Does delayed child-bearing increase the risk of levator injury in labour?

Hans P. DIETZ¹ and Judy M. SIMPSON²
¹Nepean Clinical School, University of Sydney, Penrith, and ²School of Public Health, University of Sydney, Camperdown, Sydney, New South Wales, Australia

Abstract
Background: Levator trauma is common in parous women. We have recently found a relationship with age at first vaginal delivery in women seen before and after childbirth.

Aims: To examine women presenting with symptoms of pelvic floor disorders for such an association.

Methods: Eight hundred and one women were prospectively seen for an interview, clinical examination (including for levator integrity and function in 789 cases), multichannel urodynamic testing and pelvic floor ultrasound (including 3D imaging in 350 cases). Findings were tested for association with maternal age at first vaginal delivery, parity and operative vaginal delivery using logistic regression.

Results: Mean age was 55.3 years (range 17–90), with 79% complaining of stress urinary incontinence and 28% of symptoms of prolapse. Median vaginal parity was 2 (range 0–12); mean age at first vaginal delivery was 24 (range 14–39). Levator defects were found in 170 women (21.6%), 24% of the vaginally parous. Defects were more common on the right (86%) than left (45%) (P < 0.0001). Women with levator trauma had a higher mean age (25.5 (SD 5.2) vs 23.5 (SD 4.5) years, P < 0.0001). Regression modelling confirmed findings, demonstrating an increase in the odds of levator trauma of approximately 10% for every year of delay in child-bearing. Vaginal operative delivery was associated with a near-doubling of the odds of trauma.

Conclusions: Increased maternal age is a risk factor for intrapartum pelvic floor trauma. The global trend towards delayed child-bearing may result in an increased prevalence of pelvic floor disorders in coming decades.

Key words: 3D ultrasound, birth trauma, levator muscle, prolapse, translabial ultrasound, transperineal ultrasound, vaginal delivery.

Introduction
Major childbirth-related trauma to the levator ani muscle is not uncommon in women presenting with symptoms of urinary incontinence and prolapse. While such trauma was first described in the 1940s it is not currently featured in our textbooks and has been ignored as an aetiological factor for pelvic floor dysfunction. It can be detected on magnetic resonance (MR) and 3D ultrasound imaging, although cost and access problems with MR equipment have delayed progress until the recent development of 3D pelvic floor ultrasound. Levator defects are generally palpable on digital vaginal examination, although specific training is required to detect such trauma, and learning curves may be substantial. It is therefore not surprising that the literature on digital pelvic floor assessment did not contain any references to trauma until 2006.

Major morphological abnormalities of the levator ani commonly seem to involve an avulsion injury of the insertion of the pubovisceral muscle on the inferior pubic ramus and the arcus tendineus of the levator ani on the obturator fascia. While pudendal neuropathy was in the past thought responsible for side differences in strength on palpation and also for abnormal appearances on MR, recent advances in imaging technology have made it quite clear that most morphological abnormalities are in fact traumatic in nature. Such defects are caused by vaginal childbirth and may be more common in women who are older at the time of their first vaginal delivery. This recent finding is of great potential significance as age at first delivery has been rising steadily over the last few decades. In Australia, age at first delivery in 2003 was 27.6 years, compared to 25.8 in 1991 and compared to...
approximately 23 years in women, seen today for incontinence and prolapse, who were delivered of their first child on average 30 years ago (HP. Dietz, unpubl. data). This seems an expression of a global and continuing trend\textsuperscript{10–13} in both developing and developed nations.

Levator defects are clearly associated with anterior and central compartment prolapse,\textsuperscript{2,14} and such trauma may confer a higher risk of prolapse recurrence after repair.\textsuperscript{15} It is therefore conceivable that increasing maternal age at first delivery may, via a higher likelihood of levator trauma, eventually lead to a higher prevalence of female pelvic floor dysfunction, in particular pelvic organ prolapse.

We therefore conducted a prospective study examining the association of operative vaginal delivery, parity and age at first vaginal birth with the incidence of unilateral and bilateral trauma to the pubovisceral muscle as defined on 3D pelvic floor ultrasound.

Methods

Eight hundred and one women were seen over the course of two years at a tertiary urogynaecological unit for symptoms of urinary incontinence, pelvic organ prolapse and recurrent urinary tract infections. They underwent an interview which included a question on age at first vaginal delivery. During the course of the study we decided to include a question on vaginal operative delivery, despite the fact that not all women were able to answer this question. Consequently, numbers available for analysis of the impact of vaginal operative delivery are lower. Patients were examined clinically for prolapse (ICS POP-Q grading) and levator integrity and function (modified Oxford Grading) and had full multichannel urodynamics testing using a fluid-filled system (Neomedix, Sydney, NSW, Australia). About half ($n = 350$) also underwent 3D/4D pelvic floor ultrasound, supine and after bladder emptying. 3D/4D capable ultrasound systems (Medison SA 8000 and GE Kretz Voluson 730 expert) were utilised to acquire volume imaging data at rest, on maximal valsala (best of at least three attempts) and on maximal pelvic floor contraction.\textsuperscript{4} Whenever there was a discrepancy between ultrasound and palpation, findings were reviewed until an unequivocal decision could be reached. Figures 1 and 2 illustrate findings after unilateral (Fig. 1) and bilateral (Fig. 2) avulsion injury of the pubovisceral muscle.

Institutional ethics committee approval was obtained for analysis of case notes and volume ultrasound datasets obtained during the course of routine clinical care (reference 05/029). Statistical analysis was performed using SAS version 9 (SAS Institute Inc, Cary, NC, USA). McNemar’s $\chi^2$ test was used to analyse sidedness of defects and Student’s $t$-test to compare the age of women with and without defects. The $\chi^2$ test was used to test the association between levator defects and categorical variables, using the Mantel–Haenszel trend test for ordinal variables. Multivariate logistic regression was used to produce a model with maternal age and vaginal operative delivery as predictors of trauma. A two-sided $P < 0.05$ was considered statistically significant.

Results

Of 801 patients, 789 could be examined for defects either clinically or by 3D/4D ultrasound. In 12 cases, a vaginal examination was impossible because of vaginal stenosis, pain or the patient declining consent. 3D ultrasound equipment was available in 350 cases. In all other cases such equipment was unavailable, precluding ultrasound diagnosis of levator avulsion.

The mean age was 55.3 years (range 17–90), with 79% complaining of stress urinary incontinence, and 28% of symptoms of prolapse (vaginal lump or dragging sensation). Median vaginal parity was 2 (range 0–12), mean age at first vaginal delivery was 24 (range 14–39). Seven hundred and eighteen women had given birth vaginally at least once. Information on vaginal operative deliveries was available in 436 women, 413 of whom had given birth, 118 at least once by vaginal operative delivery.

Levator defects were found in 170 of the 789 women (21.6%), 24% of the vaginally parous. No defects were found in women who had not delivered vaginally. Defects were on
the right in 147 (86%) women and on the left in 77 (45%), including 54 women with bilateral defects, implying a higher likelihood of trauma on the right (McNemar’s $\chi^2 = 41.0$, $P < 0.0001$). As we have been able to show previously, there was no association between urodynamic stress incontinence and levator trauma ($P = 0.7$), but again levator trauma was associated with symptoms of prolapse ($P < 0.001$) and clinically diagnosed prolapse ($P < 0.001$ for cystocele and uterine prolapse, and $P = 0.017$ for rectocele). Levator trauma was particularly common in patients with second or third degree anterior (34%) and central compartment prolapse (49%).

The 170 women with major levator trauma had a significantly higher mean age of 25.5 (SD 5.2) years than those without who had a mean age of 23.5 (SD 4.5) years (difference two years; $P < 0.0001$). Bilateral defects (see Fig. 2) were also more common in older women, and again the difference was two years between groups (23.8, SD 4.7 vs 25.8, SD 5.2, $P = 0.01$). When analysis was limited to those women who had undergone 3D ultrasound imaging, the difference in age at first delivery remained significant (23.6 vs 24.9 years, $P = 0.03$). Table 1 shows the relationship of levator defect with age at first delivery, number of vaginal operative deliveries and parity among the 718 women who had given birth vaginally. Parity, that is, the number of vaginal deliveries, was not associated with defects, implying that most defects are caused by the first vaginal birth.

Multivariate logistic regression analysis of levator trauma on maternal age and number of vaginal operative deliveries was performed for the 393 women with both variables recorded. The results are shown in Table 2, demonstrating an increase in the odds of levator avulsion of approximately 10% for every year of delay in child-bearing. Each vaginal operative delivery was associated with a near-doubling of the odds of major levator trauma. Figure 3 illustrates this relationship.

### Discussion

In this study, we have again confirmed that defects of the pubovisceral muscle are common and associated with symptoms of prolapse, and clinical and ultrasound measures of prolapse, but not with urodynamically stress incontinence, as shown

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**Table 1** Association between levator defect and age at first delivery, number of vaginal operative deliveries and parity in 718 women with a vaginal birth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levator defect</th>
<th>No levator defect</th>
<th>% with defect</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at first delivery ($n = 711$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14–19</td>
<td>18</td>
<td>113</td>
<td>14</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>20–24</td>
<td>61</td>
<td>238</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>25–29</td>
<td>53</td>
<td>137</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>≥ 30</td>
<td>36</td>
<td>55</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Vaginal operative delivery ($n = 396$)</td>
<td></td>
<td></td>
<td></td>
<td>0.0002*</td>
</tr>
<tr>
<td>0</td>
<td>57</td>
<td>221</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>36</td>
<td>66</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>2 or more</td>
<td>8</td>
<td>8</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Parity ($n = 718$)</td>
<td></td>
<td></td>
<td></td>
<td>0.74</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>73</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>181</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>3 or more</td>
<td>88</td>
<td>293</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

*From $\chi^2$ test for trend in proportions with 1 d.f.
previoulsy in a smaller cohort. In younger women, levator trauma may be associated with de novo or worsened stress urinary incontinence after childbirth, but this effect may be obliterated by other aetiological factors in older women, analogous to the situation with anal sphincter trauma and faecal incontinence. The association between prolapse and levator trauma seems much stronger to the extent that avulsion injury may well constitute a large part of the ‘missing link’ between vaginal childbirth and prolapse, an association that is well documented in the epidemiological literature, and we have recently been able to quantify the relative risk of significant prolapse associated with levator trauma, information which confirms data obtained on magnetic resonance imaging. In consequence, there seems little reason to doubt the aetiological link between levator avulsion injury and prolapse: levator trauma matters since it is very likely to be responsible for a significant number of parous women suffering from pelvic organ prolapse. The identification of risk factors for such trauma should therefore be a high research priority.

We have recently shown that increased maternal age may be a risk factor for intrapartum pelvic floor trauma. This has been confirmed in another imaging study using magnetic resonance, in which women with defects were on average 3.5 years older than those without, compared to our 2.8 years. Kearney et al. also found that women with levator trauma had had a much longer second stage of labour than those without. Whatever the actual causative chain of events, there is some epidemiological support for the hypothesis that maternal age at first delivery is associated with pelvic floor trauma, as a Norwegian study has documented that delayed child-bearing is linked to a higher prevalence of stress incontinence in later life. We conducted this study in order to quantify the effect of age at first delivery in a large dataset of symptomatic women.

Compared to the women seen in our previous perinatal study, the patients examined in this study were much younger on average when they delivered their first child (24.0 vs 31.6 years), but we again found a significant relationship between maternal age at first vaginal delivery and levator trauma. While there may well be differences in the accuracy of the two methods used (ultrasound and palpation), this relationship was found irrespective of whether the diagnosis was confirmed by imaging.

Taken in conjunction with the smaller ultrasound and MR studies quoted above, it is unlikely that this constitutes a spurious finding or that this relationship is due to the selection bias inherent in our study design. While the cause for the relationship between age at first delivery and levator trauma remains unknown, it is intriguing that maternal age also seems to be a predictor for anal sphincter trauma, independent of other standard obstetric risk factors such as birthweight and vaginal operative delivery. It is possible that tissue biomechanics may be an important factor in the aetiology of maternal birth trauma, a hypothesis that opens up opportunities for both prediction and prevention of such trauma. However, it is recognised that a more detailed analysis of obstetric risk factors (such as augmentation of labour, epidural anaesthesia, length of second stage, operative delivery, episiotomy, etc.) will require a prospective perinatal study design, and such a study is currently in progress at our unit. Hopefully, similar studies in other locations and other ethnic groups will help in determining to what extent our findings can be generalised.

In view of the global trend towards delayed child-bearing, we may be facing a future increase in pelvic floor morbidity because of a higher prevalence of levator trauma in the parous population. Based on our data, a change in age at first delivery from 23 to 28 years (which has taken place over the last three decades in Australia) would be expected to increase the prevalence of levator trauma from about 20% to almost 30% in vaginally parous women. However, as delayed

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**Table 2** Multivariate logistic regression model for levator avulsion injury in 393 women. The final model had an area under the ROC curve of $c = 0.67$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio (95% CI) Unadjusted</th>
<th>Odds ratio (95% CI) Adjusted for age, forceps or vacuum delivery</th>
<th>$P$ in final model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at first delivery (per year)</td>
<td>1.11 (1.06–1.17)</td>
<td>1.11 (1.05–1.16)</td>
<td>$&lt; 0.0001$</td>
</tr>
<tr>
<td>Forceps or vacuum (per delivery)</td>
<td>2.03 (1.38–3.00)</td>
<td>1.90 (1.28–2.83)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

CI, confidence interval; ROC curve, receiver operating characteristic curve.

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**Figure 3** The relationship between maternal age at first delivery and the probability of a levator defect on palpation and/or ultrasound. Dashed lines represent the same relationship for women who underwent one (- - -) or two (.....) vaginal operative forceps or vacuum (FDVD) deliveries.

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child-bearing is also associated with an increased likelihood of caesarean section, only partly explained by higher rates of antenatal and perinatal complications, actual prevalence figures are likely to be lower. Regardless of the true magnitude of the effect, a latency of up to 60 years between trauma and first presentation will further obscure the impact of delayed child-bearing on pelvic floor morbidity.

Conclusions

Major morphological abnormalities of the levator ani muscle are associated with age at first vaginal delivery. The current worldwide trend towards delayed child-bearing may result in an increased prevalence of related disorders, in particular pelvic organ prolapse, in coming decades.

References