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Prevalence of anal sphincter injury in primiparous women

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KEYWORDS: 3D/4D ultrasound; anal incontinence; anal sphincter; childbirth; fecal incontinence; obstetric anal sphincter injuries; transperineal ultrasound

ABSTRACT

Objective *To determine the prevalence of obstetric anal sphincter injuries (OASIS) in a cohort of primiparous women and to evaluate their association with demographic, obstetric and ultrasound parameters.*

Methods *This was a retrospective analysis of the ultrasound volume datasets of 320 primiparous women, acquired at 5 months postpartum. Tomographic ultrasound imaging (TUI) was used to evaluate the external anal sphincter (EAS). A significant EAS defect was diagnosed if a defect of > 30° was seen in four or more of six TUI slices bracketing the EAS.*

Results *Significant EAS defects were found in 69 women (27.9% of those delivered vaginally). In nine of those a third-degree tear was diagnosed intrapartum and was sutured. In 60 women with significant defects there was no documentation of sphincter damage at birth, implying unidentified or occult defects (60/69, 87.0%). Among them, 29 had had a second-degree tear, two a first-degree tear and three an intact perineum. In 31 cases an episiotomy had been performed, with five extensions to a third-degree tear. On multivariate analysis only forceps delivery was significantly associated with OASIS.*

Conclusions *In this cohort of primiparous women we found OASIS in 27.9% of vaginally parous women, most of which had not been diagnosed in the delivery suite. There seems to be a need for better education of labor-ward staff in the recognition of OASIS. On the other hand, it is conceivable that some defects may be masked by intact tissue. The significance of such defects remains doubtful. Forceps delivery was the only identifiable risk factor.* *Copyright © 2013 ISUOG. Published by John Wiley & Sons Ltd.*

INTRODUCTION

Fecal incontinence is a condition in which there is unintended loss of rectal contents. It can have a detrimental impact on quality of life, resulting in social exclusion and loss of self-confidence[1]. The condition is probably caused by multiple pathogenic mechanisms[2,3]. Obstetric anal sphincter injuries (OASIS) are considered an important risk factor and are commonly identified among women with anal incontinence in later life[4]. The reported incidence of OASIS varies between 0.5 and 5% which, however, is probably an underestimate[5–7]. Up to 35% of primiparous women have been found to show evidence of OASIS on transanal ultrasound at 6 weeks postpartum[8]. A meta-analysis of 717 vaginal deliveries showed an incidence of anal sphincter defects in 26.9% of primiparous women on endoanal ultrasound[9]. It appears that a large proportion of OASIS may go undiagnosed, either because they have been missed or because of clinically occult trauma[10–13].

The anal sphincters are commonly evaluated with endoanal ultrasound, which is regarded as the gold standard. However, this technique is not universally available. In addition, endoanal ultrasound imaging is invasive, involving the insertion of an ultrasound probe into the anal canal, which distorts the anatomy and precludes dynamic evaluation of the anal sphincter and mucosa on sphincter contraction, which seems to enhance the definition of muscular defects[14]. This precludes routine imaging after childbirth and has hampered translation into clinical practice.

Exoanal or transperineal ultrasound imaging, on the other hand, does not have these disadvantages and is increasingly used to evaluate the anal sphincters[15,16]. A recent study comparing three-dimensional (3D) transperineal ultrasound and two-dimensional endoanal ultrasound for the detection of anal sphincter defects showed good agreement between the two techniques[17]. Additionally, transperineal ultrasound imaging has the advantage of allowing assessment of the levator ani, which has been shown to be important in the etiology of pelvic organ prolapse and prolapse recurrence[18–21]. The technique also permits quantification of pelvic organ descent, which cannot be performed with endoanal ultrasound

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imaging[22]. The role of levator trauma in anal incontinence is controversial[2,23–25].

The aim of this study was to determine the prevalence of OASIS in a cohort of primiparous women examined before and after childbirth using transperineal four-dimensional (4D) ultrasound, and to evaluate the association between demographic, obstetric and ultrasound parameters and external anal sphincter (EAS) trauma.

METHODS

This was a retrospective analysis of the ultrasound volume datasets of 446 pregnant nulliparous women recruited at the antenatal clinics of two tertiary hospitals between July 2007 and September 2011 as part of an ongoing randomized controlled trial (RCT) testing the use of a vaginal inflatable device to prevent perineal trauma. Patients were seen between 35 and 37 weeks' gestation and all were invited for follow-up assessment at 3–6 months postpartum. All patients had undergone a standardized questionnaire, clinical examination and a translabial 4D ultrasound examination using a GE Voluson 730 Expert system with 8–4-MHz curved array volume transducer (GE Kretz Ultrasound, Zipf, Austria), as described previously[26]. The operator undertaking follow-up assessments was blinded against all antenatal findings and delivery data. At least one ultrasound volume data set was obtained on pelvic floor muscle contraction, ensuring that the entire anal canal was included in the volume for assessment of the external anal sphincter. Volume datasets were analyzed at a later time by post-processing on a desktop personal computer using the proprietary software GE Kretz 4D View version 10.0 (GE Medical Ultrasound Kretz GmbH, Zipf, Austria) by an operator blinded to all clinical data. Multislice or tomographic ultrasound imaging (TUI) was used to evaluate the EAS. On TUI, a set of eight slices is obtained. We encompass the entire EAS by placing one slice cranial (at the level of the puborectalis) to the EAS and another caudal to the internal anal sphincter (IAS) at the level of the subcutaneous part of the EAS, with a variable distance between each slice depending on the length of the EAS, leaving six slices to delineate the entire muscle (Figure 1). A 'significant' defect is diagnosed if four out of these six slices show a defect in $> 30^\circ$ of the circumference of the EAS (Figure 2), equivalent to the definition of sphincter defects on endoanal ultrasound by Roos *et al.*[27]. A test–retest series was performed by R.A.G.R. and K.L.S. to determine interobserver agreement in quantifying EAS defects. TUI was also used to determine the integrity of the levator ani muscle as previously described, using volumes acquired on pelvic floor muscle contraction[28].

Delivery and post-delivery data were collected from the hospital database and participants' records. Potential demographic and obstetric predictors of sphincter injury were analyzed, including age, body mass index (BMI), ethnicity, delivery mode, birth weight, length of second stage of labor, epidural analgesia, syntocinon use, episiotomy and major perineal trauma. We also studied the association between levator avulsion and significant EAS defects. The parent RCT was approved by the Sydney West Area Health Service Human Research Ethics Committee (SWAHS HREC 07-022).

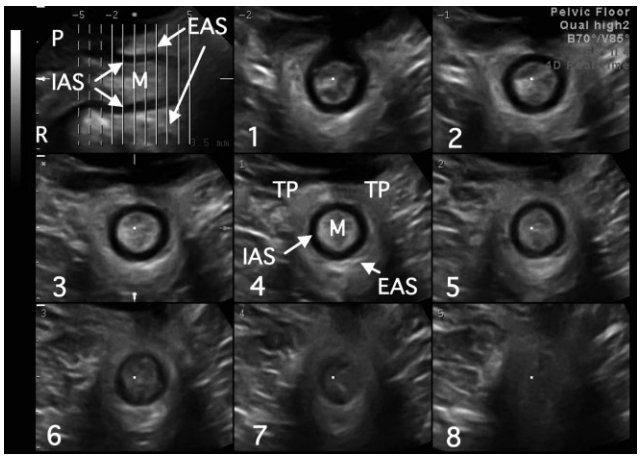

Figure 1 Normal appearance of anal sphincter complex on multislice or tomographic ultrasound imaging. A set of eight slices is obtained to encompass the entire external anal sphincter (EAS) by placing one slice cranial to the EAS (at level of puborectalis, Slice 1) and another caudal to the internal anal sphincter (IAS) (at level of subcutaneous part of EAS, Slice 8), leaving six slices to delineate the entire muscle (Slices 2–7). Interslice interval is varied depending on EAS dimensions. M, anal mucosa; P, perineal body; R, rectum; TP, transverse perineal muscle.

Statistical analysis

Statistical analysis was performed using Minitab V13 (Minitab, State College, PA, USA) and SAS V9.2 (Cary CR: SAS Institute Inc., Cary, NC, USA) for PC. Cohen's kappa was used to determine interobserver agreement, and normality was checked using the Kolmogorov–Smirnov method. The *t*-test was used for continuous normally distributed data and the Mann–Whitney *U*-test for continuous non-normally distributed data. The Chi-square test was used for categorical variables. Multivariable logistic regression was performed to control for potential confounders; a backward elimination strategy was applied. ANOVA testing was used to study the association between delivery mode and significant EAS defects, and $P < 0.05$ was considered to be statistically significant. We also tested whether associations were influenced by group allocation in the parent study.

We did not perform power calculations specific to the research question addressed in this article, as the study was a sub-analysis of the abovementioned parent project.

RESULTS

A test–retest series on 47 patients showed good agreement regarding the sonographic diagnosis of significant EAS defects (affecting $> 30^\circ$ of the circumference) in single

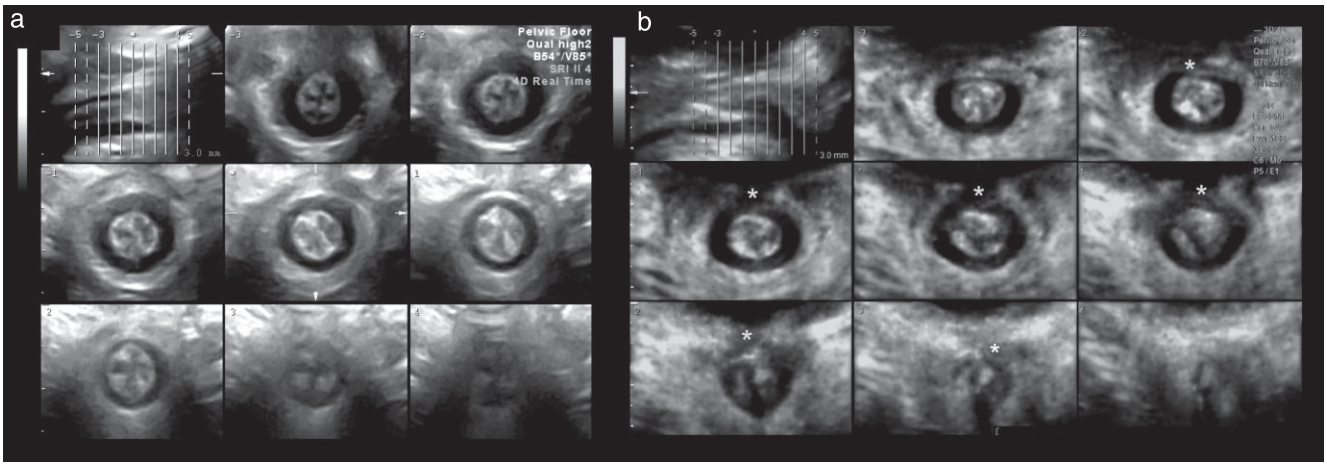

Figure 2 Anal sphincter at 36 weeks' gestation (a) and after normal vaginal delivery at term (b). The patient had a second-degree tear documented. There is a complete defect of the external anal sphincter (*) (b). Top left image in both parts shows anal canal in midsagittal plane. The rest are coronal slices through the anal canal at 3-mm interslice intervals.

slices (total observations: $n = 282$, kappa = 0.675 (95% CI, 0.57–0.78)).

Out of 446 participants seen at an average gestational age of 36 (range, 33.2–37.4) weeks, 343 (76.9%) returned for their postpartum assessment. Twenty-three women were excluded because of missing data ($n = 2$), poor image acquisition ($n = 17$), second pregnancy at the postpartum assessment ($n = 3$) or another delivery in the interim ($n = 1$), leaving 320 datasets, on which the following analysis is based. The follow-up time for those 320 women was on average 5.2 months after childbirth (median, 4.6 (interquartile range (IQR), 3.8–5.6) months).

In order to validate the method, we analyzed the antepartal volume datasets of 316 of those women, as four datasets were technically inferior. Out of 1896 single slices, we rated 30 (1.6%) as positive for an EAS defect of $> 30°$. However, none of the patients met the criterion for a 'significant defect', i.e. four or more slices being positive.

The mean maternal age was 30.8 ± 5.2 (range, 18.8–45.3) years. Mean antepartum BMI was 28.8 ± 4.9 kg/m^2. Among those for whom data were available, 253/314 (80.6%) participants were of Caucasian background and 247/309 (79.9%) were breastfeeding at follow-up. Seventy-three women (22.8%) had given birth by Cesarean section (4% elective, 14% in the first stage, 5% in the second stage) and 247 (77.2%) by vaginal delivery. This was a normal vaginal delivery in 173 (54.1%), a vacuum delivery in 52 (16.3%) and a forceps delivery in 22 (6.9%), at a mean gestational age of 39.9 ± 1.2 (range, 36–42.2) weeks. Median time of first stage of labor was 413 (IQR, 278–607) min and median time of second stage was 61 (IQR, 34–117) min. One hundred and twenty-one patients (49.0% of the vaginally parous women) had suffered perineal trauma, which was a first-degree tear in 33 (13.4%), a second-degree tear in 76 (30.8%), and a third-degree tear in 12 (4.9%). An episiotomy had been performed in 65 patients (26.3%). Mean birth weight was 3446 (range, 2222–4996) g. Syntocinon had been used in 148 (46.3% of the entire cohort), and 151 (47.2%) had an epidural for pain relief.

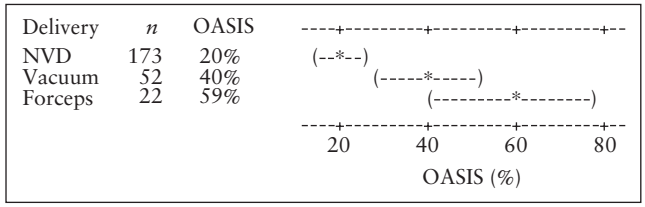

Figure 3 Association between delivery mode and significant external obstetric anal sphincter injury (OASIS) on tomographic ultrasound imaging, shown as percent OASIS with 95% CIs, in a cohort of 247 vaginally parous women. No such defects were found in women after Cesarean section. This association was highly significant ($P = 0.001$ on ANOVA). NVD, normal vaginal delivery.

At the postnatal assessment, 11 participants reported fecal incontinence (3.4%). Fifteen (4.7%) complained of symptoms of prolapse (i.e. vaginal lump/dragging sensation), 92 (28.8%) of stress incontinence, 27 (8.4%) of urge incontinence and 66 reported dyspareunia (66/306, 21.6%).

On TUI, levator avulsion was diagnosed in 44 patients (13.8%). Significant EAS defects on TUI were found in 69 patients (21.6% of the entire cohort, or 27.9% of vaginally parous women). Six women (1.9%) showed complete EAS defects, i.e. all six slices were rated as abnormal on TUI. Of those women with significant EAS defects on ultrasound, 35 (50.7%) had a normal vaginal delivery, 21 (30.4%) a forceps delivery and 13 (18.8%) a ventouse; all had been delivered vaginally. No significant defects were seen in women delivered by Cesarean section. Figure 3 demonstrates the relationship between delivery mode and occurrence of significant EAS defects.

Of 69 women with significant defects on ultrasound, nine had been diagnosed with a third-degree tear intrapartum, which was repaired. Twenty-nine were diagnosed with a second-degree tear, two with a first-degree tear, and three with an intact perineum. Thirty-one

Table 1 Association between occurrence of significant external anal sphincter (EAS) defects and demographic, obstetric and ultrasound variables in vaginally parous women ($n = 247$)

Parameter	*Significant EAS defect on univariate analysis*	P	*Significant EAS defect on multivariate analysis†*	P
Maternal age (years)	1.06 (1.00–1.12)	0.04		
Body mass index (kg/m^2)	0.97 (0.91–1.04)	0.41		
Ethnicity	1.15 (0.56–2.39)	0.69		
Gestational age (weeks)	1.03 (0.81–1.29)	0.83		
Length of 2nd stage of labor (min)	1.00 (0.99–1.01)	0.12		
Birth weight (g)	1.00 (0.99–1.00)	0.84		
Forceps delivery	5.7 (2.25–14.40)*	0.001	3.45 (1.18–10.1)	0.02
Vacuum delivery	2.67 (1.37–5.20)*	0.004	1.98 (0.91–4.34)	0.09
Syntocinon use	1.72 (0.98–3.01)	0.06		
Epidural use	2.09 (1.19–3.68)	0.01		
Episiotomy	3.46 (1.89–6.32)	< 0.001	2.03 (0.95–4.34)	0.07
Avulsion	1.83 (0.92–3.62)	0.08		

Data are given as odds ratio (95% CI). *Normal vaginal delivery used as a reference. †Backward elimination strategy was applied.

had had an episiotomy, of which five extended to a third-degree tear. In 60 women with significant sphincter defects (87.0% of this group), there was no evidence of sphincter damage in the labor ward, which implies an unidentified or occult defect. Of 12 women who had been diagnosed with a third-degree tear during labor, two had a complete defect on postpartum ultrasound (all six slices), seven had a residual defect, two had abnormalities that did not qualify as a residual defect and one was rated as completely normal on TUI. In women with significant EAS defects, levator avulsion was diagnosed in 25%, compared with 15% in those with normal sphincters ($P = 0.08$). Table 1 shows univariate and multivariate analysis of the association between significant defects and demographic, obstetric and ultrasound variables. On multivariate analysis only forceps delivery was significantly associated with OASIS.

There was only a weak trend towards fecal incontinence in those women with significant defects (4/69 *vs* 7/251, $P = 0.2$). We performed an analysis to determine whether the intervention tested in the parent study had a modifying effect on the relationships tested by us. We found no convincing evidence for this and have therefore retained those cases in the analysis.

DISCUSSION

In this cohort of primiparous women enrolled in a prospective perinatal trial, we identified significant defects of the EAS on exoanal TUI in 69 cases, representing 21.6% overall, or 27.9% of those delivered vaginally. The great majority of women with EAS damage on ultrasound (87.0%) had not been diagnosed as having EAS tears in the delivery suite. The incidence of clinically undetected OASIS was comparable with those reported in the literature using endoanal ultrasound[10].

In a prospective trial in which women after delivery were re-examined by a trained research fellow before suturing the perineum, the detection rate of OASIS increased significantly from 11 to 24.5%. Only three sphincter defects were not detected clinically in that study[11]. The authors commented that most of the so-called 'occult' injuries probably represent missed diagnoses. They felt that genuine occult sphincter injuries are uncommon, implying a need for better and more focused training of staff in the delivery suite to recognize OASIS. Our results support this contention.

Disruption of the anal sphincter during childbirth is likely to play an important role in the etiology of fecal incontinence. The incidence of fecal incontinence in women after OASIS has been shown to vary between 20 and 68%[3,8,10,29], with an overall incidence of 29.7% according to a meta-analysis by Oberwalder *et al.*[9]. Undiagnosed OASIS is also believed to be clinically relevant, as some asymptomatic women with clinically undiagnosed anal sphincter injury seem to develop symptoms of fecal incontinence after a second vaginal delivery[29]. Early detection and primary repair of OASIS may prevent the development of defecatory symptoms after the index delivery and subsequent vaginal delivery.

In this study we tested for an association between several demographic, obstetric and ultrasound parameters with significant anal sphincter defects. Episiotomy was performed exclusively as a right-sided mediolateral procedure and selectively, as evidenced by the rate of 26.3% in primiparae delivered vaginally in our cohort. Neither vacuum delivery nor selective use of episiotomy was a risk factor for EAS defects, although this may be because of a lack of power. Only forceps delivery was significant on multivariate analysis, with an odds ratio of 3.45 (95% CI, 1.18–10.1), which accords with findings in the literature[12]. Levator defects have been shown to be significantly associated with anal sphincter trauma in a study using magnetic resonance imaging[30], and we observed a non-significant trend towards an increased incidence of levator trauma in women with sphincter defects. This is plausible, as there is a substantial overlap in risk factors, especially forceps delivery.

While transperineal ultrasound is being increasingly used to evaluate the anal sphincter complex, to our knowledge this is the first attempt to define the prevalence of significant EAS defects in primiparae by transperineal

ultrasound imaging. Valsky and Yagel[31] first introduced exo-anal 3D ultrasound for assessment of the anal sphincter, however the authors did not establish a definition for anal sphincter defects on TUI. We defined significant EAS defects as defects of > 30° involving four or more of the six slices on TUI, based on the definition of Roos *et al.*[27] who, using endoanal ultrasound, rated significant or residual defects as positive if two-thirds of the anal sphincter was involved. Using this definition, a study of patients after primary repair of OASIS showed a significant association between findings of significant EAS defects on TUI and significant defecatory symptoms, validating the methodology[32]. In the current work, at the antenatal appointment, no scan out of 316 showed a significant defect, and minor abnormalities were found in only 23 of 316 patients, implying that the likelihood of a false-positive diagnosis of 'significant defect' in someone with an intact sphincter should be rather low.

Several limitations of our study have to be acknowledged. It was a retrospective analysis of datasets of an ongoing RCT. The focus of the original trial was not the detection of sphincter trauma. We did not perform power calculations to address the research question of the current study. Furthermore, we did not use a fecal incontinence scoring system, e.g. the St Mark's Incontinence Score, to quantify defecatory symptoms[33]. Women were asked a question regarding the presence or absence of fecal incontinence. This may not have provided sufficient sensitivity for the detection of impairment of sphincter function, since we did not find a significant association between sphincter defects and fecal incontinence in this cohort, probably because of insufficient power.

We only rated defects of the EAS and did not assess the IAS. Since the commencement of this study it has become clear that involvement of the IAS may be a poor prognostic factor for functional outcome after primary repair of OASIS[27]. We have now established a methodology for assessing both the EAS and the IAS using tomographic transperineal ultrasound, and will in future attempt to assess the relative prevalence and functional effect of both EAS and IAS defects. However, the volumes acquired in this study frequently did not include the entire IAS and therefore were unsuitable for internal sphincter assessment.

A further limitation is that, as is evident from our images, the exoanal method is of limited use for assessing the subcutaneous part of the EAS owing to the proximity of the anus. Tears restricted to this part of the sphincter may have been missed.

Finally, it would be preferable to combine imaging with an independent functional assessment using anal manometry. Unfortunately this is an invasive technique that is very likely to reduce recruitment and compliance with follow-up regimes, which is why we did not consider the method.

In conclusion, using transperineal exoanal ultrasonography we have demonstrated significant EAS defects in 28% of women after a first vaginal delivery, 87% of which were undiagnosed clinically. There seems to be a need for better education of labor-ward staff in the recognition and treatment of OASIS. Exoanal ultrasound should help to improve both detection and treatment by allowing universal, low-cost and non-invasive follow-up of patients after OASIS, facilitating practice improvement activities and research in this field.

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