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Pelvic floor trauma: does the second baby matter?

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KEYWORDS: avulsion; birth trauma; childbirth; levator ani; puborectalis muscle; ultrasound

ABSTRACT

Objective *To ascertain the effect of a second delivery on pelvic floor anatomy.*

Methods *This was a retrospective analysis of data obtained in two perinatal imaging studies. Women were invited for antenatal and two postnatal appointments. All had answered a standardized questionnaire and undergone a clinical examination and translabial four-dimensional ultrasound. Ultrasound volumes were acquired at rest, on Valsalva maneuver and on pelvic floor muscle contraction, and analyzed by postprocessing on a PC. Avulsion was diagnosed on tomographic ultrasound imaging. This study reports data obtained in those women who delivered a second child between the first and second postnatal assessments.*

Results *Of 715 participants, 94 reported a second birth at their second postnatal appointment on average 2.7 years after their first birth; 65 had a vaginal delivery and 29 a Cesarean section. There were nine attempts at vaginal birth after Cesarean section (VBAC), of which six were successful. When we analyzed the ultrasound findings before and after a second delivery, there was no significant change observed in bladder-neck descent, cystocele descent and hiatal area on Valsalva. Delivery mode of the second birth seemed to have little effect on changes observed between follow-ups, although there was a trend towards increased bladder-neck descent in women after vaginal delivery. On reviewing patients diagnosed with avulsion at their 2–3-year visit and comparing them with findings at the first follow-up visit, we found identical (normal) findings in 87 cases. In five there was an unchanged avulsion. In one case, findings had improved from complete to partial avulsion. There was one new avulsion, in a patient who had delivered her first baby by emergency Cesarean section and her second by vacuum delivery.*

Conclusions *A second pregnancy and delivery do not seem to have a major effect on bladder support and/or levator function. However, we documented a case of major levator trauma after VBAC. The issue of pelvic floor trauma after VBAC may have to be investigated further.* *Copyright © 2013 ISUOG. Published by John Wiley & Sons Ltd.*

INTRODUCTION

Female pelvic floor dysfunction (urinary incontinence, fecal incontinence and pelvic organ prolapse) affects a substantial proportion of women, with almost one quarter of all women and one third of older women reporting at least one pelvic floor disorder[1]. It is an important cause of both physical and psychological morbidity, and as the worldwide population of older women increases, this will place an increased burden on society in terms of healthcare costs, loss of productivity and reduced quality of life. There has been substantial progress in the field of pelvic-floor medicine over the past decade, with much emphasis placed on research into etiology and prevention, especially as regards involvement of the levator ani muscle, the principal structure involved in pelvic organ support[2].

Howard Gainey first described trauma to the levator ani muscle following vaginal childbirth in the 1940 s[3]. After a hiatus of over 60 years, technological innovations in imaging have resulted in a 're-discovery' of maternal birth trauma to the levator ani. Both magnetic resonance imaging (MRI) and translabial ultrasound have recently been developed to assess the levator ani after childbirth and in symptomatic women[4,5]. The association between levator trauma and pelvic organ prolapse is now well documented and it has become clear that levator avulsion is a risk factor not just for prolapse, but for prolapse recurrence after reconstructive surgery, suggesting that

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a diagnosis of avulsion may have a major role to play in surgical planning[6–12].

Macroscopic disruption of the levator ani involves uni- or bilateral avulsion of the puborectalis muscle from the inferior ramus of the os pubis. This is usually occult but can occasionally be observed in the labor ward in patients with large vaginal tears[13]. However, there are also macroscopically invisible alterations to muscle functional anatomy, the pathophysiology of which is uncertain. 'Microtrauma' involves irreversible overdistention of the levator hiatus and is also commonly detected in women who have delivered vaginally[14,15].

Mathematical modeling suggests that most pelvic floor trauma is due to delivery of the first baby[16], but epidemiological data show that subsequent deliveries are associated with an increased risk of prolapse[17]. In a large cohort study conducted by Mant *et al.*[18], it was reported that of all the risk factors examined, parity showed the strongest association with the risk of requiring surgery for pelvic organ prolapse. In this study, women with one child were 4.0 times more likely and women with two children were 8.4 times more likely to suffer from pelvic organ prolapse that required hospital admission than were nulliparous women. Similarly, Rortveit *et al.*[19] reported a significant association between parity and the development of stress urinary incontinence, with relative risks of 1.9 (95% CI, 1.6–2.2) for women following one delivery and 2.3 (95% CI, 2.0–2.6) for women following two deliveries.

Modern imaging techniques, most notably ultrasound and MRI, have played a pivotal role in enhancing the accurate diagnosis of pelvic floor pathology. Three-dimensional and four-dimensional (4D) ultrasound enable real-time observation of maneuvers such as Valsalva and pelvic floor muscle contraction, thereby facilitating a more comprehensive assessment of both pelvic floor anatomy and function[20]. The aim of this study was to analyze the impact of a second pregnancy and delivery on pelvic floor structure and function using this methodology.

METHODS

This study was a retrospective analysis of clinical and ultrasound data obtained in two previously reported perinatal imaging studies. In both these studies, women were invited for antenatal (36–38 weeks' gestation) and postnatal (3–6 months and 2–3 years postpartum) appointments. The operator undertaking follow-up assessments was blinded against antenatal and delivery data. All patients had answered a standardized questionnaire and undergone a clinical examination and translabial 4D ultrasound using a Voluson 730 Expert system with a RAB 8–4-MHz transducer (GE Kretztechnik, Zipf, Austria)[20,21]. Ultrasound volumes were acquired at rest, on maximal Valsalva maneuver and maximal pelvic floor muscle contraction (PFMC). At least three Valsalva maneuvers were performed, with the best volume archived and later analyzed by postprocessing on a desktop personal computer using GE Kretz 4D View v 10.0 (GE Medical Ultrasound, Ryde NSW, Australia). The ultrasound operator was blinded against all other data. Pelvic organ descent was measured on maximal Valsalva in the midsagittal plane[22]. Hiatal dimensions were determined in the plane of minimal hiatal dimensions, as previously described[23].

Tomographic ultrasound imaging (TUI) was performed on volumes obtained at maximal PFMC at 2.5-mm slice intervals, from 5 mm below to 12.5 mm above the plane of minimal hiatal dimensions. It was used to diagnose levator avulsion, as described previously, with a dataset rated positive for avulsion if the puborectalis insertion of at least the central three slices was abnormal[24,25]. Irreversible overdistention ('microtrauma') was defined as an increase of over 20% in hiatal area on Valsalva when comparing antenatal and postpartum volume datasets[15]. This study reports data obtained in those women who delivered a second child between the 3–6-month and the 2–3-year assessments.

Both parent studies were approved by the local human research ethics committee (SWAHS HREC 05–004 and 07–022). We used Minitab version 13 (Minitab Inc., State College, PA, USA) and paired *t*-tests to compare quantitative outcome measures between first and second appointments, as well as unpaired *t*-tests to compare changes in these parameters relative to delivery mode, after normality testing using the Kolmogorov–Smirnov method; $P < 0.05$ was considered statistically significant. Power calculations were omitted owing to the lack of pilot data.

RESULTS

During the inclusion period of this study, 715 women had been recruited for two perinatal imaging studies between May 2005 and December 2009. They had been assessed at an average gestation of $36 + 5$ weeks. At the time of database closure, 529 (74%) had returned for their first postpartum assessment, at a median follow-up time of 4.2 (range, 2.3–22.1) months after childbirth. Of those, 227 were seen again for a second postnatal appointment, on average 2.3 (range, 1.4–4.2) years after their first delivery. Two women were excluded because of missing data ($n = 1$) and poor acquisition ($n = 1$), leaving 225 datasets.

Of those 225 women, 94 reported a second birth at least 3 months before their second follow-up visit and were seen at an average of 2.7 (range, 1.43–4.21) years after their first delivery. Their mean age was 29.9 (range, 20–46) years and 90 (96%) were Caucasian. Mean body mass index (BMI) at the second visit was 27 (range, 16–49) kg/m^2. The average gestational age of the second delivery was 39.4 (range, 33.5–42) weeks, with a mean birth weight of 3512 (range, 1844–4800) g. Sixty-five (69%) had a vaginal delivery and 29 (31%) a Cesarean section. Of those who delivered vaginally, 58 (89%) did so by normal vertex delivery (NVD), four (6%) by vacuum extraction and three (5%) by forceps. Median length of the first stage of labor was 300 (range, 10–885) min and median length of the second stage was 21.9 (range, 2–121) min. Twenty-two patients had an epidural and 14 received Syntocinon augmentation. There were nine

Table 1 Bladder-neck descent, cystocele descent, hiatal dimensions on Valsalva maneuver and tomographic diagnosis of avulsion after first and second deliveries in a cohort of 94 women

Parameter	*After first delivery*	*After second delivery*	*Change*
Bladder-neck descent (mm)	24.4 ± 10.6	24.2 ± 10.5	−0.24*
Cystocele descent (mm)	4.1 ± 11.4	5.5 ± 11.5	+1.4*
Hiatal area on Valsalva (cm^2)	21.3 ± 7.3	22.0 ± 7.8	+0.67*
Avulsion	6 (6.4)	6 (6.4)	1 'healed', 1 new

Data are given as mean ± SD or *n* (%). *Not statistically significant.

Table 2 Changes in bladder-neck descent (BND), cystocele descent and hiatal dimensions on Valsalva maneuver and tomographic diagnosis of avulsion after a second delivery that was vaginal or by Cesarean section in a cohort of 94 women

Parameter	*Second birth as vaginal delivery (n = 65)*	*Second birth as Cesarean section (n = 29)*	P
Change in BND (mm) ($n = 88$)	+1.4 ± 10.1	−2.67 ± 8.8	0.057
Change in cystocele descent	−2.4 ± 10.4	+0.3 ± 7.7	0.19
Change in hiatal area (cm^2)	+0.14 ± 5.6	+1.67 ± 6.5	NS
New avulsion	1	—	

Data are given as mean ± SD or *n*. NS, not statistically significant.

attempts at vaginal birth after Cesarean section (VBAC), of which six were successful (two NVD, three vacuum deliveries and one forceps delivery). Of the 29 Cesarean sections, 24 (83%) were performed before the onset of labor, five (17%) during the first stage of labor and 0 (0%) during the second stage of labor.

At their second postnatal appointment, participants complained of stress incontinence ($n = 25$ (27%)), urge incontinence ($n = 14$ (15%)), frequency ($n = 11$ (12%)), nocturia ($n = 6$ (6%)) and symptoms of prolapse ($n = 4$ (4%)).

On ultrasound, we determined an average bladder-neck descent of 24.2 ± 10.5 mm and a mean hiatal area on Valsalva maneuver of 22 ± 7.8 cm^2. On assessing patients with a second delivery there were no statistically significant changes in any of the measured parameters (bladder-neck descent, cystocele descent and area on Valsalva) between the two postnatal appointments (Table 1). There were no significant differences for these outcome measures obtained after the first delivery when comparing those who had ($n = 94$) and those who had not had a second baby ($n = 131$).

When we analyzed the 94 women with subsequent delivery in more detail, there was a trend ($P = 0.057$) towards greater bladder-neck descent after a second vaginal delivery (Table 2), with no significant change observed in cystocele descent and hiatal area on Valsalva. On reviewing patients who were diagnosed with avulsion at their 2–3-year visit and comparing them with findings at their first follow-up visit, we found identical (normal) findings in 87 women. In five there was an unchanged avulsion. In one case TUI findings had improved from complete to partial avulsion, after a second delivery that was an NVD. There was one new avulsion, in a patient who had a normal pelvic floor at her 3-month appointment. This woman had delivered her first baby by emergency Cesarean section for failure to progress at 9 cm dilatation and her second by vacuum (Figure 1).

DISCUSSION

The issue of maternal birth trauma is attracting increasing attention worldwide. It is a politically sensitive issue owing to the capacity for increased intervention rates, in particular through motivating women to consider elective Cesarean section on request. The effect of such developments on health budgets and maternal and perinatal outcomes is unclear. However, it is very likely that to date most pregnant women are not fully informed of the likelihood of levator ani or anal sphincter trauma during their antenatal care, and this is unlikely to change soon without a substantial investment in the education of antenatal counselors.

In the meantime, the most clinically relevant aspect of recent developments in the assessment of pelvic floor trauma ('avulsion') is the question of how to counsel women diagnosed with such trauma after a first delivery. In the case of anal sphincter trauma, there is an increasing body of evidence to suggest that vaginal birth after anal sphincter rupture is safe in those women without functional impairment[26]. As regards levator avulsion, no such data exist at present, although mathematical modeling in symptomatic women suggests that it is primarily the first vaginal delivery that is responsible for major damage to the levator ani muscle[16].

In this series of 94 second births observed in the context of two perinatal cohort studies, we were able to assess pelvic organ descent and levator structure and function by 4D pelvic floor ultrasound. These women did not differ significantly from those who did not give birth a second time during the observation period for any of the outcome measures reported here, suggesting that a second pregnancy and delivery have no major impact on pelvic organ support and the levator plate. This confirms the findings of our previous, smaller study in the same cohort[27]. The same seems to be true for delivery mode: on comparing 65 vaginal deliveries with 29 Cesarean sections, we found that mode of delivery had little impact on bladder-neck descent or hiatal area. However, there was one new case of avulsion following vaginal birth in a woman who had previously been delivered by emergency Cesarean section at 9 cm dilatation, emphasizing that this benign effect of a second pregnancy and delivery may not apply in patients undergoing VBAC. We hypothesize that the combination of a vaginally nulliparous pelvic floor, a larger baby and more powerful uterine contractility may result in an increased likelihood of pelvic floor trauma. However, to test such a hypothesis would require a much

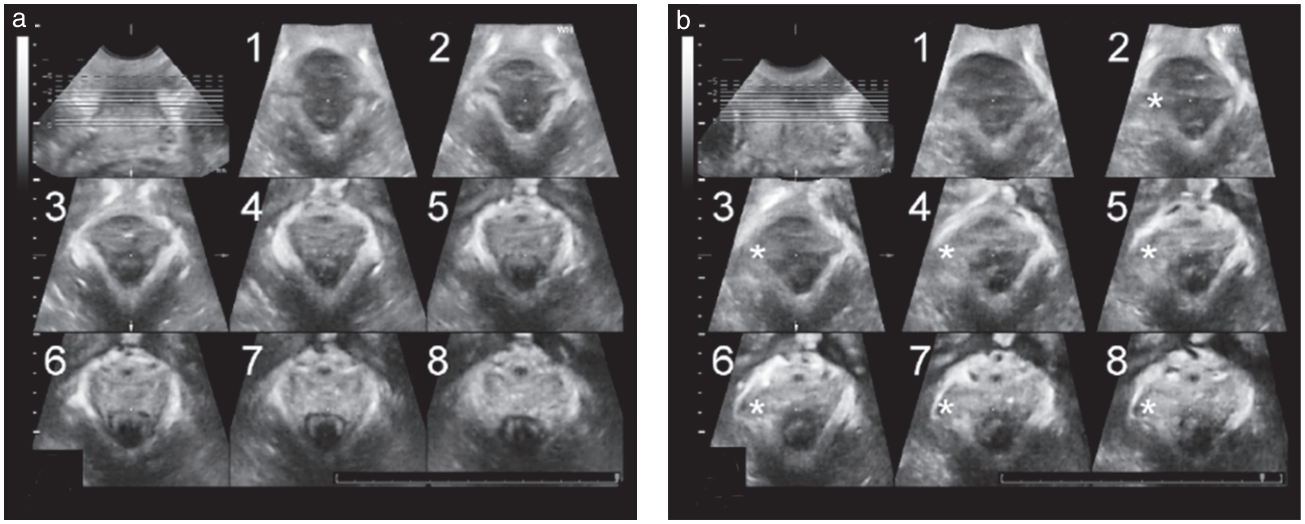

Figure 1 Tomographic ultrasound images of the puborectalis muscle in a patient 4.5 months after her first delivery by second-stage Cesarean section (a) and 1.8 years later, 9 months after her second delivery by vacuum extraction (b). Full right-sided avulsion was evident after the second delivery (* in b, slices 2–8).

larger dataset than the one currently available to us. While it may be argued that such a presumptive increased risk may depend on whether the Cesarean section was elective or emergency, there is no evidence for either a negative or positive effect of labor on the pelvic floor in the absence of vaginal delivery.

This study has several weaknesses that must be acknowledged. The vast majority of our patients were Caucasian, which suggests that any conclusions will be limited to this ethnic group. Age, gestational age, birth weight and other demographic data such as BMI are roughly representative of the Australian obstetric population[28]. We also have to acknowledge that both parent studies suffered a substantial loss to follow-up, with only 227/715 (32%) seen for a second postnatal visit, at an average of 2.3 years after their first delivery. However, perinatal studies in general deal with a highly mobile population, and low follow-up rates are common. The follow-up interval of 2.3 years may be regarded as too short, given the low number of second births (94/225 (42%)). On the other hand, extending the follow-up interval, while increasing the likelihood of further births, is likely to reduce follow-up rates even further.

Finally, one of the constituent studies tested an antenatal intervention for the prevention of pelvic floor trauma. While it is unlikely that this intervention would have affected the impact of a second birth, it has to be acknowledged that this may potentially have acted as a confounder. Future work with the help of larger datasets and longer follow-up will, we hope, allow a better understanding of the factors governing the relative role of first and subsequent births in the pathogenesis of pelvic floor disorders.

In conclusion, a second pregnancy and delivery do not seem to have a major effect on bladder-neck support and/or levator biometry and structural integrity. However, we documented a case of major levator trauma after VBAC. An increased risk of pelvic floor trauma may alter the balance of risks and benefits to be considered by women faced with the choice of attempting VBAC or undergoing elective repeat Cesarean section.

Disclosure

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