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Risk Factors for Birth Canal Lacerations in Primiparous Women

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Abstract

Lacerations of the birth canal are common side effects of vaginal birth. They are potentially preventable. Although serious long-term consequences have been identified for severe perineal lacerations, less attention has been paid to lacerations in other locations and how the risk factors vary for different lacerations. We analyzed a dataset including 1009 primiparous women with singleton pregnancies and vaginal deliveries, and we examined risk factors for third- and fourth-degree perineal lacerations and periurethral, vaginal, and labial lacerations using logistic regression analysis. Large fetal size (≥ 3500 g) substantially increased the risk of perineal (odd ratio [OR], 3.8; 95% confidence interval [CI], 1.8 to 7.9) and periurethral (OR, 2.3; 95% CI, 1.0 to 5.0) lacerations but not other types of lacerations. Episiotomy had no impact on perineal lacerations (OR 0.9) but had very strong protective effects for other lacerations (OR 0.1). Prolonged second stage of labor (>120 minutes) increased the risk of perineal and vaginal lacerations but reduced the risk for periurethral lacerations. Instrumental deliveries were significant risk factors for third- and fourth-degree perineal lacerations, with by far the strongest effect for low forceps (OR 25.0 versus <3 for outlet forceps, outlet vacuum, and low vacuum). We concluded that separating different birth canal lacerations is critical in identifying risk factors and potential preventive strategies.

Keywords

Laceration; perineum; duration of second stage; episiotomy

Laceration can be a serious side effect of vaginal delivery. Whereas lacerations can occur in different locations, the third- and fourth-degree perineal lacerations involving an injury of the anal sphincter have the highest clinical importance and draw most attention because injury to the anal sphincter is linked to short-term and long-term fecal incontinence.[1–4]

The third- and fourth-degree degree perineal lacerations were reported to occur in 2 to 19% of vaginal deliveries in the United States, depending on the population and management of delivery.[5] Several risk factors have been identified, including primiparity, large fetal size, operative vaginal delivery, occiput posterior position, prolonged second stage of labor, and horizontal position of the mother during delivery.[6–17] Less attention has been paid to other lacerations such as periurethral, vaginal, labial, or cervical lacerations. Because these

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lacerations may be preventable, we examined the risk factors for all types of lacerations in primiparous women.

METHODS

We used data from an observational retrospective study. Detailed description of the study population has been provided elsewhere.[18] Briefly, the study was designed to examine whether dramatic and rapid increase in epidural analgesia use had a significant impact on the rate of cesarean delivery. We systematically selected a sample of 500 to 700 women from two time periods: before (October 1992 to October 1993) and after (October 1995 to March 1996) a change in the policy advocating the use of epidural analgesia for labor in a military hospital in Hawaii. All women who met the following criteria were included: primiparous, singleton pregnancy, mother's age between 18 and 34 years at admission, gestational age between 37 0/7 and 41 6/7 weeks at delivery (based on last menstrual period or ultrasound), birthweight between 2500 and 4000 g, vertex presentation, and spontaneous onset of labor. Women whose cervical dilatation was >7 cm at admission or duration of labor from admission to delivery was <3 hours were excluded because they would potentially not have sufficient time to use epidural analgesia.

The following information was extracted from medical records by trained midwives: demographic information, assessment at admission, labor progression, labor and delivery summary, anesthesia, and postpartum information. Between the two time periods of data collection, some changes occurred, such as increased use of vacuum versus forceps for operative vaginal delivery, reduction in episiotomy, and increasing maternal age and body mass, most of which reflect changes in practice patterns and social trends but are not necessarily related to the risk factors of interest. Nonetheless, to avoid potential confounding we controlled for the time period in our analysis.

The total sample size of the original study was 1329 women. For the current analysis we restricted the dataset to women who were delivered vaginally (N = 1159). Furthermore, we removed women with missing information for any of the considered variables (13% of eligible women), resulting in a final sample size of 1009 women. Five types of lacerations based on clinical diagnosis were recorded in the medical records: perineal (with additional classification into first to fourth degree), periurethral, vaginal, labial, and cervical lacerations. Because cervical lacerations occurred only in five subjects, we excluded these women from further analysis.

The selection of variables considered in this analysis was based on findings from previous studies. We first present the population characteristics. Women with any types of lacerations were compared with women without laceration in bivariate analysis. All variables associated with the outcome in bivariate analysis at $p < 0.05$ level were included as potential covariates in the initial multinomial logistic regression model. To construct the final model, we used forward selection of variables based on the likelihood ratio test with a significance level of $p < 0.05$. Given the relatively small sample size in relation to the number of variables investigated and the absence of strong theory in support of effect modification, we refrained from the analysis of interactions.

RESULTS

The first column in Table 1 describes the population characteristics. Two thirds of the women were <25 years; 65% were white. Twenty-one percent of the women were overweight or obese before pregnancy. The median weight gain during pregnancy was around 15 kg. The majority of women were primigravid. Half of the women in the sample

had epidural analgesia. Episiotomy was performed in two thirds of the sample (midline episiotomy was used in all but five cases). Information about duration of active phase of first stage (from 4 to 10 cm cervix dilation) was missing for 22% of the women (because they were not examined at 4-cm dilation). Seventeen percent of women had a second stage of labor >2 hours. Five percent of deliveries had occiput-posterior or transverse presentation, 74% had spontaneous delivery, and 39% of the women experienced no lacerations.

Table 1 shows that the third- and fourth-degree perineal lacerations tended to be more common in women who were older (not statistically significant), were underweight prior to pregnancy, had a larger fetus, and received no epidural analgesia. Episiotomy, longer duration of the second stage, occiput-posterior or transverse presentation, and delivery with low forceps were associated with a higher incidence of the perineal laceration. In contrast, longer duration of second stage also reduced the risks of periurethral and labial lacerations. Also episiotomy was consistently associated with lower incidence of these lacerations. Low forceps increased the risk of vaginal laceration.

We then included all the variables just described into a multivariable multinomial logistic regression model using no laceration as a reference category and forward variable selection. Table 2 presents the risk factors for types of lacerations from the final model (controlling for all factors in the table as well as the study period). Older maternal age was only associated with third- and fourth-degree perineal laceration. Large fetal size substantially increased risk of third- and fourth-degree perineal and periurethral lacerations. The effect was much smaller on vaginal and labial lacerations. Episiotomy did not affect the risk of perineal lacerations in the multivariable model (in contrast to bivariate findings) but had very strong protective effects on other lacerations. Prolonged second stage increased risk of perineal and vaginal lacerations. Although all instrumental deliveries were risk factors for third- and fourth-degree lacerations, low forceps was the most prominent with a relative risk of 25 (95% CI, 12.2 to 51.2). Low forceps also increased the risk of vaginal lacerations sevenfold.

DISCUSSION

Our study shows that risk factors for lacerations in different locations of the birth canal vary substantially. Higher maternal age increases the risk of third- and fourth-degree perineal lacerations. Large fetal size brings along with it a higher risk of perineal and periurethral lacerations. Instrumental deliveries, low forceps in particular, are significant risk factors for most lacerations. Episiotomy is not associated with third- and fourth-degree perineal lacerations but exerts strong protection against periurethral, vaginal, and labial lacerations. A long second stage of labor increases risks for perineal and vaginal lacerations but tends to reduce risks for periurethral and labial lacerations.

Most of our findings are consistent with previous literature. For example, instrumental deliveries are consistently associated with a higher risk of lacerations in the literature, and vacuum extraction results in fewer lacerations than forceps.[19–22] We found that this was the case mainly for perineal lacerations and, to a lesser extent, for vaginal, periurethral, or labial lacerations. Our study further showed that the disadvantage of forceps as compared with vacuum was restricted to low forceps, whereas outlet forceps presented a similar risk to vacuum.

In our bivariate analysis, episiotomy was strongly associated with third- and fourth-degree perineal laceration (25.7% with episiotomy versus 5.5% without), which is consistent with previous studies.[23–25] However, after controlling for other factors, especially instrumental delivery, in the multivariable model, episiotomy was no longer a risk factor, suggesting that most of the risk associated with the perineal laceration was mediated through instrumental

delivery or due to confounding by indication. However, our study shows that episiotomy is associated with a reduced risk for lacerations other than perineal. The latter finding was previously reported from randomized trials of episiotomy[26] and observational studies.[27,28] In a meta-analysis of four randomized trials comparing restrictive versus routine use of episiotomy, the restrictive use of episiotomy was associated with a risk increase of 1.79 (95% CI, 1.55 to 2.07) for anterior perineal lacerations.[26]

We also found that duration of the second stage of labor may have opposing effects on different lacerations. Longer duration was associated with a higher risk of perineal and vaginal lacerations, consistent with previous studies.[5,7,10,16,29] On the contrary, a shorter second stage appears to be associated with a higher risk of periurethral and labial lacerations. To our best knowledge, the latter findings have not been reported previously. This association might be explained by mechanics of the delivery: a fast extension of fetal head in a short second stage resulting in the anterior trauma.

Several limitations in our study should be noted. First, like most previous studies, the diagnosis of lacerations was based on clinical judgment in our study. Comparing with a randomized trial in which assessment of lacerations was standardized,[30] our study appeared to have a lower incidence of most lacerations (i.e., superficial tears may not have been recorded). Thus our findings may be more applicable to more substantial lacerations. Second, classification of the degree of perineal laceration could vary from physician to physician. This variation is more likely to be non-differential, which could have drawn the results toward the null.

Third, because the data were collected a decade ago, obstetric practice may have changed to certain degree. For instance, episiotomy is less used now. Although differences in obstetric practice could potentially affect the incidence of lacerations, it is less likely that the practice change would materially influence the *associations* between the risk factors and the different types of lacerations in the multivariable model controlling for other factors. Finally, our study population consisted of women of 18 to 34 years of age with a normal birthweight baby. Thus our findings may not be extrapolated to women outside this age range or with macrosomia or low birthweight babies.

In conclusion, we confirmed the association between longer second stage and perineal lacerations, but our findings point toward an increased risk of periurethral or labial lacerations in deliveries with a short second stage. Future studies should classify subtypes of laceration according to their location to allow more specific analyses. Findings from detailed analyses may help identify preventive strategies.

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References

1. Eason E, Labrecque M, Marcoux S, Mondor M. Anal incontinence after childbirth. CMAJ. 2002; 166:326–330. [PubMed: 11868640]
2. Borello-France D, Burgio KL, Richter HE, et al. Fecal and urinary incontinence in primiparous women. Obstet Gynecol. 2006; 108:863–872. [PubMed: 17012447]
3. Crawford LA, Quint EH, Pearl ML, DeLancey JO. Incontinence following rupture of the anal sphincter during delivery. Obstet Gynecol. 1993; 82:527–531. [PubMed: 8377977]

4. Fenner DE, Genberg B, Brahma P, Marek L, DeLancey JO. Fecal and urinary incontinence after vaginal delivery with anal sphincter disruption in an obstetrics unit in the United States. Am J Obstet Gynecol. 2003; 189:1543–1549. discussion 1549–1550. [PubMed: 14710059]
5. Albers LL, Migliaccio L, Bedrick EJ, Teaf D, Peralta P. Does epidural analgesia affect the rate of spontaneous obstetric lacerations in normal births? J Midwifery Womens Health. 2007; 52:31–36. [PubMed: 17207748]
6. Altman D, Ragnar I, Ekstrom A, Tyden T, Olsson SE. Anal sphincter lacerations and upright delivery postures—a risk analysis from a randomized controlled trial. Int Urogynecol J Pelvic Floor Dysfunct. 2007; 18:141–146. [PubMed: 16636770]
7. Altman MR, Lydon-Rochelle MT. Prolonged second stage of labor and risk of adverse maternal and perinatal outcomes: a systematic review. Birth. 2006; 33:315–322. [PubMed: 17150071]
8. Baumann P, Hammoud AO, McNeeley SG, Derose E, Kudish B, Hendrix S. Factors associated with anal sphincter laceration in 40,923 primiparous women. Int Urogynecol J Pelvic Floor Dysfunct. 2007; 18:985–990. [PubMed: 17211527]
9. Benavides L, Wu JM, Hundley AF, Ivester TS, Visco AG. The impact of occiput posterior fetal head position on the risk of anal sphincter injury in forceps-assisted vaginal deliveries. Am J Obstet Gynecol. 2005; 192:1702–1706. [PubMed: 15902181]
10. Cheng YW, Hopkins LM, Caughey AB. How long is too long: does a prolonged second stage of labor in nulliparous women affect maternal and neonatal outcomes? Am J Obstet Gynecol. 2004; 191:933–938. [PubMed: 15467567]
11. Christianson LM, Bovbjerg VE, McDavitt EC, Hullfish KL. Risk factors for perineal injury during delivery. Am J Obstet Gynecol. 2003; 189:255–260. [PubMed: 12861171]
12. Dandolu V, Chatwani A, Harmanli O, Floro C, Gaughan JP, Hernandez E. Risk factors for obstetrical anal sphincter lacerations. Int Urogynecol J Pelvic Floor Dysfunct. 2005; 16:304–307. [PubMed: 15809773]
13. Lowder JL, Burrows LJ, Krohn MA, Weber AM. Risk factors for primary and subsequent anal sphincter lacerations: a comparison of cohorts by parity and prior mode of delivery. Am J Obstet Gynecol. 2007; 196:344.e1–5. [PubMed: 17403415]
14. Samuelsson E, Ladfors L, Wennerholm UB, Gareberg B, Nyberg K, Hagberg H. Anal sphincter tears: prospective study of obstetric risk factors. BJOG. 2000; 107:926–931. [PubMed: 10901566]
15. Senecal J, Xiong X, Fraser WD. Effect of fetal position on second-stage duration and labor outcome. Obstet Gynecol. 2005; 105:763–772. [PubMed: 15802403]
16. Sheiner E, Walfisch A, Hallak M, Harlev S, Mazor M, Shoham-Vardi I. Length of the second stage of labor as a predictor of perineal outcome after vaginal delivery. J Reprod Med. 2006; 51:115–119. [PubMed: 16572912]
17. Wu JM, Williams KS, Hundley AF, Connolly A, Visco AG. Occiput posterior fetal head position increases the risk of anal sphincter injury in vacuum-assisted deliveries. Am J Obstet Gynecol. 2005; 193:525–528. discussion 528–529. [PubMed: 16098883]
18. Zhang J, Yancey MK, Klebanoff MA, Schwarz J, Schweitzer D. Does epidural analgesia prolong labor and increase risk of cesarean delivery? A natural experiment. Am J Obstet Gynecol. 2001; 185:128–134. [PubMed: 11483916]
19. Johanson RB, Rice C, Doyle M, et al. A randomised prospective study comparing the new vacuum extractor policy with forceps delivery. Br J Obstet Gynaecol. 1993; 100:524–530. [PubMed: 8334086]
20. Johnson JH, Figueroa R, Garry D, Elimian A, Maulik D. Immediate maternal and neonatal effects of forceps and vacuum-assisted deliveries. Obstet Gynecol. 2004; 103:513–518. [PubMed: 14990415]
21. Meyer L, Mailloux J, Marcoux S, Blanchet P, Meyer F. Maternal and neonatal morbidity in instrumental deliveries with the Kobayashi vacuum extractor and low forceps. Acta Obstet Gynecol Scand. 1987; 66:643–647. [PubMed: 3439447]
22. Bofill JA, Rust OA, Schorr SJ, et al. A randomized prospective trial of the obstetric forceps versus the M-cup vacuum extractor. Am J Obstet Gynecol. 1996; 175:1325–1330. [PubMed: 8942509]
23. Shiono P, Klebanoff MA, Carey JC. Midline episiotomies: more harm than good? Obstet Gynecol. 1990; 75:765–770. [PubMed: 2183106]

24. Minaglia SM, Ozel B, Gatto NM, Korst L, Mishell DR Jr, Miller DA. Decreased rate of obstetrical anal sphincter laceration is associated with change in obstetric practice. Int Urogynecol J Pelvic Floor Dysfunct. 2007; 18:1399–1404. [PubMed: 17390092]

25. Hartmann K, Viswanathan M, Palmieri R, Gartlehner G, Thorp J Jr, Lohr KN. Outcomes of routine episiotomy: a systematic review. JAMA. 2005; 293:2141–2148. [PubMed: 15870418]

26. Carroli G, Belizan J, Stamp G. Episiotomy for vaginal birth. Birth. 1999; 26:263. [PubMed: 10655834]

27. Ecker JL, Tan WM, Bansal RK, Bishop JT, Kilpatrick SJ. Is there a benefit to episiotomy at operative vaginal delivery? Observations over ten years in a stable population. Am J Obstet Gynecol. 1997; 176:411–414. [PubMed: 9065190]

28. Bansal RK, Tan WM, Ecker JL, Bishop JT, Kilpatrick SJ. Is there a benefit to episiotomy at spontaneous vaginal delivery? A natural experiment. Am J Obstet Gynecol. 1996; 175:897–901. [PubMed: 8885744]

29. Fitzgerald MP, Weber AM, Howden N, Cundiff GW, Brown MB. Risk factors for anal sphincter tear during vaginal delivery. Obstet Gynecol. 2007; 109:29–34. [PubMed: 17197584]

30. Albers L, Garcia J, Renfrew M, McCandlish R, Elbourne D. Distribution of genital tract trauma in childbirth and related postnatal pain. Birth. 1999; 26:11–17. [PubMed: 10352050]

Table 1

Incidence of Lacerations by Women's Characteristics

		Lacerations			
		Perineal 3rd or 4th Degree	Periurethral	Vaginal	Labial
	Population Characteristics	(N = 182)	(N = 88)	(N = 94)	(N = 64)
Variable	N (%)	%	%	%	%
Age of the mother					
<20 y	117 (12)	13.7	8.6	11.1	6.8
20–24 y	549 (54)	16.8	9.5	8.6	6.7
25–29 y	262 (26)	21.4	8.4	10.3	5.0
≥ 30 y	81 (8.0)	22.2	4.9	8.6	7.4
Race of the mother					
Asian	113 (11)	25.7	8.0	10.6	6.2
Black	121 (12)	12.4	11.6	12.4	6.6
Hispanic	69 (6.9)	20.3	7.3	8.7	8.7
White	660 (65)	17.6	8.2	9.1	5.9
Other	46 (4.6)	17.4*	13.0	2.2	8.7
Mother's BMI prior to pregnancy					
<20 kg/m^2	236 (23)	24.2	6.4	8.1	5.1
20–24.9 kg/m^2	564 (56)	16.8	10.1	9.2	7.1
25–29.9 kg/m^2	159 (16)	13.8	8.2	11.3	6.9
>30 kg/m^2	50 (5.0)	16.0	6.0	10.0	2.0
Weight gain during pregnancy					
<10 kg	135 (14)	15.6	4.4	6.7	10.4
10–20 kg	631 (63)	17.3	8.7	10.3	5.2
≥ 20 kg	243 (24)	21.4	11.1	8.2	7.0
Gestational age at delivery					
37 wk	67 (6.6)	10.5	4.5	10.5	9.0
38 wk	179 (18)	15.6	8.9	7.8	5.0
39 wk	290 (29)	16.6	11.0	7.6	7.2

		Lacerations			
		Perineal 3rd or 4th Degree	Periurethral	Vaginal	Labial
	Population Characteristics	(N = 182)	(N = 88)	(N = 94)	(N = 64)
Variable	N (%)	%	%	%	%
40 wk	347 (35)	19.3	8.1	11.2	5.5
41 wk	126 (12)	25.4†	7.1	9.5	7.1
Birthweight					
2500–2999 g	160 (16)	8.8	8.1	10.0	8.8
3000–3499 g	457 (45)	19.0	8.3	8.8	5.5
3500–4000 g	392 (39)	20.7†	9.4	9.7	6.4
Epidural anesthesia					
No	494 (49)	21.7	9.9	9.3	5.3
Yes	515 (51)	14.6‡	7.6‡	9.3‡	7.4‡
Episiotomy					
No	382 (38)	5.5	13.6	14.7	13.1
Yes	627 (62)	25.7	5.7	6.1	2.2
Duration of active phase (cervix dilation 4–10 cm)					
Missing	219 (22)	19.6	10.1	9.1	4.6
<5 hr	225 (33)	15.8	8.7	11.0	7.2
≥ 5 hr	455 (45)	18.9‡	8.1‡	8.1*	6.6*
Duration of second stage					
<30 min	243 (24)	11.5	13.2	7.4	9.9
30–60 min	309 (31)	14.9	11.3	11.7	5.8
60–90 min	177 (18)	20.9	5.1	6.2	4.0
90–120 min	112 (11)	21.4	8.0	9.8	2.7
>120 min	168 (17)	28.0*	1.8*	10.7	7.1
Presentation at delivery					
Occiput anterior	951 (95)	17.5	9.04	9.2	6.4
Occiput transverse or occiput posterior	51 (5.1)	31.4‡	0.00	11.8*	5.9
Delivery mode					

		Lacerations			
		Perineal 3rd or 4th Degree	Periurethral	Vaginal	Labial
	Population Characteristics	(N = 182)	(N = 88)	(N = 94)	(N = 64)
Variable	N (%)	%	%	%	%
Spontaneous	750 (74)	10.7	9.6	8.1	6.5
Outlet forceps	38 (3.8)	29.0	2.6	7.9	7.9
Low forceps	99 (9.8)	58.6	5.1	18.2	6.1
Outlet vacuum	93 (9.2)	24.7	8.6	10.8	6.5
Low vacuum	29 (2.9)	34.5	6.9	6.9	0.0

$^{*}p < 0.05$,

$^{\dagger}p < 0.01$,

$^{\ddagger}p < 0.001$, based on chi-square test comparing women with the given subtype of lacerations with women who did not have this laceration.

Table 2

Variables Associated with Lacerations in Nulliparous Women (Each Laceration Category Compared with No Laceration)

	Risk of Lacerations			
	Perineal (3rd or 4th Degree)	**Periurethral**	**Vaginal**	**Labial**
Variable	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age of the mother				
<20 y	Reference	Reference	Reference	Reference
20–24 y	1.0 [0.5, 1.9]	1.0 [0.4, 2.2]	0.6 [0.2, 1.3]	0.8 [0.3, 2.2]
25–29 y	2.0 [1.0, 4.2]	1.6 [0.7, 4.0]	1.4 [0.6, 3.4]	0.6 [0.2, 2.1]
≥ 30 y	2.0 [0.8, 5.0]	0.8 [0.2, 3.5]	0.9 [0.2, 3.1]	2.0 [0.5, 7.5]
Birthweight				
2500–2999 g	Reference	Reference	Reference	Reference
3000–3499 g	3.4 [1.6, 7.0]	1.5 [0.7, 3.3]	1.4 [0.7, 3.2]	0.9 [0.4, 2.0]
3500–4000 g	3.8 [1.8, 7.9]	2.3 [1.0, 5.0]	1.8 [0.8, 4.1]	1.5 [0.6, 3.0]
Episiotomy				
No	Reference	Reference	Reference	Reference
Yes	0.9 [0.5, 1.6]	0.1 [0.0, 0.1]	0.1 [0.0, 0.1]	0.0 [0.0, 0.1]
Duration of second stage				
<30 min	Reference	Reference	Reference	Reference
30–60 min	1.4 [0.8, 2.6]	0.9 [0.5, 1.7]	2.4 [1.1, 5.5]	0.7 [0.3, 1.6]
60–90 min	1.9 [1.0, 3.7]	0.3 [0.1, 0.8]	1.0 [0.4, 2.9]	0.4 [0.1, 1.2]
90–120 min	2.0 [1.0, 4.3]	0.7 [0.3, 1.9]	2.8 [1.0, 7.8]	0.4 [0.1, 1.6]
>120 min	1.9 [1.0, 3.9]	0.2 [0.1, 0.7]	2.4 [0.9, 6.6]	0.7 [0.3, 2.2]
Delivery mode				
Spontaneous	Reference	Reference	Reference	Reference
Outlet forceps	2.8 [1.2, 6.4]	0.4 [0.0, 3.2]	1.0 [0.2, 3.9]	1.2 [0.3, 5.1]
Low forceps	25.0 [12.2, 51.2]	2.3 [0.7, 7.7]	7.0 [2.6, 18.7]	1.6 [0.3, 7.9]
Outlet vacuum	2.8 [1.5, 5.2]	1.7 [0.6, 4.4]	1.8 [0.7, 4.7]	1.4 [0.4, 4.6]
Low vacuum	2.2 [0.9, 5.6]	1.4 [0.3, 6.9]	1.5 [0.3, 8.0]	NA

Note: Multinomial logistic regression adjusted for period of data collection and all other variables in the table.

If a woman had more than one type of laceration, which is uncommon in our study (8%), we assigned her to the most severe laceration.

OR, odds ratio; CI, confidence interval; NA, not available.