6 slices> 30°
Tejedor et al. 2019[146]	Spain		47.5	EAUS	prospective	56, mixed	3 m pp.	Starck´s score
Thomas et al 2017[147]	UK	44%		EAUS	retrospective	1495 with OASI	4 m pp.	none
Gold et al 2021[148]	Canada	31%		EAUS	retrospective	49 with OASI	9–20 w pp	>1h or >30°
Andrews et al 2006[143]	UK		1.2%	EAUS	prospective	241 , mixed	Immediately after delivery and at 6 w	none
Nichols et al 2006[149]	US		19%	EAUS	prospective	138, mixed	6–8 w pp.	Break/gap
Ozuyrt et al 2015[150]	Turkey		11,5%	EVUS	prospective	201, episiotomy	Before discharge from delivery ward	Loss of continuity
Corton et al 2013[81]	US		12%	EAUS	prospective	107 without OASI	Within 72 h of delivery	Loss of continuity
Sioutis et al 2017[151]	UK	7%		EAUS	prospective	908 with OASI	3 m pp.	>1h or> 30°
Faltin et al 2005[123]	Switzerland		5.6%	EAUS	RCT	752 (342) with second degree	Immediately after delivery	none
Anglim e al. 2019[152]	Ireland	33% IAS 8% EAS	20% IAS	EAUS	prospective	75, OASI	4–12 m pp.	>1 h
Gillor et al 2020[153]	Australia	11%		TUI	retrospective	215 with OASI	1-11 m pp.	Abnormality (distorsion, thinning, defect)

Table 8. Selection of studies evaluating prevalence of obstetric anal sphincter injury postnatally with ultrasonography. pp=postpartum.

The prevalence of OASI is one quality parameter in evaluating maternity care. Obviously, there is a risk for paradoxical results when units work towards lowering the OASI rate if that entails that the rate of undiagnosed OASI would be raising at the same time. This could make the situation worse for women giving birth, as missed OASI would not be repaired by primary suture. The "true incidence" of a unit is hard to assess since a unit with a high incidence could either be better at diagnosing OASI or worse at preventing it. The role of ultrasonography in this debate has primarily been to establish the rate of undiagnosed OASI at some point after the delivery, since a missed OASI can have severe consequences[163].

To our knowledge, there is no delivery unit in Sweden that uses 3D-EAUS to diagnose OASI immediately after birth, but some units try using the endovaginal approach to support or neglect the diagnosis of OASI, especially tears of the IAS.

Magnetic Resonance (MR) has been proposed in some studies[164]. However, since ultrasonography is the primary tool for obstetricians, and MR accessibility on the delivery ward hardly exists, it is not feasible in the immediate postpartum period. It is also costly and has the same image quality problems with edema and bleeding. When discussing accessibility, it is worth mentioning that neither 3D-EAUS nor the comparable use of rotational probes endovaginally are readily available at maternity units in Sweden, and the skill required for performing and interpretating the results is not universal amongst obstetricians and gynaecologists.

TPUS on the other hand, is usually available where foetal scans are performed and has the advantage of being noninvasive. One study showed excellent agreement between TPUS and EAUS in diagnosing the presence of an EAS defect, and perfect agreement in diagnosing the presence of an IAS defect[165]. Similar studies conclude that TPUS is not inferior and shows good agreement with 3D-EAUS when evaluating residual defects and associated symptoms[87]. However, even this modality requires educational efforts in order to be feasible for routine use, and to our knowledge, no studies have been performed using TPUS immediately after delivery prior to suturing.

Whether injury to the sphincter diagnosed by ultrasonography is called missed or occult, and the exact degree of definition of the defect is probably of lesser importance. More important is whether that information helps in the assessment, treatment, and counseling of sequalae after delivery or later. In a study assessing over 600 women following repair of OASI, 9% missed IAS defects were detected, and symptoms scores were higher in those with a defect >30°[157]. Another interesting finding was that women with reduced sphincter tone on digital rectal examination were more likely to have an IAS defect. Rectal examination is easily performed, and reduced tone could indicate the need for further investigation with ultrasonography. The association between postnatal sphincter defect and anal incontinence has been shown in multiple studies[55, 59, 161, 166-168]. In Study IV, we detected an association between defect and dyspareunia/perineal pain but not between defect and anal incontinence. The definition of anal incontinence in Study IV included flatus incontinence and prevalence one year postpartum in Study IV was similar in both groups regardless of defect (16-17%). In Study I the overall prevalence of anal incontinence one-year after delivery was around 13% except from women with OASI (32%). This is in concordance with recent research from Norway, where overall prevalence of AI was 13% at one year, although flatus incontinence was only included if occurring weekly or more often in their definition[169].

Healing from perineal tears

"Everyone is different and recovery from a third- or fourth-degree tear will vary", states a patient information leaflet from RCOG (Royal College of Obstetricians & Gynecologists, rcog.org.uk) for women who had an OASI during childbirth. This statement is probably applicable to moderate or even minor tears as well.

In Study II, it was obvious that the healing and coping process differed between women and was not only dependent on the severity of the tear or the number of complications. For some women healing was experienced purely as a struggle, while others could cope with their situation, moved on and felt restored. Similar results emerged when experiences from women with OASI were analysed in a qualitative study based on written responses from the postoperative evaluation of perineal injury provided by the National Swedish Society of Obstetrics and Gynecology[74].

For others who maybe plan to have children in the future, for them to know, that there is like ... that things can go well even if there was such a large injury."

Fig 21. Citation from a participant in Study II.

Elements that had a negative influence on women's experiences were the pain and physical symptoms of pelvic floor dysfunction, normalisation of symptoms by healthcare providers, and unrealistic expectations about how this period in life would be like.

In one of the national reports regarding birth injury, factors related to poor emotional health included bodily pain and lack of support[2], which is in accordance with the findings in Study II.

Many studies, including Study I, shows that physically, long- and short-term consequences are more common after perineal tears,[50, 56, 59, 70, 170, 171] so naturally healing will be a bigger issue for those affected.

A small study from Finland reported a 32% prevalence of failed OASI repair, with more tears being repaired by less experienced personnel and more repairs performed during on-call hours than in those with successful repair[101]. Postnatal complications, such as infections or wound dehiscence further deteriorate the situation, prolong physical healing, and aggravate pain. In a review assessing incidence of wound complications after OASI, overall incidences were 4.4% for wound infection and 6.9% for wound dehiscence[172]. In a multicentre study from Denmark, the prevalence for infection was 9% for second-degree tear and 3% for OASI, and for wound dehiscence 18% and 13% respectively. Risk factors for these complications were BMI≥35 and episiotomy. Antibiotic treatment was protective, which could explain the lower prevalence in the OASI group[173].

A Cochrane review from 2013 compared secondary suturing to no suturing for broken down perineal wounds. The authors concluded that the evidence was too poor to recommend either, even if there was a non-significant trend in favour of secondary suturing[174]. A retrospective analysis from the Croydon Perineal Clinic, London, UK demonstrated positive outcomes of early resuturing of perineal wound dehiscence[175]. Another recent study from the same centre on women monitored with 3D-EAUS during infection after OASI found that sphincter integrity was not affected[176]. Hopefully, an array of studies on management of complications after perineal wounds will shortly provide us with better information upon which improved guidelines on this matter can be based.

Another Cochrane review from 2017 set out to evaluate the effects of antenatal education on postnatal perineal wound healing, but no studies met the inclusion criteria for the review[177].

In summary, it is our belief that more research on healing of perineal tears is warranted. While awaiting high quality evidence, comprehensive care, where women feel that they are seen and acknowledged, will probably get us far. An open-minded approach, in a society without shame and guilt because of childbirth trauma or PFD, will at least contribute to the emotional healing of women affected. To offer help with emotional issues such as anger, fear, anxiety, and post-traumatic stress from the delivery experience, as well as reminding of positive factors and support of resilience are important parts of the healing process[178].

Our suggestion based on experiences from these studies and at our local perineal clinic, is to allow enough time for the counselling to be able to go through experiences from the delivery, to explicitly address function in all areas including sexual function, and not just look at the anatomical situation. Providing advice for future deliveries through postpartum counselling was shown beneficial in a study from a centre in Switzerland, but they admitted that further consideration of sexual and emotional sequelae would be an improvement[179].

Luckily, and perhaps, partly thanks to this project, the follow-up for complicated tears now includes a postpartum clinical check-up where women are examined by a specialised midwife and physiotherapist. We also have a monthly pelvic floor team meeting (with midwifes, physiotherapist, urotherapists and doctors) to discuss more complicated patients, and a specialised out-patient clinic for pelvic floor disorders after childbirth.

Sexual function after childbirth

In a study where the relative importance of women's reasons for preference of mode of delivery were assessed in a discrete choice experiment, women placed the most emphasis on sex after childbirth[128].

In a study of over 2000 women evaluating physical symptoms after childbirth using a questionnaire, dyspareunia was the second most common problem reported by primiparas, affecting 39%[180]. This is in line with Study I, where the overall prevalence was 38%. Perineal trauma contributes to dyspareunia, as shown in study I, II and IV as well as others[181]. Perineal tears are also associated with an elevated risk for not resuming intercourse before 6 months after delivery[182]. Similar results were found in Study IV, where women with defect seen at endosonography had an increased risk (OR 3.4) for not being sexually active compared to women without defects.

It is however difficult isolate the impact of perineal trauma on sexual function without considering other factors affecting women postpartum. It is probable that more research evaluating function prior to pregnancy as well as following a cohort with more detailed and validated information on all aspects of sexual function (not only dyspareunia) over a longer period is needed to properly evaluate this matter.

It is encouraging that a recent large epidemiological study reported no association between sexual enjoyment/frequency and mode of delivery, concluding that women had equally satisfactory sex after vaginal as after caesarean delivery[183].

Methodological Considerations

Consideration of the study designs

The cohort study design in Studies I and IV is analytic in its design and is thereby suitable to quantify relationships between two factors. It is, however, inferior to a randomised control trial (RCT) which provides the highest level of evidence. RCTs are often ethically difficult to perform when it comes to childbirth[184], which is why cohort studies have become a commonly used design in this setting. The advantages of a prospective cohort study design is that is it ethically feasible, establishes direction of events, may be standardised in terms of outcome assessments, and is often administratively easier and cheaper than a RCT. Major disadvantages are the risk of confounders and the fact that for rare conditions, a large sample sizes or long follow-up is needed[185].

For quantifying the accuracy of a diagnostic test (Study III) the cross-sectional survey design is usually applied, and a reference standard is chosen based on previous research or clinical experience[185].

Qualitative study design (Study II) is descriptive and is used to explore a wide variety of phenomena, its strengths lie in the richness and depth of the exploration[186].

Reliability

Reliability refers to the consistency of a measurement, that is the extent to which a study is free from errors of measurements[187].
In our setting, one can discuss whether there was internal consistency in the clinical diagnosis of perineal tear. The routine in our department, as well as in Sweden in general, is that the examination is performed by the responsible accoucheur, in most cases the midwife. If there is any concern about the extent of the tear, a senior colleague is called for help. If a junior doctor is uncertain, the senior obstetrician will be called for. In our unit, all midwifes, and doctors must regularly complete a web-based education and test[99], regular quality control is made to check the rate of tears, and there is repeated education on diagnostic of tears, perineal support, and suturing.

Intrarater reliability is the extent to which an observer is consistent in their judgments and was tested with endosonographic OASI diagnoses in Study III, as well as for residual defects in Study IV. The person that performed the interpretation of the volumes had long experience in examining endosonographic volumes and was blinded to all clinical and demographical data.

Pain is a difficult outcome to measure, due to its multifaceted and subjective nature. In the questionnaire used in Studies I and IV, we assessed prevalence of self-reported dyspareunia and perineal pain. Pain assessment can be done using open-ended questions such as “tell me about your pain”, or more specific questions addressing for example location, duration, or intensity of pain. Scales can be used, either numerical (such as rating from 0-10 where 10 is worst imaginable pain) or more descriptive ones[188]. We chose to use a descriptive scale (see Appendices I and II) to better understand how women were affected in their daily life. In asking for pain in the perineal area, we used the

Swedish word “underlivet”, which refers to the lower vaginal, vulval and perineal area. There is no such definition in documents from international societies, where vulvodynia and perineal pain are defined separately[98]. Based on our clinical experiences, women with pelvic floor dysfunction after childbirth seldom divide pain in these areas, however the pain is distinguishable from intrabdominal pain such as dysmenorrhoea.

In analysis of PFDs, we chose any confirmatory response (Yes, 1-3 a month, Appendices I and II) as having PFD symptoms, except from stress urinary incontinence with a cut off 1-3 times a week. This may have contributed to the relatively high prevalence of PFDs in our study population. It is difficult to compare rates since studies evaluating short time consequences on the pelvic floor are scarce. The rates in our study are quite in line with another study evaluating PFD 5-10 years after delivery[189].

Internal validity

Internal validity refers to the performance of the study and can be largely affected by systematic errors (bias) [187].
Any result of an epidemiological study may reflect the true effect of an exposure, but at the same time the finding could be an effect of chance (random error), bias (systematic error) or confounders. Results and decision-making that emanate from statistical analyses can only be as good as the quality of the data collected. More than 50 types of bias have been identified in epidemiological studies. Biased results from systematic errors in the study design and their magnitude is generally difficult to quantify.

Random error
The key to reducing random error is to increase sample size. As the population for the follow-up studies were based on the sampling of Study III, and there was loss to follow-up, sample size was limited. As regards the second 3D-EAUS at three months postpartum, one must bear in mind that the distance to Östersund Hospital, where examinations were performed could be up to 300km, and that participants were mothers with an infant.

Questionnaire
One limitation is the lack of a fully validated questionnaire. Validation of a questionnaire is the process to determine whether or not the questionnaire measures what it is designed to measure. We chose to use

a Swedish questionnaire designed to evaluate outcomes after OASI (lately also for second-degree tears)[104]. The term “partly validated” refers to the fact that several of the scoring parts are validated, for instance the questions about incontinence and prolapse, which are the same as in validated scoring systems[190-192].

Furthermore, we chose to omit some of the questions from the original questionnaire regarding use of pessary and bowel habits, so we cannot claim complete validation. The fact that we chose to omit questions on bowel habits was a mistake, since such bothers may influence the interpretation of outcomes. Our reason for shortening the questionnaire was to gain sufficient information about the construct of interest, without losing the motivation of respondents[193]. To achieve face and content validation, the questionnaire was pilot tested on participants with different socioeconomic and educational backgrounds. The questionnaire was only available in Swedish.

Bias

An effect on the study that results in a systematic deviation of the results from reality[187].

A general problem with questionnaires is that they are prone to bias. Selection bias is a distortion in a measure of association such as a risk ratio due to a sample selection that does not accurately reflect the source population. This occurs by non-participation or loss to follow-up (see below). Selection bias occurs when the association between exposure and outcome is different for those who complete a study compared with those who are in the source population. Individuals who volunteer for a study may possess different characteristics than the average individual in the source population. For example, those experiencing symptoms of pelvic floor dysfunction may be more motivated to respond. In Study I, however, the characteristics of non-responders and responders did not differ other than age (29 versus 30 years), which can be assumed to increase the validity and enable generalisability of the findings. The exposure (perineal tears) rate was similar in the responder and non-responder groups. However, the instrumental delivery rate was markedly higher in the responder group, which could affect outcomes. It is impossible to obtain data of non-responders or persons lost to follow-up in studies with self-reported outcomes.

Missing values of possible confounding factors can also introduce selection bias. In Study I (n =13) and Study IV (n=4), the BMI of a few participants were missing. There were no missing values for age or birthweight.

Recall bias occurs when participants in a research study or clinical trial do not accurately remember a past event or experience or leave out details when reporting about them. It is thus possible that women with more symptoms recall more complications. As the main outcomes where focused symptoms suffered by the participants at the point when they were answering the questionnaire, recall bias should be low in this cohort.

Sources of bias in studies evaluating diagnostic test accuracy (Study III) are also numerous[194]. Diagnostic review bias occurs when the results of the index test are known to reviewers who interpret the reference standard. In most cases, 3D-EAUS was performed by a midwife other than the one assessing the perineal tear. Midwifes were trained in performing the endosonography but not in interpreting images. The 3D-EAUS volume was immediately stored, no interpretation of the volume was performed at the time of the delivery. Archived 3D-EAUS volume datasets were analysed by a colorectal surgeon blinded to all clinical, demographic, and delivery data, to avoid diagnostic review bias. One could argue that there is a bias risk due to an inappropriate reference standard since we chose the clinical diagnosis as reference. This could have underestimated results of diagnostic accuracy if there were "genuinely missed" OASIs. We argued that if 3D-EAUS is to be used to diagnose OASI requiring surgical exploration and primary repair, it should at least be good at confirming an already clinically diagnosed OASI, to avoid an unnecessary surgical procedure.

Loss to follow-up
The follow-up rate is calculated on the denominator, meaning the number of participants receiving a treatment or attaining a procedure. In Study I, the response rate was 66%, which is reasonable, but the total loss to follow-up was over 40% which poses a serious threat to validity[195]. If participants are lost to follow-up, baseline differences between the groups compared in the analysis may compromise the validity of trial results.

One of the reasons for loss to follow up was language difficulties. The study period coincided with a period of major immigration caused by the war in Syria. Many of these women were included in the first part (Study III) as it was possible to inform them about the study using an interpreter during visits, but invitations to the second endosonography in Study IV, the interviews in Study II, and the questionnaire in Study I and IV were in Swedish, as well as the questionnaire itself. We identified 54 cases where language was the reason for drop-out, but it is possible that immigration/language was partly the reason for withdrawal in 51 cases, change of residence (n=22), missing the second endosonography visit (n=250), and incomplete questionnaires in 12 cases (see Fig 11). It is unfortunate for both the interview study and the questionnaire study, that women with foreign background are seemingly under-represented as their experiences are also important. Women from abroad represent a significant proportion of pregnant women needing care, and their input would have been valuable, but performing interviews and translating the questionnaire/webpage was beyond the resources at hand. Besides, a translated questionnaire must be revalidated. Future efforts are needed to ensure that this kind of research includes women with a foreign background, as it may entail elevated risk for outcomes, for example regarding female mutilation[196].

Confounders

A confounder is a factor that is associated with the exposure studied while at the same time being a risk factor for the outcome dependent measured. Confounding can result in a risk estimate that is too low or an estimate that is too high, depending on whether the effects of the confounder are in the opposite or the same direction on exposure and outcome[184, 187].

Randomisation is considered the best way to avoid confounding as it increases the probability of confounders being equally distributed in both groups. However, and as previously mentioned, RCTs are difficult to perform in the setting of this project[184].BMI, birthweight and age are important risk factors for both pelvic floor trauma and pelvic floor disorders[197], which is why we chose to adjust for these factors in the logistic regression of Studies I and IV. Another possible confounding factor to consider is smoking, but there were so few participants that smoked during pregnancy, two in Study I, that we decided not to adjust for this.

Missing data

Missing data from questionnaire answers was generally very low, in questions about pelvic floor symptomatology there were ≤2. For questions regarding sexual functioning, 4 women chose not to answer, and numbers of missing data was between 2 and 4. Because numbers of missing data were well below 5%, and assuming that participants with missing data could be thought of as a random sample of those that were intended to be observed, we decided that we could exclude those participants and perform a complete-case analysis[198, 199]. No sensitivity analysis or imputation was performed. In the last section of the questionnaire regarding effect of tear on quality-of-life and complications, missing data were 25 in the no injury/first degree group and 10 in the second-degree group. We believed that this was the result of answering “no” to the preceding question 9a “Did you suffer a tear that required suturing when you gave birth?”, which led to skipping of the questions regarding general life quality and complications. This indicates that some women are unaware of the kind of tear they suffered, as at least second-degree tears are routinely sutured. It is a weakness in the construction of the questionnaire that was only detected afterwards.

External validity

External validity refers to the ability to generalise the results to other populations or settings[187].

By inviting all nulliparas giving birth during the study period, we strived to obtain an unselected population. One can assume that if sample was representative, results from our region should be generalisable to at least Swedish or even European settings. However, one must bear in mind that the source population of Jämtland -Härjedalen may differ in some respects from the rest of the Swedish population. In table 9, age, BMI and basic obstetric outcomes are presented for our region and for Sweden as a whole during the study period 2016-2017.

	National 2016	**Jämtland-Härjedalen 2016**	**National 2017**	**Jämtland Härjedalen 2017**
Age (mean)	28.6	27.8	28.7	28.0
BMI (mean)	24.4	24.8	24.7	24.7
Fetal weight (mean, g)	3410	3430	3412	3400
Spontaneous start (%)	74	74	72	68
Induction (%)	19	17	21	24
Instrumental delivery (%)	12.9	15.5	11.8	7.6
Caesarean section (%)	19.3	19.5	18.6	17.7
Epidural (%)	53	57	56	70
OASI (%)	5.1	6.8	5.1	4.1

Table 9. Descriptive overview of obstetrical characteristics of the population of primiparas nationwide and in the county of Jämtland-Härjedalen during the study period of 2016-2017.

What stands out here is the high OASI rate amongst primiparas in the county in 2016. It is possible that a focus on perineal tears caused by the study increased awareness and of diagnosis of tears (observer bias). The higher rate during 2016 and the decrease during 2017 are interpreted as normal variation.

Qualitative methodology

Qualitative research has the capacity to explain how things work in specific contexts. It is not about describing how many in a setting that share a particular problem, it is about exploring and describing a wide array of dimensions to that context. Conclusions develop through the process of data collection, analysis and structuring of the results, in an inductive and interactive process where the researcher is a part of the study process. We aimed to ensure the trustworthiness in Study II by applying the prime components of qualitative research *i.e.,* transferability, credibility, dependability, confirmability and authenticity[200, 201].

To enhance transferability in Study II, the study size was preset to the number of interviews (10-15), with purposive sampling method (participants representing varying backgrounds). At interview 9, saturation in data was obtained, but the data collection continued with 11 interviews in total. The degree of impact of OASI varied considerably between the women participating in the study, which implies richness of data, a requisite for credibility and transferability. Attaining dependability is based on the analysis process described above, and by supporting findings with appropriate quotes. Representative citations also help the reader to judge the degree of interpretation and level of abstraction, which adds to the credibility and authenticity of the findings.

The core theme in study II was “From hell to healed”. Shortly after we completed analysis of our material, but before publishing, a local newspaper published an article about a mother’s experiences after OASI (Fig 22, Nathalie did not participate in the study) and the title, which was a citation, was very similar to the theme of this study, which indicates transferability to another settings and authenticity. The findings of Study II are in line with the current picture that normalisation is still applied in cases with sequelae after pelvic floor trauma, but it also provides hope of healing properties.


”Du har fått en liten bristning” fick Nathalie Vedin höra efter den traumatiska förlossningen då hon födde sin första dotter Silje. Den lilla bristningen visade sig vara av grad 4 och krävde operation för att åtgärdas.

Nathalie är en av många kvinnor som berättar om sina förlossningsskador under #alltserfintut.

”Jag kan berätta om en hemsk upplevelse med ett bra slut”

Nathalie vill att fler ska våga prata om sina förlossningsskador

FOTO: ANNA-KARIN PERNEVILL

Fig 22. 2020, Östersundsposten (Local newspaper). Nathalie wants women to dare to talk about perineal tears. The title is translated as follows:” I can tell you about a terrible experience with a good ending”.

Awareness of the author’s pre-understanding is another challenge to dependability, since it can influence how question are asked and results are interpreted. As all three authors work in obstetrics & gynaecology, and two of them have special interest in the pelvic floor, there was a certain level of pre-understanding on the issue, or “biased selves”. This kind of bias works in both directions, as it can facilitate the comprehension as well as negatively affect the analysis by preconception that unconsciously affects interpretations. To address this, we used investigator triangulation (involvement of two or more researchers in the analysis to provide multiple observations and conclusions). This type of triangulation can bring both confirmation of findings and different perspectives, adding breadth to the phenomenon of interest.

A key finding from Study II was the discovery of an inherent and possibly unconscious process of healing both physically and mentally, that these women possessed. A curious, and unexpected finding (under the subcategory “Facing childbirth again”) was how some of these women dealt with a new pregnancy, and the possibilities and challenges that entailed. The general quality of the follow-up after OASI often came in for criticism (in the subcategories “burdened by normality” and “requesting answers”), which has led to a reformation process in our unit. Highly favourable modes of reception were when healthcare providers focused on the function rather the anatomical appearance of the pelvic floor.

In this study, we chose to apply Qualitative Content Analysis (QCA). Although other qualitative methods could have been used, QCA proved to be a satisfactory way of approaching the subject area of this project, given its particular emphasis on interpreting and understanding the variety of experiences. The viability of semi-structured interviews was established at the pilot stage. The main study also showed that the interview process was not merely fruitful from a research perspective but was also a meaningful exercise for the participants themselves. Many said they had both enjoyed and gained something from taking part in the study.

The fact that women with perineal tears suffer from pain, difficulties in daily life and their relationship, and experience a lack of support from healthcare providers has been shown in other studies, adding confirmability to our findings[73-75].

The possibility of bias existed since some of the participants also had been patients of mine. However, I was transparent about this, and I believe they were very honest in what they shared since their transcripts did not read any more positively than the others. This research study has also provided some insights which have helped me reconsider my own professional values and future clinical practice. I am now more aware of how personal treatment impacts the healing process after pelvic floor trauma. I now question how my colleagues and I are regarded as healthcare providers, how we pay more attention to how our patients experience pelvic floor issues, how much more we understand their need for help and the negative role that factors such as normalisation affect patients' experiences after a perineal tear.

When exploring the women's experiences of relationships, the views of the partner or relative were not considered. This could be regarded as a weakness of our study. To gain a broader understand of the experiences of a woman affected by OASI, interviews with the partner or a close relative could add to the overall picture and be used to mirror those of the woman affected. We suggest that this be included in further research.

Conclusions

I

Pelvic floor dysfunction is common one year after childbirth, even in women with moderate injury. Women with OASIS had a significantly higher risks for prolapse, urge urinary incontinence, pain, and dyspareunia impacting their daily life. Sexual dysfunction was experienced by a large proportion of women one year after giving birth.

II

This study investigated women's experience of daily life, relationships, and sexuality after OASI at childbirth. We found that OASI caused much suffering from both physical symptoms such as pain and incontinence, and emotionally. In summary these stories were condensed into the encompassing theme "From hell to healed", embracing individual experience and in general.

III

Acquisition of optimal three-dimensional endoanal ultrasound images in the immediate postpartum period presents significant challenges that may affect image quality and interpretation. When 3D-EAUS is performed in the screening setting, it adds no extra diagnostic power to simple clinical examination in the diagnosis of OASI.

VI

The findings of this study suggest that endosonographically diagnosed anal sphincter defect after delivery is associated with perineal pain and dyspareunia. A perineal height <2 cm, measured by bidigital palpation immediately after delivery, was significantly associated with anal sphincter defects diagnosed by endosonography.

Clinical relevance

It remains to be established if our results can be extrapolated to measurable benefits for women affected by pelvic floor trauma and pelvic floor dysfunction.

Perineal laceration and PFD are research areas that have been expansively explored over the last three decades although many questions remain unanswered. Randomised controlled studies are often unsuitable in the context of childbirth, and certainly regarding pelvic floor trauma. In recent years, research into childbirth related sequalae has gained public attention mainly driven by alarm calls from patients. Recently LAM injuries and the relationship between perineal/vaginal tears, levator avulsion, composite trauma and PFD have gained much attention.

Our findings suggest that pelvic floor dysfunction is common one year after childbirth. A severe tear is a major risk factor for symptoms of pelvic floor dysfunction and experiencing problems that affect daily life. Dyspareunia after childbirth was very common in these studies and perineal trauma is recognised as a risk factor for postpartum sexual health issues[202]. Results from this thesis regarding sexual function indicates the importance of addressing women's sexual health after childbirth, both in the clinical context as well as in future research.

A clinically relevant factor that it is hard to quantify, or measure is personal treatment, or "clinical conduct", and if or how this affects the healing process. A description of how women affected by a perineal tear experience their encounter with healthcare service provides important knowledge for healthcare workers, and maybe some insight into one's own areas for improvement.

When it comes to ultrasonography and diagnosis of perineal tears immediately after delivery, the final say has yet to come. Our results suggest that it is not suitable as a general tool, but it may be feasible in the hands of specialised examiners[123]. In the follow-up of pelvic floor trauma, and for pelvic floor dysfunction, the use of different modalities of ultrasonography is well established[203].

Future perspectives

Whether it is women's health empowerment or not, things are happening in this area of research. Many colleagues in my profession are exploring the short- and long-term sequelae of birth related pelvic floor trauma on the pelvic floor and hopefully we will see new guidelines emerge on how to manage undetected, badly sutured, or dehiscent perineal tears in the first months after delivery. Expectations are high for a care bundle that covers not only OASI but also moderate injuries and newly developed PFD after childbirth.

One prominent risk factor in terms childbirth injury is foetal macrosomia. The weight of the baby is one of the first things we inform the parents of, and that they share with friend and family when posting news about their new child. Macrosomia in the context of diabetes has been evaluated in terms of outcomes but the evidence regarding management of the large foetus generally has low level of evidence. Induction of labour before the baby gets too big has not been fully evaluated. Induction has its own morbidity and is often associated with longer hospital stay. With the new guidelines of induction of labour prior to post term (41+0-6) emerging in Sweden, a possible beneficial outcome will be a decrease in pelvic floor trauma.

Our ambition to be better at detecting perineal tears remains. Even though 3D-EAUS did not show promising results in the "screening setting" this does not rule it out as a possible tool in our quest for better diagnostics. In more experienced hands, with someone who can interpret the results immediately, at least a negative result should be adequate enough to rule out OASI since the negative predictive value was almost 97%. As mentioned previously, there are other ultrasound modalities that are being used more and more in the obstetric setting. In the end, however, no matter how it is diagnosed, the most important goal is to eliminate the risk of a woman being discharged from the maternity ward with an undetected and untreated tear.

Research into the use of stem cells to treat various diseases has been in vogue since the end of the last century. Stem cell therapy promotes the repair response of diseased, dysfunctional, or injured tissue using stem cell transplantation. Last year promising results were published from the STEFFI study where a new approach for therapy of AI after obstetric trauma was tested using injection of autologous skeletal muscle-derived cells into the EAS. In a randomised controlled trial, patients that received high dose cell-therapy had a significant improvement in incontinence frequency[204]. These findings are still subject to confirmatory phase 3 clinical trials, but there is hope that this will emerge as a valuable treatment for anal incontinence in the future.

Another rapidly advancing field in healthcare is artificial intelligence. There are multiple applications for artificial intelligence in medical imaging, but many steps and challenges face its clinical implementation. If, one day, artificial intelligence can live up to expectations, it will surely be beneficial to clinicians working with pelvic floor imaging. If it could be used for basic separation, such as "defect" or "no defect", the human eye could then take over for a more detailed interpretation, thus relieving the load of examining many unaffected women.

There is little need to point out that research into the sexuality of women has been neglected for decades, especially amongst new mothers and women approaching that are at the end of their fertile period in life. There are still many aspects to explore, for example sexuality in women after childbearing age before the menopause.

In clinical research it is easy to miss out on the "soft values" or to validate quantitative research above qualitative, when in fact qualitative research can add insight into the details and a human voice to the results. From my clinical experience in meeting women affected by pelvic floor trauma, I have come to realise that an important tool to the healing process is to be an open-minded, supportive, and honest care provider. Thankfully, I can also see likewise developments in the research community[135]. It would be interesting to further explore and research the healing process and come to understand which actions we healthcare providers can take to encourage healing.

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“The final version of the thesis should be written, with hindsight, knowing where one has been.”

Pat Cryer

Appendices

Appendix I. Questionnaire in Swedish (Study I and IV)

Appendix II. Questionnaire in English (Study I and IV)

Appendix III. Interview guide in Swedish (Study II)

Appendix I. Questionnaire in Swedish (Studies I and IV)

Enkäten handlar om hur du upplever att ditt underliv och bäckenbotten fungerar när nu ungefär ett år sedan förlossningen passerat. Den består av 15 korta frågor och tar ungefär 5 minuter att besvara. Ditt deltagande är viktigt för att förbättra kunskapen om hur kroppen fungerar efter en förlossning. Som ett litet tack för din medverkan skänker vi en summa till UNICEF som arbetar för bättre mödrar och barnhälsovård i världen. Du kan gå fram och tillbaka i enkäten fram till dess att du klickat ”slutför” på sista sidan.
Tack för din medverkan!

1. Datum när enkäten ifylls:

2. Är du gravid igen?

☐ Ja

☐ Nej

Fråga om framfall

3. Har du en känsla av att något buktar ut ur slidan?

☐ Aldrig ☐ Nästan aldrig ☐ 1–3 ggr per månad ☐ 1–3 ggr per vecka ☐ Dagligen

Frågor om urinläckage

4a Händer det att du läcker urin i samband med fysisk aktivitet, när du skrattar, hostar eller nyser?

☐ Aldrig

☐ Nästan aldrig

☐ Ja, 1-3 gånger i månaden

☐ Ja, 1-3 gånger i veckan

☐ Ja, dagligen
☐ Mer än 1 gång per dag

4b. Upplever du någonsin en hastigt påkommande, stark känsla av att behöva kissa och läcker urin innan du hinner fram till toaletten?

- ☐ Aldrig
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan
- ☐ Ja, dagligen
- ☐ Mer än 1 gång per dag

4c. Påverkar dina läckage- eller träningsproblem din livsstil?

- ☐ Nej
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan
- ☐ Ja, dagligen

Frågor om avföringsvanor

5a Händer det att du har svårt att tömma tarmen?

☐ Aldrig ☐ Nästan aldrig ☐ 1–3 ggr per månad ☐ 1–3 ggr per vecka ☐ Dagligen

5b Händer det att du behöver hålla emot bakre slidväggen för att tömma tarmen?

☐ Aldrig ☐ Nästan aldrig ☐ 1–3 ggr per månad ☐ 1–3 ggr per vecka ☐ Dagligen

Frågor om att kunna hålla avföring:

6a. Har du svårt att hålla avföring eller gaser?

- ☐ Nej
- ☐ Ja

Om du har svarat nej på ovanstående fråga, **hoppa till fråga 7a**

6b. Händer det att du släpper dig även när det är olämpligt?

- ☐ Nej
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan
- ☐ Ja, dagligen

6c. Har du läckage av lös avföring?

- ☐ Nej
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan
- ☐ Ja, dagligen

6d. Har du läckage av fast avföring?

- ☐ Nej
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan
- ☐ Ja, dagligen

6e. Använder du skydd pga. avföringsläckage?

- ☐ Nej
- ☐ Nästan aldrig
- ☐ Ja, 1-3 gånger i månaden
- ☐ Ja, 1-3 gånger i veckan

☐ Ja, dagligen

6f. Påverkar dina läckageproblem din livsstil?

☐ Nej

☐ Nästan aldrig

☐ Ja, 1-3 gånger i månaden

☐ Ja, 1-3 gånger i veckan

☐ Ja, dagligen

Frågor om underlivet

7a. Har du haft samlag de senaste 3 månaderna?

☐ Ja ☐ Nej ☐ Avstår från att svara

7b. Om ja på fråga 7a, känner du smärta i underlivet vid samlag?

☐ Nej, ingen smärta

☐ Ja, lite smärta

☐ Ja, måttlig smärta

☐ Ja, stark smärta

☐ Ja, olidlig smärta

7c. Om ja på fråga 7a, upplever du

slidöppningen alltför liten/trång?	☐ Ja	☐ Nej
slidöppningen alltför stor/öppen?	☐ Ja	☐ Nej
smärta i slidöppningen?	☐ Ja	☐ Nej
andra besvär från slidöppningen?	☐ Ja	☐ Nej

Om ja, vilken typ av besvär?

Frågor om smärta i underlivet som ej är relaterad till samlivet

8. Har du haft smärta i underlivet de senaste 3 månaderna?

☐ Nej, ingen smärta

☐ Ja, Smärta som lätt har kunnat ignoreras

☐ Ja, Smärta som inte har kunnat ignoreras, men som inte påverkat dina vardagsaktiviteter

☐ Ja, Smärta som inte har kunnat ignoreras, och som påverkat koncentrationen på sysslor/aktiviteter

☐ Ja, Smärta som har förhindrat de flesta aktiviteter

☐ Ja, Smärta som har krävt vila/sängläge

☐ Ja, Smärta som har varit så svår att du var tvungen att söka omedelbar hjälp

9a. Fick du någon bristning som behövdes sys i samband med din förlossning?

☐ Nej, **hoppa till fråga 14**

☐ Ja

9b Om du fick en bristning var den…(kryssa i de alternativ som stämmer)

☐ I vulva, tex blygdläppar eller vid slidöppningen

☐ Inne i slidan

☐ I mellangården, mellan slidöppningen och ändtarmsöppningen

☐ I ändtarmens slutarmuskel

☐ Vet ej

9c. Var och av vem syddes din bristning i underlivet?

☐ Av barnmorska på rummet där du födde barn

☐ Av läkare på rummet där du födde barn

☐ På operationsavdelningen

☐ Vet ej

10a Har du under perioden två månader efter förlossningen och fram till nu haft besvär eller komplikationer till följd av förlossningsbristningen?

☐ Nej, **hoppa till fråga 13**

☐ Ja, lindrig

☐ Ja, svår

10b. Har du behövt uppsöka sjukvården under tiden efter förlossningen pga. dessa besvär/komplikationer från bristningen?

☐ Nej

☐ Ja.

Beskriv dina besvär/komplikationer genom att <u>välja ett eller flera av följande alternativ</u>.

11a. Vilket/vilka organ drabbades?

☐ Operationsärr

☐ Nerv/Känsel

☐ Urinblåsan

☐ Urinrör

☐ Slida

☐ Tarm

☐ Annat/annan (Beskriv vid fråga 11b).

11b Beskriv de besvär/komplikationer du haft:

11c Har du fortfarande besvär som beror på förlossningsbristningen?

☐ Nej
☐ Ja Om Ja, beskriv:

12. Vad tycker du om resultatet av lagningen av din förlossningsbristning?

☐ Mycket nöjd
☐ Nöjd
☐ Varken nöjd eller missnöjd
☐ Missnöjd
☐ Mycket missnöjd

13. Påverkar besvär från din bristning ditt vardagsliv idag ungefär ett år efter förlossningen?

☐ Nej

☐ Ja, Besvär som lätt kan ignoreras

☐ Ja, Besvär som inte kan ignoreras, men som inte påverkar dina vardagsaktiviteter

☐ Ja, Besvär som inte kan ignoreras, och som påverkar förmåga till sysslor/aktiviteter

☐ Ja, Besvär förhindrar de flesta aktiviteter

14 Har du fått behandling eller träningsråd av sjukgymnast/PT eller uroterapeut för ditt underliv sedan du skrevs ut från BB?

☐ Nej

☐ Ja

15. Har du några ytterligare kommentarer?

Appendix II. Questionnaire in English (Studies I and IV)

The survey is about how you feel that your pelvic floor is functioning now that it has been approximately one year since you gave birth. It consists of 15 short questions and takes approximately five minutes to answer. Your participation is important in helping us to better understand how the body works after childbirth. As a small thank you, we will donate a sum to UNICEF, an international organization working for better maternity and child health services throughout the world. You can navigate back and forward through the survey up until you click 'finish' on the last page.

1. Date on which you are completing the survey:

2. Are you pregnant again?

☐ Yes (excluded from further analysis)

☐ No

Question about prolapse

3. Do you ever get the sensation that something is protruding down out of your vagina?

   ☐ Never ☐ Almost never ☐ 1–3 times per month ☐ 1–3 times per week ☐ Daily

Questions about urinary incontinence

4a Does urine ever leak out when you take part in physical activities or when you laugh, sneeze or cough?

   ☐ Never

   ☐ Almost never

   ☐ Yes, 1–3 times per month

   ☐Yes, 1–3 times per week

   ☐ Yes, daily

   ☐ More than once per day

4b. Do you ever experience a very sudden and strong urge to urinate and begin leaking urine before you make it to the bathroom?

- ☐ Never
- ☐ Almost never
- ☐ Yes, 1–3 times per month
- ☐Yes, 1–3 times per week
- ☐ Yes, daily
- ☐ More than once per day

4c. Does your incontinence affect your lifestyle?

- ☐ No
- ☐ Almost never
- ☐ Yes, 1–3 times per month
- ☐Yes, 1–3 times per week
- ☐ Yes, daily

Questions about your bowel movements

5a Do you ever have difficulty evacuating your bowels?

☐ Never ☐ Almost never ☐ 1–3 times per month ☐ 1–3 times per week ☐ Daily

5b Do you ever find that you need to support your posterior vaginal wall in order to evacuate your bowels?

☐ Never ☐ Almost never ☐ 1–3 times per month ☐ 1–3 times per week ☐ Daily

Questions about controlling bowels:

6a. Do you find it difficult to hold in faeces or gas?

☐ No

☐ Yes

If you answered no to the above question, **proceed directly to question 7a**

6b. Do you ever find that you release gas also at a time which is inconvenient?

☐ No

☐ Almost never

☐ Yes, 1–3 times per month

☐Yes, 1–3 times per week

☐ Yes, daily

6c. Do you ever leak loose faeces?

☐ No

☐ Almost never

☐ Yes, 1–3 times per month

☐Yes, 1–3 times per week

☐ Yes, daily

6d. Do you ever leak firm faeces?

☐ No

☐ Almost never

☐ Yes, 1–3 times per month

☐Yes, 1–3 times per week

☐ Yes, daily

6e. Do you use any kind of protection as a result of your leakage?

☐ No

☐ Almost never

☐ Yes, 1–3 times per month

☐Yes, 1–3 times per week

☐ Yes, daily

6f. Does your incontinence problem affect your lifestyle?

☐ No

☐ Almost never

☐ Yes, 1–3 times per month

☐Yes, 1–3 times per week

☐ Yes, daily

Questions about sexuality and perineal pain

7a. Have you had sexual intercourse within the last three months?

☐ Yes ☐ No ☐ Would rather not say

7b. If you answered yes to question 7a, do you feel pain in your genital areas during intercourse?

☐ No, no pain

☐ Yes, a little pain

☐ Yes, moderate pain

☐ Yes, strong pain

☐ Yes, insufferable pain

7c. If you answered yes to question 7a, do you find that

your vaginal opening is too tight/narrow?	☐ Yes	☐ No
your vaginal opening is too wide/open?	☐ Yes	☐ No
you experience pain in your vaginal opening?	☐ Yes	☐ No
you experience other kinds of discomfort or problems in your vaginal opening?	☐ Yes	☐ No

If yes, describe what kind of trouble you have?

……………………………………………………………

Questions about pain in the genital area that are not related to intercourse and intimacy

8 Have you experienced pain in your genital area over the last three months?

☐ No, no pain

☐ Yes, pain that has been easily possible to ignore

☐ Yes, pain that has not been possible to ignore but which has not affected your day-to-day activities

☐ Yes, pain that has not been possible to ignore and which has affected your concentration in tasks/activities

☐ Yes, pain that has prevented you from performing most activities

☐ Yes, pain that has required rest / bed rest

☐ Yes, pain that has been so severe you have been forced to seek urgent help

9a. Did you suffer a tear that required suturing when you gave birth?

☐ No, **proceed to question 14**

☐ Yes

9b If you suffered a tear was it ... (tick all options which apply)

☐ In the vulva; e.g. the labia or at the vaginal opening

☐ Inside the vagina

☐ In the perineum, between the vaginal opening and the anus

☐In the sphincter muscles

☐ Don't know

9c. Where and who stitched up the tear in your genital area?

☐ The midwife in the room where you gave birth

☐ The doctor in the room where you gave birth

☐ In the operating theatre

☐ Don't know

10a Have you experienced any issues or complications relating to your tear within the period running from two months after childbirth up until the present day?

☐ No, **proceed to question 13**

☐ Yes, mild

☐ Yes, severe

10b. Have you had to seek medical care subsequent to giving birth as a result of issues or complications relating to your tear?

☐ No

☐ Yes.

Describe the issues/complications you have experienced <u>by selecting one or more of the following options.</u>

11a. Which organ(s) were affected?

☐ Surgical scars

☐ Nervous system

☐ Bladder

☐ Urethra

☐ Vagina

☐ Bowels

☐ Other (Describe in question 11b).

11b Describe what issues/complications you have experienced:

11c Do you still experience any issues as a result of your postpartum tear?

- ☐ No
- ☐ Yes If yes, please explain:

12. How do you feel about the repair of your postpartum tear?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Neither satisfied nor dissatisfied
- ☐ Dissatisfied
- ☐ Very dissatisfied

13. Do you still experience any issues with your tear that affect your day-to-day life/ quality of life now that about a year has passed since you gave birth?

- ☐ No
- ☐ Yes, issues that can easily be ignored
- ☐ Yes, issues that cannot be ignored but which do not affect your day-to-day activities
- ☐Yes, issues that cannot be ignored and which affect your ability to undertake tasks/activities
- ☐ Yes, issues which prevent most activities

14 Have you received any treatment or training advice from a physiotherapist/PT or urotherapist for your pelvic floor since you were discharged from the birthing centre?

- ☐ No
- ☐ Yes

15. Have you got any further comments?

Appendix III. Interview guide in Swedish (Study II)

Inledning prata fritt om förlossningsupplevelse.Stödjande frågor vid behov:

Förlossningsskadan

- Berätta om din upplevelse av förlossningsskadan och om/hur den påverkat/påverkar ditt vardagliga liv?
- Utmaningar?
- Stöd från vården?
- Tabun?
- När upplevde du att du ”var dig själv igen” fysiskt/psykiskt efter skadan?

Relationer

- Om relationen påverkats av din förlossningsskada, beskriv på vilket sätt?
- Om det funnits utmaningar i relationen, hur hanterade ni det?
- Andra områden i familjelivet som påverkats av förlossningsskadan?
- Vad kunde ha underlättat?
- Betydelse av övriga relationer tex moder/syskon/kompisar

Samlivet

- Hur kan samlivet påverkas av förlossningsskadan?
- Om det funnits utmaningar i samlivet, hur hanterade ni det?
- Vad kunde ha underlättat?
- Vilka kan du dela funderingar om samlivet med?

Mötet med vårdgivare

- Hur har kontakten med vården sett ut?
- Vad har varit bra och vad har varit mindre bra?

Media

- Var har du hämtat kunskap kring detta
- Tankar kring medias sätt att presentera
- Stöd från grupper tex facebook?

Avslutning

Något mer du vill dela? Erfarenheter som du upplever att vi inte berört?