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CLINICAL ARTICLE

Levator ani injury in primiparous women with forceps delivery for fetal distress, forceps for second stage arrest, and spontaneous delivery

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ABSTRACT

Objective: To compare levator ani muscle injury rates in primiparous women who had a forceps delivery owing to fetal distress with women delivered by forceps for second stage arrest; and to compare these injury rates with a historical control group of women who delivered spontaneously. *Methods:* Primiparous women who delivered by forceps were recruited retrospectively into 2 groups: forceps for fetal distress with short second stage (25 ± 11 minutes; n = 19); and forceps delivery for second stage arrest (137 ± 26 minutes; n = 19). MR images of the levator ani muscles were compared with a historical control group of women from a previous study who had delivered spontaneously (n = 129). *Results:* Major defect rates were: 42% for forceps and short second stage; 63% for forceps and second stage arrest; and 6% for spontaneous delivery. The odds ratios for major injury were: 11.0 for forceps and short second stage compared with spontaneous delivery; 25.9 for forceps and second stage arrest compared with spontaneous delivery; and 2.3 for forceps and second stage arrest compared with short second stage ($P = 0.07$). *Conclusion:* Women delivered by forceps have a higher rate of levator ani injury compared with spontaneous delivery controls; the difference between the forceps groups did not reach significance.

1. Introduction

Visible defects can be seen in the levator ani muscle after vaginal birth that do not occur in nulliparous women [1,2]. These defects are found more commonly in women with pelvic floor dysfunction than in asymptomatic controls [3,4]. Defects that involve more than half of the levator ani muscle's pubic portion are found in 55% of women with pelvic organ prolapse but only in 15% of matched controls, indicating an association between major levator ani muscle defects and pelvic organ prolapse [3]. These defects are also seen twice as often in women who have stress incontinence that persists a year after first vaginal birth compared with continent controls [4].

In a study of women who sustained levator damage after vaginal birth, forceps delivery was associated with an odds ratio of 14.7 for developing a defect [4]. In addition, women who had a defect had a second stage of labor that was over 1 hour longer than those who did not. Unfortunately, because many of the women who had a long second stage also had forceps, it was not possible to determine the relative contributions of these two factors.

Although forceps delivery is associated with levator ani muscle defects, some authors have also suggested that the cause of the injury might be related to the length of the second stage of labor and resultant nerve injury that may have led to the use of forceps [5–7]. The question then is whether a prolonged second stage reflects dystocia predisposing to levator ani injury—with forceps simply being the method of procuring the delivery in this instance—or whether the damage to the levator ani is caused by forceps delivery.

Forceps delivery necessitated by fetal distress offers an opportunity to assess the impact of forceps delivery independent of the length of the preceding second stage. The aim of the present study was to compare levator ani muscle injury rates in women delivered by forceps for fetal distress who did not have a prolonged second stage with women requiring forceps for second stage arrest, and to compare these groups with women who had a spontaneous delivery.

2. Materials and methods

Women who delivered their first baby at term by forceps delivery for fetal distress or forceps delivery for second stage arrest at the National Maternity Hospital, Dublin between January 1, 2003 and

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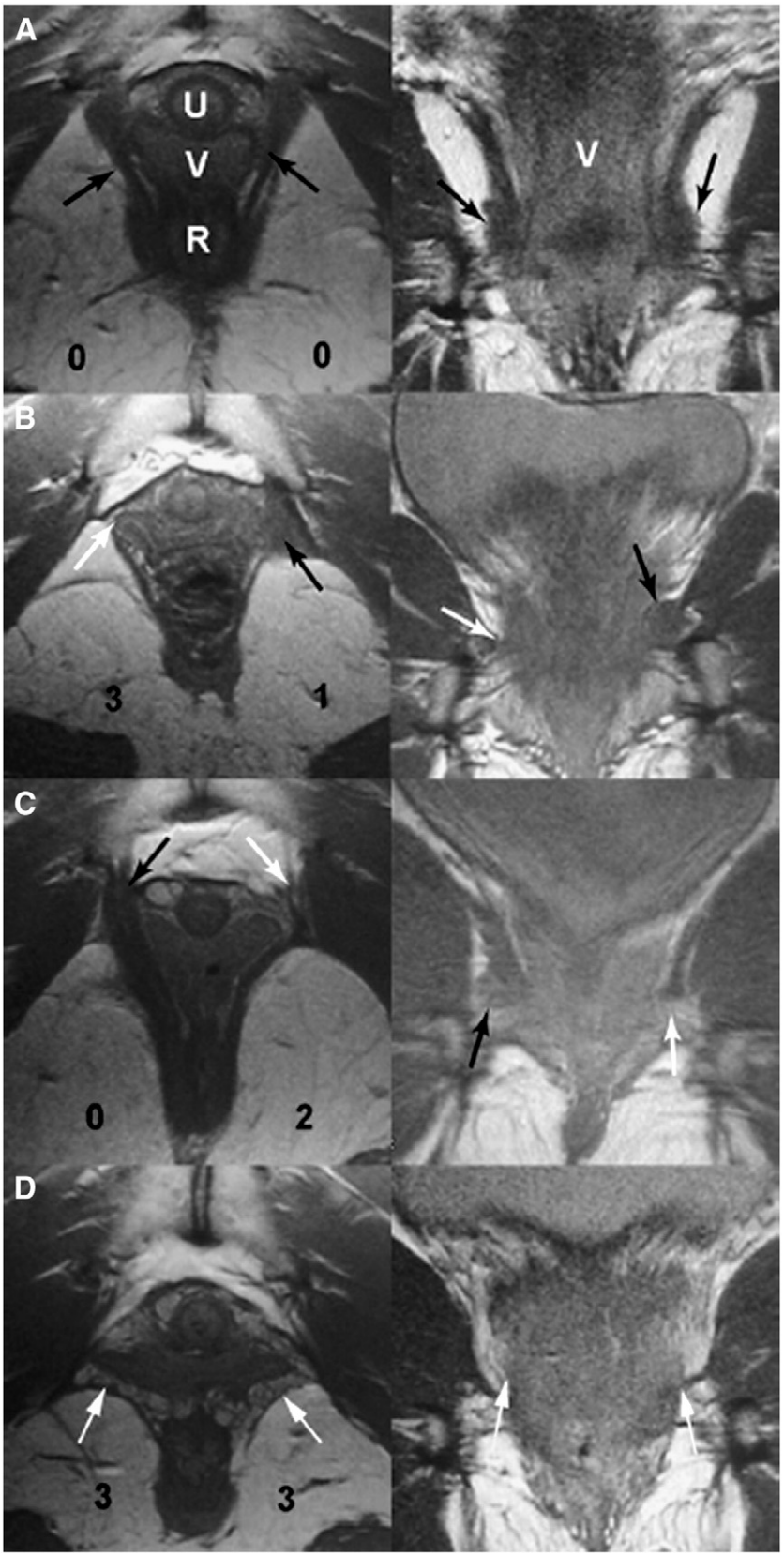

Fig. 1. Examples of the appearance of different grades of levator ani pubovisceral muscle defects in axial and coronal magnetic resonance images. Example A represents a woman with normal muscles; B and D represent women with major defects, and C, a woman with a minor defect. Defect scores in the left panels represent the scores for each side. *Black arrows* identify normal muscle and *white arrows* represent areas where muscle is defective or should be present. U, urethra; V, vagina; R, rectum. Reproduced, with permission, from Ref. [4].

Table 1
Demographics of the study groups.[a]

Characteristics	Forceps delivery and short second stage (n = 19)	Forceps delivery and second stage arrest (n = 19)	Spontaneous delivery (n = 129)
Age, y	31.3 ± 4.4	30.3 ± 7.2	29.6 ± 5.0
Birth weight, g	3618 ± 410	3736 ± 556	3460 ± 505 [b]
Fetal head circumference, cm	36.3 ± 1.1	35.7 ± 1.2	35.0 ± 1.4 [c]
Second stage length, min	25.5 ± 11.6	136.9 ± 26.4	88.8 ± 62.9 [b,c]
Oxytocin	16 (84.2)	18 (94.7)	73(56.5) [b,c]
Epidural	15 (78.9)	19 (100.0)	79(61.2) [b]
Vacuum delivery	8 (42.1)	13 (68.4)	N/A

[a] Values are given as mean ± SD or number (percentage).
[b] $P<0.05$ between second stage arrest and spontaneous delivery groups.
[c] $P<0.05$ between short second stage and spontaneous delivery groups.

July 31, 2005 were recruited retrospectively. Computerized delivery records identified primiparous women delivered by forceps and the length of the second stage. Inclusion criterion for the forceps delivery for suspected fetal distress group was a second stage length of less than 60 minutes; while the criterion for the second stage arrest group was a second stage length greater than 100 minutes. Women who met the inclusion criteria were invited to participate and provided written informed consent. Women with subsequent pregnancies, multiple pregnancy, or previous pelvic floor surgery were excluded from the study. Ethical approval for the study was obtained from the National Maternity and Mater Misericodiae Hospitals, Dublin, and the Institutional Review Board of the University of Michigan.

Data for the control group of spontaneously delivered women were available for 129 women from our earlier study conducted at the University of Michigan between 1998 and 2001 [4]. A sample size of 20 in each forceps group was calculated to allow a power of over 0.84 and an alpha of 0.05 to detect a difference between an expected injury rate of 70% postulated for the group delivered for second stage arrest, an injury rate of 25% for the group delivered for fetal distress, and an injury rate of 5% for spontaneous delivery estimated from data in our earlier work [4].

All forceps deliveries were non-rotational low-cavity forceps performed by experienced registrars or by consultants. A right mediolateral episiotomy was performed in all of the deliveries.

MRI scans were obtained from the participants at least 1 year after delivery so that transient changes would have resolved. Multiplanar proton density MR images were acquired using the same protocol as in our previously published studies that have demonstrated test-retest reliability [1,4,8]. All MR scans were reviewed independently by two examiners with a minimum of 4 years' experience in assessing levator ani muscles on MR, and the pubovisceral portion of the levator ani muscles were scored on each side on a scale of 0–3 and classified as normal, minor defect, or major defect as previously described [4] (Fig. 1). The examiners were blinded to the second stage group. The *t* test was used to compare continuous variables. The Fisher exact and Mantel-Haenszel tests were used to evaluate differences in muscle defect severity for the different delivery types and to calculate odds ratios and confidence intervals. $P<0.05$ was considered statistically significant.

3. Results

Forty-two women agreed to participate in the study: 21 who had forceps delivery for fetal distress (short second stage) and 21 who had forceps delivery for second stage arrest. One woman from the second stage arrest group became pregnant after recruitment and was withdrawn from the study. Complete scan information was not available for 2 women (1 from each group) because symptoms of claustrophobia led to early termination of the MR scan. In 1 woman in the short second stage group the scan quality was insufficient to grade the muscle defect. The delivery details of the 38 women for whom MRI scans were obtained are shown in Table 1.

Major levator ani muscle defects were seen more frequently in the two forceps groups compared with women who delivered spontaneously: 8 (42%) women with a short second stage and 12 (63%) women with second stage arrest, compared with 8 (6%) who delivered spontaneously (Fig. 2). Odds ratios comparing delivery type and major and minor defects are shown in Table 2. Forceps delivery and second stage arrest compared with spontaneous delivery had the highest odds ratio for major levator injury (OR 25.9; 95% CI, 8.0–84.0). Forceps for fetal distress with short second stage was also greatly increased compared with spontaneous delivery (OR 11.0; 95% CI, 3.5–35.0). Minor injuries were similarly increased in both forceps groups. Although there was a small increased risk of major injury in the forceps for second stage arrest group compared with the short second stage group, this did not reach statistical significance (OR 2.3; 95% CI, 0.64–8.7; $P=0.07$).

In the women delivered by forceps, the right pubovisceral muscle was injured in 30 women (78.9%), and the left muscle in 28 women (73.7%). Three women sustained a disruption of the anal sphincter; all 3 had a major defect. Fifteen women were delivered by senior consultants. There was no difference in the occurrence of defects or defect severity according to obstetrician seniority.

Vacuum delivery was attempted in 21 (55.3%) women prior to delivering the baby by forceps, but no relationship was found between the use of sequential instruments and levator ani injury.

4. Discussion

The data presented in this paper provide evidence that women who are delivered by forceps have higher rates of major levator ani injury compared with women who deliver spontaneously. We found that 42% of woman delivered by forceps for fetal distress and 63% of women delivered by forceps for second stage arrest had major levator defects compared with 6% of women who delivered spontaneously. The odds ratios for fetal distress second stage forceps and for second stage arrest forceps were 11.0 and 25.9, respectively. We focused on major injuries because women with prolapse have an odds ratio of 7.3 for this level of injury compared with controls, while there is no difference in minor injuries for women with prolapse [3]. Although the levator ani muscles were more frequently injured in the group of

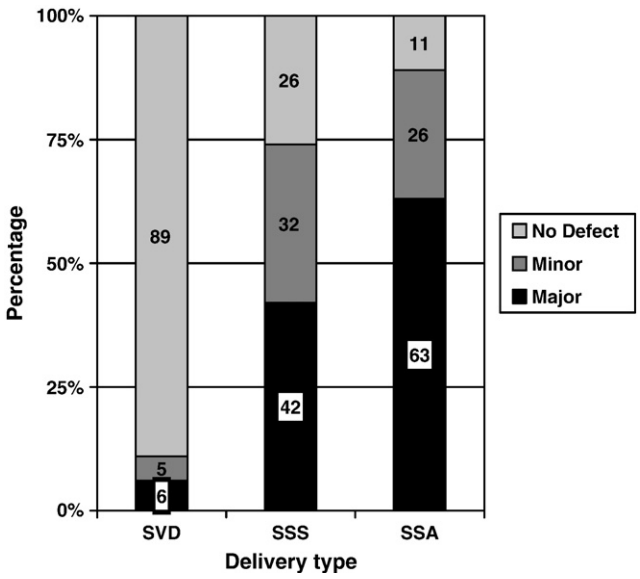

Fig. 2. Percentage of women with major, minor, and no levator ani defects among women who had forceps delivery and short second stage, forceps and second stage arrest, and spontaneous vaginal delivery. SVD, spontaneous vaginal delivery; SSS, short second stage; SSA, second stage arrest.

Table 2
Odds ratios for major and minor injuries comparing forceps delivery with short second stage, forceps with second stage arrest, and spontaneous delivery.

Comparisons	Major injury	Minor injury
	Odds ratio (95% CI)	Odds ratio (95% CI)
Short second stage vs spontaneous	11.0 (3.5–35.0)	9.5 (2.7–33.6)
Second stage arrest vs spontaneous	25.9 (8.0–84.0)	7.3 (2.0–27.1)
Second stage arrest vs short second stage	2.3 (0.64–8.7)	1.3 (0.32–5.3)

women delivered for second stage arrest with long second stages than the group delivered for fetal distress, this result was not statistically significant ($P=0.07$). The finding of a 42% rate of major levator ani injury in the fetal distress group was higher than the 25% postulated at the beginning of the study. This figure of 25% was chosen for the power calculation since it represented the rate of levator ani injury found with vacuum delivery in a previous study [4]. It may be with a larger sample size that the rate of levator ani injury for forceps with second stage arrest is statistically higher than for forceps for fetal distress.

The findings that forceps delivery is associated with increased risk for levator damage are consistent with our earlier investigation of a 14.7 odds ratio for levator injury after forceps and the significant association with operative vaginal birth and levator ani injury shown in other studies [2]. The fact that both groups have substantially more major injuries than women who deliver without forceps indicates that injury is related to the typical use of forceps, even in the absence of second stage arrest and prolonged second stage duration. The increase in defects seen in women delivered for dystocia confirms that forceps are not the only factor involved in increased injury rates in forceps delivery performed for prolonged second stage and that the situation that necessitated the need for operative vaginal delivery also plays a role. Forceps deliveries have been implicated in many studies as a contributing factor to the future development of pelvic floor dysfunction [7,9–12]. Our grading system, which has demonstrated good inter-rater reliability, has been shown to be relevant to pelvic floor dysfunction by positive correlation of major damage categories with pelvic organ prolapse and stress incontinence after birth and reduced muscle contraction force [3,4,8].

Several factors should be kept in mind when interpreting the results of the present study. A case-control design is powerful in seeking specific differences between identified groups, but does not allow us to know the risk for these occurrences in a typical obstetric population. Because of the considerable expense of obtaining MR scans we used historical controls from another study as a comparison group so that the occurrence of injury in the two forceps groups could be compared with that occurring in spontaneous delivery. Although this could introduce some degree of bias owing to the different obstetric practices in the two units, it seems unlikely to explain the dramatic differences in injury rates. In interpreting the results of these studies it is important to recognize the substantial differences in the use of forceps in different regions. Active management of labor in Dublin has been effective in enhancing the success of spontaneous vaginal delivery [13]. In addition, there are considerable variations among obstetric units regarding the length of time that a woman is allowed in the second stage before intervention is undertaken. It is possible that forceps use for second stage arrest might represent individuals with more significant dystocia than seen in other countries, and thus repeat of this research in other populations seems appropriate. It seems likely that with the recent advances in 3D ultrasound, the expense of these studies will be reduced and more observations will become possible.

The findings of this study demonstrate the damage to the levator ani muscles caused by forceps delivery, in association with both long and short second stages of labor. This study suggests that it is the mechanical injury to the levator ani muscle caused by forceps deliveries that predisposes women to developing pelvic floor dysfunction in later life. Although no single study will be able to disentangle this complex web of individual observations concerning obstetric events and levator damage, individual studies can add needed data that will accumulate over time to provide an improved knowledge of causal mechanisms. Our results, in part, explain why other studies have demonstrated problems related to forceps deliveries, such as weaker pelvic floor muscles, that are not entirely explained by neurophysiological investigations. Further research will need to follow up the women with levator ani injury after forceps deliveries to quantify future pelvic floor dysfunction in this population.

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Conflict of interest

The authors have no conflicts of interest to disclose.

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