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ORIGINAL ARTICLE

The evolution of transperineal ultrasound findings of the external anal sphincter during the first years after childbirth

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Abstract
Introduction and Hypothesis Obstetric anal sphincter injuries (OASI) are a major form of maternal birth trauma. Ultrasound imaging is commonly used to evaluate the condition. We undertook a study to compare the sonographic appearance of the external anal sphincter (EAS) 3 to 6 months and 2 to 3 years after a first birth.
Methods A retrospective analysis of data of primiparous women obtained in a prospective perinatal imaging study. Women were invited for postnatal assessment 3 – 6 months and 2 – 3 years after a first delivery. All had completed a standardized questionnaire, and had undergone clinical examination and translabial 4D ultrasound imaging. A "significant" EAS defect was diagnosed if four out of six slices on tomographic ultrasound imaging showed a defect of ≥30° circumference.
Results Datasets of 76 women with complete data and no intervening birth were assessed. Their mean age was 30.0 years (range 19.5 – 45.3 years) at the time of antenatal assessment. They were delivered at a mean gestation of 40 weeks (range 37 – 42 weeks), by caesarean section in 19, normal vaginal delivery in 42, vacuum delivery in 14 and forceps delivery in 1. A significant EAS defect on transperineal ultrasound imaging was found in 13 of 57 women (23 %) at an average of 4.7 months and in 12 of 57 (21 %) at a mean 26.4 months after a first vaginal delivery.
Conclusions In this cohort of primiparous women after a term singleton delivery, we found only minor improvement in sonographic appearance of the EAS between 4.7 months and 26.4 months on transperineal ultrasound imaging, arguing against any significant degree of structural recovery during this time period.

Keywords Anal sphincter · Imaging · Levator ani · Obstetric trauma · Ultrasound imaging

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Introduction

Obstetric anal sphincter injuries (OASI) are an important form of maternal birth trauma. They are a risk factor for short-term and long-term anal incontinence, the prevalence of which ranges from 15 % to 59 % [1]. Proper diagnosis and adequate repair of OASI is considered important to prevent subsequent morbidity. It has recently become clear that OASI are more common than previously thought, potentially reaching an incidence of 20 % and higher in vaginally parous women [2, 3]. It appears that the diagnosis is often missed in the delivery suite [3]. True occult trauma, i.e. tears underneath intact skin or fascia, is thought to be uncommon [2]. Such trauma can be diagnosed with endoanal or translabial ultrasound imaging [2, 4]. It seems to be mostly associated with the first vaginal birth [5, 6].

It has been suggested that women after anal sphincter trauma are at a higher risk of faecal incontinence after a second vaginal birth, implying further trauma [7]. Hence, longitudinal studies of anal sphincter function and morphology are urgently needed to improve counselling, and two such studies are ongoing in our unit. However, the interpretation of longitudinal data requires information on the 'natural history' of sphincter tears in the absence of further vaginal births. To date, there is a lack of information on whether (or how) postnatal imaging findings develop over time. We therefore undertook a study to compare external anal sphincter (EAS) imaging findings 3 – 6 months and 2 – 3 years after a first birth.

Methods

This was a retrospective analysis of data obtained in a prospective perinatal imaging study of primiparous women recruited between July 2007 and September 2011. The parent study was approved by the Sydney West and Sydney South Area Health Service Human Research Ethics Committees (SWAHS HREC 07-022 and SSAHS HREC X09-0384). Women were invited for postnatal appointments 3 – 6 months and 2 – 3 years after a first delivery. All had filled in the Edinburgh Postnatal Depression Questionnaire, the King's Health Questionnaire and a standardized in-house questionnaire for urinary, bowel and sexual symptoms, and all had undergone clinical examination and translabial 4D ultrasound imaging using a GE Voluson 730 Expert system (GE Kretz Ultrasound, Zipf, Austria). All women were asked about the presence of anal incontinence at follow-up. Sonographic volume datasets were acquired at rest, on Valsalva manoeuvre and pelvic floor muscle contraction as previously described [8].

Abdominal volume transducers placed transversely on the perineum with an aperture of 60° and a volume angle of 70° were used. One single focal zone was set at 1 – 2 cm depth. Harmonics were set to high, and depth was set to approximately 5 cm to allow optimal resolution. For sphincter imaging, ultrasound volumes were obtained on pelvic floor contraction, ensuring that the entire anal canal was included in the volume for assessment of the EAS [2]. Volume datasets were analysed at a later time by postprocessing on a desktop personal computer using the proprietary software GE Kretz 4D View version 10.0. Multislice or tomographic ultrasound imaging was used to evaluate the EAS, with a set of eight slices obtained as described previously [2]. In brief the entire EAS was encompassed by placing one slice cranial to the EAS (at the level of the puborectalis muscle) and another caudal to the internal anal sphincter (IAS) at the level of the subcutaneous part of the EAS, with an interslice interval of between 1.5 and 3.5 mm, depending on the longitudinal extent of the EAS as ascertained dorsally (Fig. 1).

A "significant" defect was diagnosed if four of these six slices showed a defect of ≥30° of the circumference of the EAS, equivalent to the definition of sphincter defects on endoanal ultrasound imaging [9]. The use of four of six slices as the tomographic definition of a significant defect has been validated against symptoms in a perineal clinic population and in a urogynaecological population [10, 11]. A test–retest series in 20 women was performed by V.D.Z. and R.G.R. to determine interobserver reproducibility before the start of the project. All ultrasound volumes were later assessed by V.D.Z. blinded to all clinical data and ultrasound findings. All discrepancies between findings obtained at the two postnatal visits were re-evaluated by the senior author, taking care to produce imaging in identical locations and at identical interslice intervals before a final decision was made. Figure 2 shows the images in a patient with clinically undiagnosed EAS trauma 3 months and 32 months after a first normal vaginal delivery.

Results

A test–retest series in 20 patients showed good interobserver agreement regarding the diagnosis of significant EAS defects on single-slice images, i.e. defects measuring ≥30° circumference (120 total observations, kappa = 0.619) and excellent agreement regarding the sonographic diagnosis of significant EAS defects (four of six slices positive, 20 total observations, kappa = 1). Of the 660 women recruited in the prospective perinatal imaging study, 503 returned for follow-up at 3 – 6 months postpartum and 132 had been seen 2 – 3 years after the index birth by the time of study closure. Of these 132 women, 56 were excluded, in 53 because of a second birth and in 3 because of missing EAS volume data. The remaining 76 women comprised the study population. Their average age was 30.0 years (range 19.5 – 45.3 years) at the time of antenatal assessment. They had delivered their first baby at a mean gestation of 40 weeks (range 37 – 42 weeks), and the mean birth weight was 3,461 g (range 2,470 – 4,455 g). In 19 the birth was by caesarean section, in 42 by normal vaginal delivery, in 14 by vacuum delivery and in 1 by forceps delivery. The mean length of the second stage was 76 min (range 6 – 231 min). Of the women with a vaginal delivery, 19 were diagnosed with an intact perineum clinically, 24 had a perineal tear (4 first degree, 16 second degree, 4 third degree tears), and 16 had an episiotomy that in two women extended to a third degree tear.

The women were seen on average at 4.7 months (range 2.7 – 14.8 months) and 26.4 months (range 16.9 – 41.8 months) postpartum, yielding a mean interval between ultrasound assessments of 21.6 months. The methodology of volume acquisition was identical in each woman. Assessment of stored volume datasets showed a grossly normal EAS (fewer than four positive slices as defined above) in 62 women (82 %), and an abnormal EAS on both scans in 11 women (14 %; see Fig. 2 for a typical case). All women with abnormal scans had delivered vaginally. After excluding women delivered by

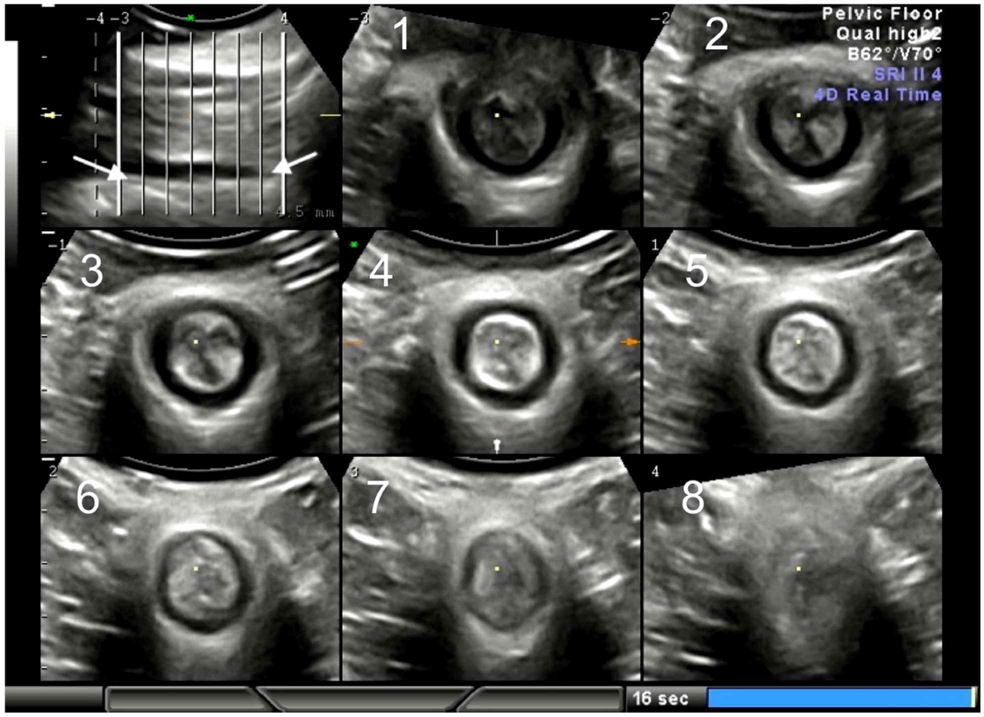

Fig. 1 Tomographic translabial imaging of a normal anal sphincter in a nulliparous patient. The *top left* image shows the midsagittal plane, the remaining eight images (*1* – *8*) represent coronal slices through the anal canal. The location of these slices is given by the *vertical lines* in the midsagittal plane. *Slice 1* and *slice 8* are represented by the *bold lines* at the left and right, respectively, of the midsagittal plane image. The *arrows* indicate the landmarks used to place these slices in the midsagittal plane: the *left arrow* indicates the cranial margin of the EAS, the *right arrow* the caudal margin of the IAS. *Slice 1* is located above the EAS, *slice 8* below the IAS within the subcutaneous component of the EAS

caesarean section there were discrepancies in the ultrasound findings at the two time points in three women, all of whom showed abnormalities in some slices (Table 1). In two women there seemed to be improvement, and in one there was apparent deterioration. This equates to a kappa of 0.846 and agreement of 95 %.

One of 13 women (8 %) with significant anal sphincter defects on ultrasound imaging at the first postpartum visit complained of anal incontinence, compared with three of 44 (7 %) with no defects. All four women were asymptomatic at the second postpartum visit. At the second visit, only one of 12 women (8 %) with significant anal sphincter defects on ultrasound imaging complained of faecal incontinence compared with none with no defects.

Discussion

Endoanal ultrasound imaging is generally regarded as the gold standard for the evaluation of the anal sphincter complex. There is a recent trend towards exoanal ultrasound imaging [10–13] using either vaginal or abdominal probes transperineally, i.e. noninvasively. While there are limited data correlating ultrasound and surgical findings [14], studies comparing transperineal with endoanal ultrasound imaging have shown a moderate to good correlation between the two imaging techniques [15, 16]. Transperineal ultrasound imaging has the additional advantage of allowing assessment of pelvic floor functional anatomy, including the integrity of the levator ani muscle, which is believed to be important in the

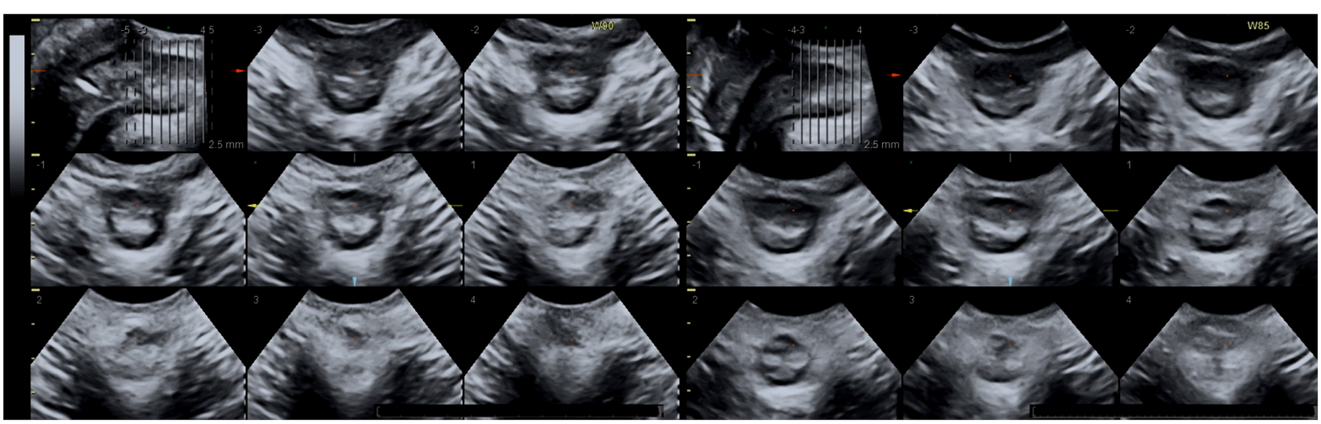

Fig. 2 Comparison of tomographic findings 3 months and 32 months after a normal vaginal delivery in a patient with a clinically diagnosed second degree perineal tear. In both sets of images there is evidence of EAS defects in four of six slices

Table 1 Comparison between EAS assessments (tomographic translabial 4D ultrasound imaging) at an average of 4.7 months and 25.6 months in 57 women with vaginal delivery. The difference is nonsignificant ($p = 1.00$, Fisher's exact test)

		3 – 6 months		Total
		Normal	Abnormal	
2 – 3 years	Normal	43	2	45
	Abnormal	1	11	12
Total		44	13	57

maintenance of anal continence [17]. Anal sphincter defects have recently been shown to be associated with defects of the levator ani [18], and there is a clear overlap in risk factors, with forceps delivery being the most important [2, 19–21].

In 57 primiparous women after a term singleton vaginal delivery, we found residual sphincter defects in 13 (23 %) at an average of 4.7 months and in 12 (21 %) at an average of 26.4 months on transperineal ultrasound imaging, arguing against any significant improvement in anatomical appearance during the time period covered. While there is a lack of robust scientific data to inform clinicians and patients concerning future delivery mode after OASI, it is recommended that caesarean section be offered to women with significant sphincter defects on ultrasound imaging [22]. The timing of anal sphincter imaging, however, has not been specified. The findings of our study suggest that translabial ultrasound imaging of the anal sphincter complex 3 – 6 months postpartum is likely to represent a steady state that seems unlikely to evolve. However, we acknowledge that the wide range of individual time points in our study is a potential weakness. We are unable to comment on any potential evolution of findings in the first 3 months after childbirth, which is a limiting factor given that women after OASI are commonly seen and assessed between 6 and 12 weeks after delivery [22].

As far as we are aware, this is the first study on the evolution of transperineal ultrasound findings of the anal sphincter over time. The assessors were blinded to all clinical and other ultrasound data to avoid bias. While our definition of a "significant" defect is novel, it has been validated in two different populations [10, 11]. However, our study clearly does not have enough power to allow comment on symptoms, which is a weakness that needs to be acknowledged. Larger studies and longer observation periods are required to investigate the link between sonographic appearance and the development of symptoms of anal incontinence. Furthermore, our methodology did not include the assessment of the subcutaneous EAS as this is often difficult due to artefact. To address this issue we are currently undertaking a study to determine if the subcutaneous EAS can be validly assessed using our tomographic ultrasound imaging methodology. Finally, we did not attempt to evaluate the IAS which is responsible for a substantial proportion of anal resting tone [23] because the volumes acquired in this study frequently did not include the entire IAS and therefore were unsuitable for IAS assessment. The IAS ought to be included in future studies.

In conclusion, no significant improvement in sonographic appearance of the EAS was found on transperineal ultrasound imaging in a cohort of primiparous women seen at a mean of 4.7 months and again 26.4 months after a term singleton vaginal delivery. This argues against any significant degree of structural recovery during this time period.

Compliance with ethical standards

Conflicts of interest H.P. Dietz and K.L. Shek have received unrestricted educational grants from GE Medical.

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