

Factors associated with anal sphincter laceration in 40,923 primiparous women

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Abstract The objective of this study was to identify factors associated with anal sphincter laceration in primiparous women. A subpopulation of 40,923 primiparous women at term with complete data sets was abstracted from a state-wide perinatal database in Germany. Outcome variable was anal sphincter laceration. Independent variables were 17 known obstetrical risk factors/conditions/interventions impacting childbirth recorded on the perinatal data collection sheet. Cross table analysis followed by logistic regression analysis was used for data analysis. Logistic regression showed episiotomy (OR, 3.23; CI, 2.73–3.80) and forceps delivery (OR, 2.68, CI, 2.17–3.33) to be most strongly associated with anal sphincter laceration. Women with a BMI ≥ 30 kg/m², and smokers had a significantly lower risk of anal sphincter laceration. Local, pudendal, and epidural analgesia all reduced the risk of anal sphincter laceration. Iatrogenic factors most strongly associated with anal sphincter laceration in primiparous women include routine episiotomy and forceps delivery.

Keywords Body mass index · Anal sphincter laceration · Labor analgesia · Vacuum · Forceps · Routine episiotomy

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Introduction

In 2001, the Joint Commission on Accreditation of Health-care Organizations introduced anal sphincter lacerations as a quality indicator of obstetrical care and, as of 2003, started publicizing this information for accredited hospitals [1]. The rationale is that these lacerations can result in significant long-term morbidity including, but not limited to, dyspareunia, flatal and fecal incontinence, anorectal abscess, and rectovaginal fistula [1, 2]. As active measures to “protect” the perineum, e.g., perineal massage, have been and continue to be investigated without any of them showing a clear-cut benefit [3–5], the commissions advisory panel apparently intended to promote the prudent application of obstetrical interventions that are known to be associated with anal sphincter laceration, e.g., routine episiotomy or forceps delivery [6–8]. Among extensive existing literature, there are only few studies that have large enough numbers to permit a comprehensive analysis of the contemporary process of parturition [7, 9, 10].

Drawing on a large state-wide perinatal database spanning the years from 1991–1997 including 40,923 complete data sets, we set out juxtaposing maternal factors, fetal factors, and contemporary obstetrical interventions and anal sphincter laceration to determine if and to what extent those factors may contribute to this condition.

Materials and methods

We used a version of the perinatal database of the State of Schleswig–Holstein, Germany between 1991 and 1997 containing data that had been blinded in compliance with national and state health data protection regulations. This study has been reviewed by Wayne State University's

Human Investigation Committee and found to qualify for exemption according to paragraph #2 of 45 CFR 46.101 (b) of the Code of Federal Regulations of the Department of Health and Human Services. Data used in this paper had been collected prospectively at the time of admission for delivery. Upon taking the mother's "history and physical" data already entered in a prenatal care booklet, it was reviewed with the mother. This data pertained to past health issues, those existing at the beginning of and those having arisen during pregnancy. This information was then transferred to a data collection form divided into five sections: maternal socio-demographic characteristics, course of pregnancy including risk factors, delivery characteristics including indications for operative delivery, characteristics of the neonate, and postpartum maternal complications. The data collection sheet did not provide for entry of different types of episiotomy. On a monthly basis, each delivery unit in the state of Schleswig–Holstein forwards the perinatal data sheets to a central collecting agency, where the data is entered into a computer and checked for plausibility.

Inclusion criteria for our study were nulliparity, singleton pregnancy, 37–42 completed weeks gestation, vertex presentation, and vaginal delivery of a live or still born baby.

Statistical analysis was performed with SPSS 13.0 using cross table analysis with χ^2 -testing to determine differences in rates between anal sphincter laceration and presence or absence of obstetrical risk factors/conditions/interventions impacting child birth defined in the perinatal data collection sheet. Those shown to be associated with anal sphincter laceration were included in logistic regression analysis to determine whether they were independently associated with anal sphincter laceration. A sample size estimate revealed that 18,779 complete data sets were needed to demonstrate an association between variables and anal sphincter laceration with a $p < 0.001$ and a power of 99% [11]. Bonferroni's correction was used with exact two-sided $p < 0.005$ ($p = 0.05/17$) based on 17 variables considered significant to alert for any variables in the logistic regression that may indicate mere chance than true association with anal sphincter association. For practical obstetrical purposes, continuous variables were transformed into interval variables such as to allow for analysis of interval scales. For practical, statistical reasons up to a maximum of seven intervals rather than percentiles were chosen: duration of labor, seven increments of 2 h starting at <2 h, ending at ≥ 12 h; active pushing as of the woman's urge to push, seven increments of 5 min starting at <5 min, ending at ≥ 30 min; birth weight, seven increments of 250 g starting at <2,500 g, ending at $\geq 4,000$ g; head circumference, seven increments of 1 cm starting at <32 cm, ending at ≥ 38 cm. Body mass index (BMI) was calculated using

the weight recorded at the last prenatal visit before delivery; women were classified into BMI <25, 25–29.9, 30–34.9, 35–39.9, and ≥ 40 . For variables with several classes (maternal BMI, birth weight, head circumference, duration of labor, duration of pushing, and analgesia), in logistic regression analysis, the class consisting of the highest number of women was chosen as the reference class. Outcome variable was absence or presence of anal sphincter laceration. Independent dichotomous variables were: advanced maternal age (AMA, age < or ≥ 35 years), cigarette smoking, prolonged first (>6 h) and second (>2 h) stage of labor, episiotomy, vertex malpresentation, e.g., occiput posterior, operative vaginal delivery separately for forceps and vacuum, labor augmentation with oxytocin, and administration of i.v. tocolytics (fenoterol; i.v. push or, e.g., after a prolonged deceleration as long as needed to have a fetal heart rate between 120 and 160 bpm for 30 min).

Results

From 170,258 singleton pregnancies, 40,923 complete data sets of women meeting inclusion criteria were used. The study population was exclusively of Caucasian origin. Table 1 displays descriptive statistics as well as results of cross table analysis and logistic regression of obstetrical risk factors/conditions/interventions impacting child birth in women without and with anal sphincter laceration.

Women with anal sphincter laceration were slightly older than those without the affliction (28.4 ± 4.0 vs 27.1 ± 4.5 years, mean \pm standard deviation; $p < 0.001$). Moreover, women with anal sphincter laceration had longer been in labor (9.0 ± 5.7 h vs 8.1 ± 5.3 h; $p < 0.001$), had longer been actively pushing (22 ± 15 min vs 19 ± 14 min; $p < 0.001$), and their off-spring had higher birth weights ($3,600 \pm 430$ g vs $3,455 \pm 430$ g; $p < 0.001$) and greater head circumferences (35.4 ± 1.5 cm vs 34.9 ± 1.4 cm; $p < 0.001$) than controls.

Bivariate (cross table) analysis revealed significantly higher proportions of age ≥ 35 years, i.v. tocolysis, prolonged second stage of labor, oxytocin augmentation, episiotomy, forceps, vacuum, and abnormal vertex presentation in women who suffered from anal sphincter laceration than in those who did not (Table 1).

In contrast, women who smoked cigarettes and women with a BMI > 30 kg/m² had lower rates of anal sphincter laceration (Table 1).

The following 17 variables were forcedly entered into logistic regression: age ≥ 35 years, BMI, smoker, oxytocin augmentation, i.v. tocolysis, analgesia, abnormal vertex presentation, prolonged first stage, prolonged second stage, duration of labor, duration of pushing, pyrexia in labor, episiotomy, forceps, vacuum, birth weight, and head circumference. Among these, the following were signifi-

Table 1 Cross table analysis of descriptive characteristics and forced entry logistic regression of factors associated with third/fourth degree anal sphincter laceration in 40,293 primiparous women with singleton

pregnancies abstracted from the state of Schleswig–Holstein, Germany Perinatal Database 1991–1997 (complete datasets)

	Anal sphincter laceration (ASL)						
	Cross table analysis				Logistic regression		
	ASL No		ASL Yes		Odds ratios	95 % Confidence interval	
	Number	Percent	Number	Percent			
Maternal age >35	1,380	3.6	93	4.6*	1.17	0.94	1.45
Cigarette smoking	7,986	20.9	301	14.9***	0.80	0.70	0.90
BMI \geq 30 kg/m ²	2,363	6.2	76	3.8***			
Preeclampsia	894	2.3	35	1.7 ^a			
Diabetes mellitus	46	0.1	0	0 ^a			
Gestational diabetes	98	0.3	6	0.3 ^a			
Abnormal vertex present.	1,606	4.8	166	9.4***	1.71	1.43	2.04
Labor induction	5,093	13.3	256	12.7 ^a			
Oxytocin labor augmentation	17,577	45.9	1050	52.1***	1.02	0.92	1.13
Intrauterine resuscitation with i.v. fenoterol	3,344	8.7	238	11.8***	1.33	1.15	1.54
Premature rupture of membranes	9,933	25.9	543	26.9 ^a			
Temperature > 38°C during labor	258	0.7	26	1.3**	1.43	0.94	2.19
Prolonged first stage of labor (>6 h)	1,954	5.1	119	5.9 ^a			
Prolonged second stage (>2 h)	4,504	11.8	407	20.2***	1.17	1.01	1.36
Meconium-stained amniotic fluid	3,213	8.4	194	9.6 ^a			
Analgesia							
Epidural	5,034	13.2	285	14.1	0.66	0.57	0.77
Pudendal	3,600	9.4	119	5.1	0.38	0.31	0.47
Local	9,152	23.9	495	24.6	0.64	0.56	0.72
Paracervical block	19	0.0	9	0.4	2.29	0.98	5.33
General anesthesia	756	2.0	66	3.3	1.31	1.00	1.71
Other	665	1.7	71	3.5	1.58	1.21	2.06
No analgesia	19,052	49.8	970	48.1			
Episiotomy	29,450	76.9	1851	91.9***	3.23	2.73	3.80
Vacuum	4,316	11.3	322	16.0***	1.21	1.03	1.42
Forceps	943	2.5	145	7.2***	2.68	2.17	3.32

*p<0.05; **p<0.01; ***p<0.001

^aNS

cantly associated with anal sphincter laceration: episiotomy (OR, 3.23; CI 2.73–3.80), forceps delivery (OR, 2.68; CI, 2.17–3.32), abnormal vertex presentation (OR, 1.71; CI, 1.43–2.04), use of fenoterol (OR, 1.33; CI, 1.15–1.54), and vacuum delivery (OR, 1.21; 1.03–1.42; Table 1). Whereas anal sphincter lacerations were observed in any birth weight or head circumference category, as compared with the reference groups 3,250–3,499 g and 35–35.9 cm, a significant and steady increase in laceration rates started to be seen at birth weights greater than 3,750 g [3,750–3,999 g (OR, 1.21; CI, 1.04–1.41) and \geq 4,000 g (OR, 1.53; CI, 1.29–1.80); Fig. 1] and head circumferences of 36 cm and greater [36–36.9 cm (OR, 1.21; CI, 1.06–1.37), 37–37.9 cm (OR, 1.23; CI, 1.04–1.46), and \geq 38 cm (OR, 1.55; CI, 1.22–1.96); Fig. 2]. Duration of pushing, but not duration of labor, was significantly associated with anal sphincter lacerations after more than 25 min [25–29.9 min

(OR, 1.29; CI, 1.04–1.60) and \geq 30 min (OR, 1.32; CI, 1.11–1.48)] in this model (Figs. 3 and 4). Whereas oxytocin labor augmentation was not associated with anal sphincter lacerations, fenoterol administration increased the risk by 33% (OR, 1.33; CI, 1.15–1.54; Table 1).

Compared to “no analgesia”, local, pudendal, or epidural analgesia all reduced the risk of anal sphincter laceration (Table 1). Interestingly, women who smoked and those with a BMI \geq 30 kg/m² had a significantly lower risk of anal sphincter laceration (Fig. 5).

Discussion

During the time period of our study, obstetrics in this most northern part of Germany bordering the Scandinavian countries was characterized by almost every other woman’s

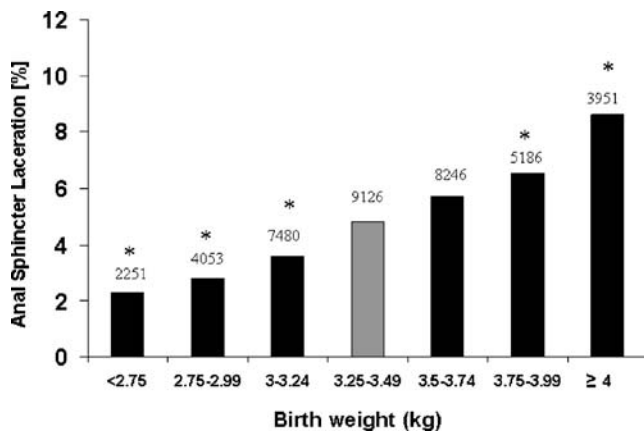


Fig. 1 Rates of anal sphincter laceration in different birth weight classes in 40,293 primiparous women. *Numbers*, number of cases in class; *asterisks*, statistically significantly different ($p < 0.001$) from reference class (column in gray) as determined by logistic regression analysis. Odds ratios and 95 % confidence intervals: <2,750 g (OR, 0.580 and CI, 0.42–0.80), 2750–2,999 g (OR, 0.64; CI, 0.51–0.80), 3,000–3,249 g (OR, 0.80 and CI, 0.68–0.93), 3,500–3,749 g (OR, 1.12 and CI, 0.98–1.29), 3,750–3,999 g (OR, 1.21; CI, 1.04–1.41), and $\geq 4,000$ g (OR, 1.53 and CI, 1.29–1.80)

labor being augmented with oxytocin, almost 10% receiving iv. fenoterol for intrauterine fetal resuscitation or for epidural placement, a comparably low rate (19%) of women receiving epidural anesthesia for pain relief, and an episiotomy rate of almost 80%. In terms of operative vaginal deliveries, obstetricians by far preferred vacuum to forceps. Given this scenario, the rate of anal sphincter lacerations was 5.2%; recent studies from Austria and the USA quote rates of 4.4 and 4.6%, respectively [6, 12]. Our analysis shows that obstetrical interventions as well as fetal and maternal factors were associated with anal sphincter lacerations. Interestingly, obstetrical interventions, predom-

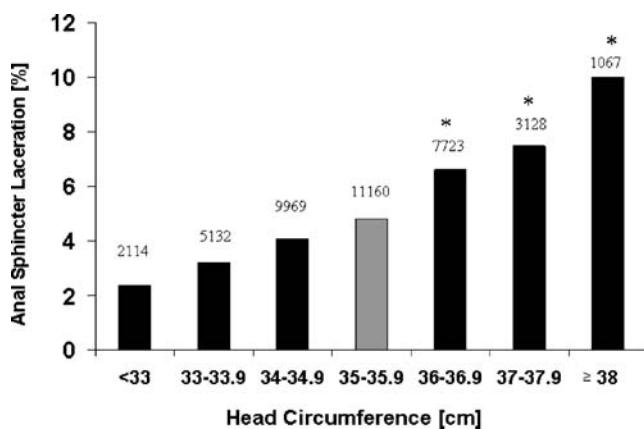


Fig. 2 Rates of anal sphincter laceration in different head circumference classes of newborns in 40,293 primiparous women. For legend, see Fig. 1. Odds ratios and 95 % confidence intervals: <33 cm (OR, 0.73 and CI, 0.53–1.01), 33–33.9 cm (OR, 0.89 and CI, 0.73–1.08), 34–34.9 cm (OR, 0.98 and CI, 0.86–1.13), 36–36.9 cm (OR, 1.21 and CI, 1.06–1.37), 37–37.9 cm (OR, 1.23 and CI, 1.04–1.46), and ≥ 38 cm (OR, 1.55 and CI, 1.22–1.96)

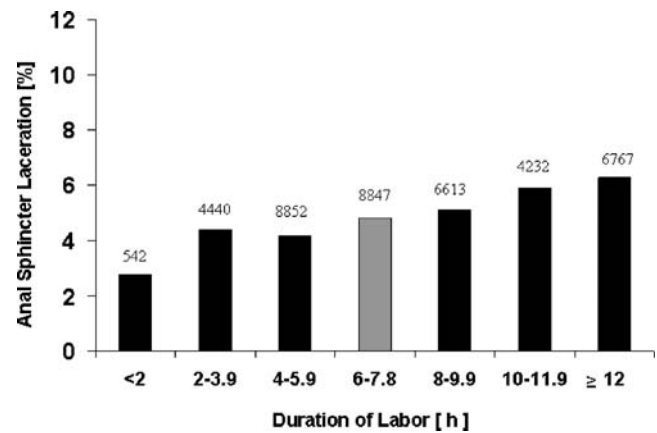


Fig. 3 Rates of anal sphincter laceration in different duration-of-labor classes in 40,293 primiparous women. For legend, see Fig. 1. Odds ratios and 95 % confidence intervals: <2 h (OR, 0.74 and CI, 0.44–1.25), 2–3.9 h (OR, 1.07 and CI, 0.89–1.27), 4–5.9 h (OR, 0.93 and CI, 0.80–1.07), 8–9.9 h (OR, 1.0 and CI, 0.86–1.16), 10–11.9 h (OR, 1.14 and CI, 0.96–1.34), and ≥ 12 h (OR, 1.14 and CI, 0.98–1.31)

inantly episiotomy, and forceps assisted delivery had the gravest impact.

Historically, caretakers focused on avoiding anal sphincter laceration by manually supporting the perineum of head and shoulders during delivery, many times unsuccessfully [5]. One of the protagonists of perineotomy who, making necessity a virtue, tried to avoid more severe injury by intentionally creating space by means of episiotomy/perineotomy was Michaelis in Germany in 1799. In fact, he performed a midline perineotomy in a selected case; subsequently, systematic studies from the US as well as from Europe reporting favorably on this technique appeared in the literature [13–15] Indiscriminate use of episiotomy led to the currently prevailing notion that “routine”

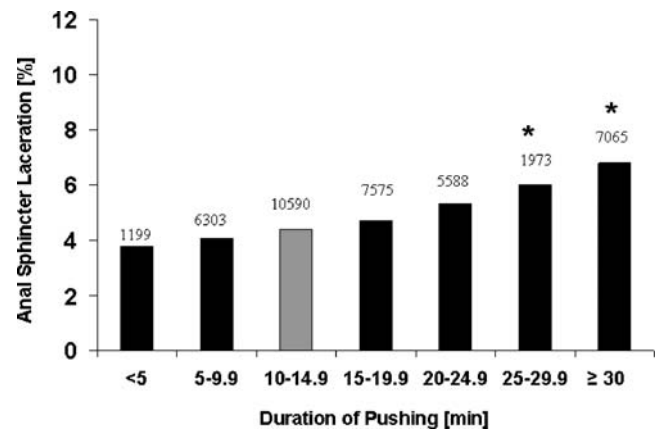


Fig. 4 Rates of anal sphincter laceration in different duration-of-active-pushing classes in 40,293 primiparous women. For legend, see Fig. 1. Odds ratios and 95 % confidence intervals: <5 min (OR, 0.88 and CI, 0.64–1.20), 5–9.9 min (OR, 0.97 and CI, 0.83–1.14), 10–14.9 min (OR, 1.02 and CI, 0.89–1.18), 20–24.9 min (OR, 1.15 and CI, 0.99–1.38), 25–29.9 min (OR, 1.29 and CI, 1.04–1.60), and ≥ 30 min (OR, 1.32 and CI, 1.15–1.52)

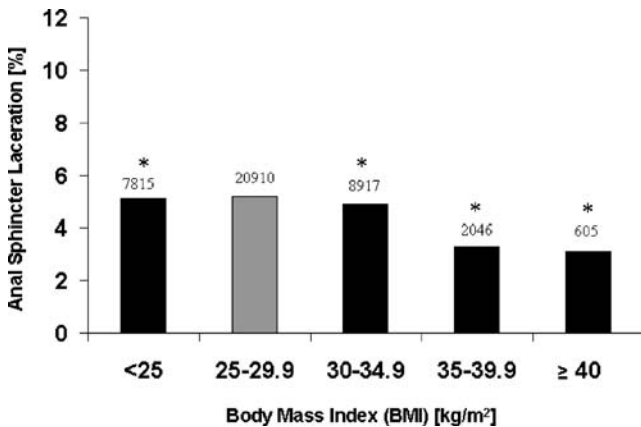


Fig. 5 Rates of anal sphincter laceration in different BMI classes in 40,293 primiparous women. For legend, see Fig. 1. Odds ratios and 95 % confidence intervals: <25 (OR, 1.15 and CI, 1.02–1.30), 30–34.9 (OR, 0.88 and CI, 0.78–0.98), 35–39.9 (OR, 0.55 and CI, 0.43–0.71), and ≥40 (OR, 0.63 and CI, 0.42–0.95)

episiotomy does more harm than good [16]. Our database supports that notion with the caveat that we do not have information on the type of incision. During the study period, midline as well as mediolateral episiotomies were used, the former said to promote, whereas the latter said to protect from perineal injury [6, 9, 12, 15, 17]. Although the direction of the episiotomy seems to be important, other factors are likely to be as important, e.g., cutting the episiotomy at or shortly after the pain acme, with one expeditious cut at exactly the anticipated length or controlling expulsion of head and shoulders [8, 18].

Use of forceps in our model is the second most prominent factor in the strength of association with anal sphincter injury. This is in line with the literature where there is now unequivocal agreement that forceps-assisted vaginal delivery exposes surrounding tissues and the pelvic floor at risk for potentially severe damage [6, 7, 9, 19]. In contrast, vacuum assisted delivery in our study shows a much weaker association with anal sphincter injury than forceps-assisted delivery.

Among the remaining factors in our study shown to be associated with anal sphincter injury, “abnormal fetal vertex presentation,” e.g., occiput posterior or occiput transverse, fetal weight, head circumference, and prolonged labor have been recognized as risk factors for anal sphincter laceration in previous publications [6–9, 12, 19–22]. An additional factor in our study presenting a risk for anal sphincter lacerations was prolonged pushing, starting with the parturients urge to push of more than 25 min [18, 23]. Augmentation of labor with i.v. oxytocin is probably the most frequent medical intervention during labor. Our findings are in accord with those of others who, also, did not find oxytocin augmentation to be an independent factor associated with pelvic floor injury [24]. We did, however, find another medical interven-

tion, i.v. administration of fenoterol, to pose an independent risk of anal sphincter laceration to the almost 10% of women in our study who received this β -sympathomimetic agent for intrauterine fetal resuscitation or to block contractions while an epidural catheter was placed. To our knowledge, the role of β -sympathomimetics has never been examined in any study of pelvic floor injuries. Beta-sympathomimetics have profound pharmacological effects including, but not limited to, increased tissue oxygen consumption, hyperglycemia, hypokalemia, and an increase in lactic acid output [25, 26]; they may alter the electro-mechanical coupling mechanism of muscle cells via calcium antagonism, which altogether potentially promotes tissue disintegration under physical stress [27, 28].

Still another “drug” that, in contrast to fenoterol, we found to have a “protective” effect on anal sphincter laceration, is nicotine, i.e., cigarette smoking. Whereas many authors reported their rates of smokers in subjects and controls, we are not aware of any who included smoking as a potentially independent predictor for anal sphincter laceration. Nicotine has common elements with the neurotransmitter acetylcholine; it can penetrate lipophilic membranes including the blood–brain barrier and the blood–placental barrier. It has been shown to elicit a wide variety of complex stimulant and depressant effects that involve the central and peripheral nervous, cardiovascular, endocrine, gastrointestinal, and skeletal motor systems [29]. Most importantly, nicotine stimulates Renshaw inhibitory neurons in the spinal cord, which leads to a skeletal muscle relaxant effect [30].

We recently reported that the success rate of vaginal births after cesarean is inversely associated with maternal BMI [31]. Our current data supported by those of others show that in primiparous women with vaginal birth, a higher BMI is associated with a lower rate of perineal injury [22]. On the other hand, a positive correlation between BMI and length of laceration has been reported [19, 32].

In agreement with the findings of the Collaborative Perinatal Project 1959–1965 in the USA in primiparous women, we did not find advanced maternal age being associated with perineal injuries [16].

Epidural analgesia, inaugurated by Fidel Pages in 1921 and increasingly used in obstetrics since the 1980s, has come more and more under scrutiny for its role in anal sphincter laceration, specifically for allegedly increasing duration of second stage labor and increasing risk of operative delivery; it has also been linked to an increased C/S rate and increased fetal malposition [24, 33–37]. Indeed, our cross table analysis seemed to confirm those allegations; however, when subjected to multiple logistic regression analysis and when controlled for by other forms of analgesia, we actually found a beneficial effect on anal sphincter laceration.

In conclusion, in our model, episiotomy and forceps-assisted delivery remained the strongest factors associated

with anal sphincter lacerations in primiparous women at term. Numerous other factors displayed much smaller, although significant, associations with anal sphincter laceration.

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