Duration of second stage of labor and instrumental delivery as risk factors for severe perineal lacerations: population-based study

Marija Simic 1*, Sven Cnattingius 1, Gunnar Petersson 1, Anna Sandström 1,2 and Olof Stephansson 1,2

Abstract

Background: We sought to investigate the impact of the duration of second stage of labor on risk of severe perineal lacerations (third and fourth degree).

Methods: This population based cohort study was conducted in the Stockholm/Gotland region, Sweden, 2008–2014. Study population included 52,211 primiparous women undergoing vaginal delivery with cephalic presentation at term. Unconditional logistic regression analysis was used to calculate crude and adjusted odds ratios (OR), using 95% confidence intervals (CI). Main exposure was duration of second stage of labor, and main outcome was risks of severe perineal lacerations (third and fourth degree).

Results: Risk of severe perineal lacerations increased with duration of second stage of labor. Compared with a second stage of labor of 1 h or less, women with a second stage of more than 2 h had an increased risk (aOR 1.42; 95% CI 1.28–1.58). Compared with non-instrumental vaginal deliveries, the risk was elevated among instrumental vaginal deliveries (aOR 2.24; 95% CI 2.07–2.42). The risk of perineal laceration increased with duration of second stage of labor until less than 3 h in both instrumental and non-instrumental vaginal deliveries, but after 3 h, the ORs did not further increase. After adjustments for potential confounders, macrosomia (birth weight > 4 500 g) and occiput posterior fetal position were risk factors of severe perineal lacerations.

Conclusions: The risk of severe perineal laceration increases with duration until the third hour of second stage of labor. Instrumental delivery is the most significant risk factor for severe lacerations, followed by duration of second stage of labor, fetal size and occiput posterior fetal position.

Keywords: Pregnancy, Second stage of labor, Perineal lacerations, Instrumental delivery, Episiotomy, Occiput posterior position, Macrosomia, Partograph, Obstetric anal sphincter injury

Background

Severe perineal laceration is a common and important complication of vaginal delivery, with a strong impact on quality of life. Depending on the anatomical structures involved, severe perineal lacerations fall into two categories: third-degree lacerations, which involve the anal sphincter complex, and fourth-degree lacerations, which extend to the rectal mucosa. Severe perineal lacerations are associated with later faecal incontinence and pelvic organ prolapse [1–3]. Third and fourth degree perineal lacerations have been reported to occur in approximately 7% of vaginal deliveries among primiparous mothers in Sweden [4]. Clinical guidelines emphasize the importance of being aware of the risk factors for obstetric anal sphincter injury in order to prevent severe perineal lacerations. Several risk factors have been identified, including primiparity, large fetal size, vaginal instrumental delivery, and occiput posterior position [5–10].
The second stage of labor is defined as the time period from complete dilation of the cervix to birth of the infant. Prolonged second stage of labor has been associated with risks of adverse maternal outcomes, including severe perineal lacerations [8, 11–16]. However, these studies have methodological limitations, including oversimplified categorization of second stage of labor, lack of information on study population characteristics and control of confounding [11, 15]. To our knowledge, no previous study has used prospectively recorded information to investigate the duration of the second stage of labor as an independent risk factor for severe perineal lacerations, taking important maternal and delivery characteristics into account.

In the present population-based cohort study, we used data recorded from the partograph to investigate the effect of duration of the second stage of labor on the risk of severe perineal lacerations in primiparous mothers.

**Methods**

**Design and setting of the study**

Data from the population-based Stockholm-Gotland obstetrical database were used for the study. Through the electronic medical record database, prospectively collected information was obtained from all antenatal, delivery, and postnatal care units in the regions of Stockholm and Gotland, Sweden. There were 7 delivery hospitals in the region during the study period with approximately 25 000 annual births. Detailed data on maternal, pregnancy, delivery, and infant characteristics are forwarded on a daily basis from the medical records system to the database, which contains information from 2008 onwards.

**Study population**

The study population included all primiparous mothers who underwent vaginal delivery of a live singleton infant in cephalic presentation at 37 completed gestational weeks or later, between 2008 and 2014 (n = 52 211), which is approximately 35% of all deliveries during the study period in the region. Deliveries without partographs or notation on complete dilation of the cervix were excluded.

**Exposures and outcomes**

Labor partograph data were used to measure the duration of the second stage of labor, defined as the time from the first notation of fully dilated cervix until delivery. Duration of the second stage of labor was categorised into five groups: 0 to <1 h (reference); 1 to <2 h; 2 to <3 h; 3 to <4 h; and ≥ 4 h.

From the first antenatal visit (usually at 7–12 gestational week), information about reproductive history, smoking habits, height, weight, state of health, family situation, the first day of the last menstrual period, were recorded by midwives. Delivery characteristics, such as onset of labor, epidural analgesia, use of oxytocin for labor augmentation, fetal head position, episiotomy, and mode of delivery were obtained from the partograph and standardized delivery records. Onset of labor was noted as either spontaneous start or induction. Use of oxytocin was analysed as any use during delivery or not. Since 2011, national guidelines with indications for augmentation with oxytocin exists. These implies use of oxytocin in the active first stage of labor when expected progress of 1 cm per hour has been delayed for 3 h or more. In the second stage, oxytocin is indicated without progress for one hour in the descending phase or 30 min or more in the pushing phase [17]. Use of methods of analgesia, including epidural, are based on the delivering mother’s preferences as well as access to different methods in the delivery hospitals [18]. Information on fetal position at delivery was recorded by midwife as occiput posterior position or not. Episiotomy included medio-lateral and midline incision. The approach to use episiotomy was decided by the obstetrician or midwife. There are no national guidelines when to use episiotomy but it is recommended to perform medio-lateral or midline incision. Mode of vaginal delivery was obtained from delivery charts and diagnostic codes according to the Swedish version of the International Classifications of Diseases, tenth revision (ICD-10), and divided into non-instrumental and instrumental vaginal deliveries (the latter included both vacuum assisted vaginal delivery and forceps delivery). Information about infant birth weight and head circumference was obtained from standard delivery charts. Fetal macrosomia was defined as birth weight of more than 4 500 grams. Hospitals included in the study, follow the recommendations on delivery management issued by Swedish Society of Obstetrics and Gynecology [18].

Gestational age was determined using the following hierarchy: a) date of embryo transfer, b) early second trimester ultrasound, which is offered to all women early in the second trimester (generally at 18 weeks), c) date of last menstrual period reported at the first antenatal visit and d) from a postnatal assessment.

The outcome measure was severe perineal laceration involving the anal sphincter (third and fourth degree). Perineal lacerations were classified according to the standardized obstetric record or diagnostic codes (ICD-10: O70.2 and O70.3).

**Statistical analyses**

We investigated the effects of maternal, delivery and fetal factors on severe perineal lacerations. Unconditional
logistic regression analysis was used to calculate crude and adjusted odds ratios (OR) with 95% confidence intervals (CIs). In the analysis of duration of second stage of labor and risk of severe perineal lacerations, we adjusted for maternal age, BMI, height, parental cohabitation, smoking, epidural analgesia, oxytocin augmentation, induction of labor, gestational age, episiotomy (yes/no), mode of delivery, occiput posterior position (yes/no), head circumference ≤35 cm (yes/no), birth weight more than 4500 g (yes/no). Variables were categorized according to Table 1. To investigate effect modification of duration of second stage of labor by mode of vaginal delivery (non-instrumental versus instrumental) an interaction variable was included in the regression models (mode of delivery in two categories and duration of second stage of labor in five categories). Stratified analyses by mode of delivery were also performed. A p-value <0.05 was considered statistically significant.

The statistical software package SAS 9.4 (version 6.1; SAS, Cary, NC, USA) was used for analysis.

Results

Among 52 211 primiparous mothers with singleton vaginal deliveries and information on the second stage of labor, 4050 (7.8%) had third- or fourth-degree perineal lacerations.

Table 1 presents the proportion of severe perineal lacerations according to maternal, delivery, and infant characteristics. The rates of perineal lacerations increased from 5.3 to 12.2% with increasing duration of second stage of labor. Rates of perineal lacerations generally increased with maternal age, gestational age and with short maternal stature. Compared to smokers, non-smokers had higher rates of perineal lacerations. The rates of severe perineal lacerations in women with vaginal instrumental and vaginal non-instrumental deliveries were 15.3% and 6.0%, respectively. Vacuum extraction was the most common method used in 3940 deliveries while forceps were used in 110 (2.7%) instrumental deliveries. Occiput posterior position, a high birth weight and large head circumference were also associated with increased rates of perineal lacerations (13.8%, 20.9% and 11.4% respectively).

Rates by mode of delivery are presented graphically in Table 1. In instrumental vaginal deliveries, rates of severe perineal lacerations were much higher at each time point than in spontaneous vaginal deliveries. In both groups, the rates remained about the same beyond the third hour.

When we calculated the risk of third and fourth degree lacerations depending on mode of vaginal delivery, we adjusted for duration of second stage of labor, maternal age, BMI, maternal height, cohabitation, smoking, epidural analgesia, oxytocin augmentation, induction of labor, gestational age, episiotomy, occiput posterior position, head circumference and birth weight. The aOR for instrumental deliveries was 2.24, 95% CI 2.07–2.42 (crude OR 2.87, 95% CI 2.68–3.07).

The results of the crude and adjusted logistic regression analyses of duration of second stage of labor and severe perineal lacerations are presented in Table 2. Compared to women with duration of second stage of labor less than 1 h, the adjusted OR for perineal lacerations for 2-<3 h was 1.42; 95% CI 1.28–1.58. Similar risks were found for second stage of labor of 3-<4 h: OR 1.45; 95% CI 1.29–1.64; and >4 h: OR 1.41, 95% CI 1.24–1.61.

In stratified analyses by mode of vaginal delivery, rates and adjusted OR are presented in Table 3. In instrumental vaginal deliveries, rates of severe perineal lacerations were higher at each time point than in spontaneous vaginal deliveries but remained the same after 2 h.

The relative risk of perineal laceration increased with duration of second stage of labor during the first 3 h but then remained almost unaltered, both in instrumental and non-instrumental deliveries. The absolute risk of severe perineal lacerations was more than 2 times higher in instrumental versus non-instrumental deliveries for each category of second stage duration. The occiput posterior fetal head position, high birth weight and large head circumference were significantly associated with perineal lacerations in both vaginal instrumental and non-instrumental deliveries. Episiotomy was a significant protector for severe perineal lacerations among vaginal instrumental deliveries, whereas it was a significant risk factor among non-instrumental deliveries (OR 0.81, 95% CI 0.70–0.94 and OR 1.46, 95% CI 1.27–1.69, respectively). (Table 3) The test of interaction for duration of second stage of labor and mode of delivery was not significant (p = 0.43).

Discussion

In this large population-based cohort study we found an increasing risk of severe perineal lacerations within first 3 h of second stage of labor. Instrumental delivery was the most important risk factor for severe lacerations, together with parameters indicating large fetal size, such as high birth weight and large head circumference, and occiput posterior fetal position.

We used a population-based cohort from an electronic perinatal database based on medical records with prospectively recorded information analysed retrospectively. This enabled us to investigate the length of the second stage of labor in relation to severe perineal lacerations in various clinical scenarios. Our study base included a large population of primiparous women with detailed characteristics.
information on demographic data, maternal and delivery characteristic, which made it possible to control for relevant confounders.

Patients were recruited over a 6-year period, reflecting current practice in the study region between 2008 and 2014. The study period was short, which precluded any examination of labor patterns over time. Management of labor at the seven hospitals in the study region may differ from that of other regions, thereby limiting the generalizability of our findings. However, the majority of clinics involved in the study follow the current management recommendations issued by the Swedish Society of Obstetricians and Gynecologists, which are based on international guidelines [18].

### Table 1 Maternal, fetal and delivery characteristics, among nulliparous women with singleton term vaginal births

| Time $^b$     | Total $(n = 52,211)$ | Severe perineal lacerations $^a$ $(n = 4,050)$ | n   | %       | p-value |
|---------------|----------------------|---------------------------------------------|-----|---------|---------|
| 0–< 1 h       | 16972                | 903                                         | 5.3 | <.0001  |         |
| 1–< 2 h       | 15238                | 1114                                        | 7.3 |         |         |
| 2–< 3 h       | 9424                 | 849                                         | 9.0 |         |         |
| 3–< 4 h       | 6217                 | 654                                         | 10.5|         |         |
| ≥ 4 h         | 4360                 | 530                                         | 12.2|         |         |
| Maternal age  |                      |                                             |     |         | <.0001  |
| ≤ 24          | 8846                 | 460                                         | 5.2 |         |         |
| 25–29         | 17176                | 1273                                        | 7.4 |         |         |
| 30–34         | 18632                | 1650                                        | 8.8 |         |         |
| ≥ 35          | 7523                 | 665                                         | 8.8 |         |         |
| Missing       | 34                   | 2                                           | -   |         |         |
| BMI (kg/m²)   |                      |                                             |     | 0.014   |         |
| < 19.9        | 7102                 | 550                                         | 7.7 |         |         |
| 19.9–24.9     | 30021                | 2271                                        | 7.6 |         |         |
| 25.0–29.9     | 9099                 | 783                                         | 8.6 |         |         |
| ≥ 30          | 3021                 | 241                                         | 7.9 |         |         |
| Missing       | 2968                 | 205                                         | -   |         |         |
| Maternal height (cm) |              |                                             |     | <.0001  |         |
| 130–154       | 1321                 | 127                                         | 9.6 |         |         |
| 155–159       | 4811                 | 440                                         | 9.1 |         |         |
| 160–164       | 12401                | 977                                         | 7.9 |         |         |
| 165–169       | 14832                | 1127                                        | 7.6 |         |         |
| 170–200       | 18309                | 1343                                        | 7.4 |         |         |
| Missing       | 537                  | 36                                          | -   |         |         |
| Cohabitating  |                      |                                             |     | 0.9     |         |
| Yes           | 47336                | 3664                                        | 7.7 |         |         |
| No            | 4385                 | 337                                         | 7.7 |         |         |
| Missing       | 490                  | 49                                          |     |         |         |
| Daily smoking |                      |                                             |     | <.0001  |         |
| Non-smoker    | 49543                | 3921                                        | 7.9 |         |         |
| Smoker        | 2259                 | 106                                         | 4.7 |         |         |
| Missing       | 409                  | 23                                          | -   |         |         |
| Gestational age (weeks) |           |                                             |     | <.0001  |         |
| 37            | 2284                 | 104                                         | 4.5 |         |         |
| 38            | 5375                 | 297                                         | 5.5 |         |         |
| 39            | 11956                | 716                                         | 6.0 |         |         |
| 40            | 16775                | 1351                                        | 8.1 |         |         |
| 41            | 11702                | 1124                                        | 9.6 |         |         |
| 42            | 4109                 | 448                                         | 11.1|         |         |

$^a$ Perineal lacerations third- and fourth degree

$^b$ Time from fully dilated cervix to birth
The prevalence of third and fourth degree lacerations (7.8%) was similar to a previously reported prevalence for the Stockholm-Gotland region (8.2%) but higher than the national Swedish prevalence (6.6%) [4, 19]. This can be explained by differences in population characteristics between the Stockholm-Gotland region (predominantly a large city region) and the rest of the country. Furthermore, the diagnosis of lacerations is based on clinical examination, and classification of the degree of perineal laceration could vary between hospitals and regions. Previously, it has been described that cases of clinically undetected sphincter lacerations have later been diagnosed by endo-anal ultrasound, which indicates that the incidence of severe perineal injuries, may be higher than reported [20]. Still, we have no reason to believe that diagnostic accuracy would vary by length of second stage of labor, and any possible misclassification would be non-differential.

Duration of the second stage of labor was defined as the time from complete dilatation of the cervix until birth based on the first notation of a fully dilated cervix. The transition between the first and second stages of labor could not be precisely established, and recorded data depended on the timing of cervical examination relative to time of complete cervical dilatation. Although previous studies have focused on adverse maternal and perinatal outcomes associated with prolonged duration of the second stage of labor, several studies have not observed an increased risk of severe perineal lacerations in women with prolonged second stage of labor [6, 8, 14]. However, in a cohort of women with term deliveries, rates of perineal lacerations increased with increasing duration of labor, after controlling for potential confounding variables [11, 13, 15]. Cheng et al., showed that a prolonged second stage of labor increased the risk of severe perineal lacerations after adjusting for maternal, fetal and delivery characteristics, and for instrumental vaginal delivery [11]. Rousse et al. also showed that risk for severe perineal lacerations increased for each additional hour of the second stage, after adjusting for mode of delivery [15]. Our results correspond well with these findings, although the risk estimation in our study was of lower magnitude. One possible explanation is that we included additional factors in the analysis, such as fetal head position and fetal head circumference.

Mode of vaginal delivery (non-instrumental versus instrumental) has been identified as an effect modifier in studies evaluating the influence of duration of the second stage on risks of severe perineal lacerations [8, 15]. Given the causal relationship between duration of the second stage and instrumental delivery, we wanted to investigate the independent effect of duration of the second stage of labor in instrumental and non-instrumental vaginal deliveries in stratified analyses. We found that the risk for perineal lacerations increased during the first 3 h and thereafter remained relatively unaltered in both instrumental and non-instrumental deliveries. Similarly to our results, Cheng et al. reported increased risk (OR 1.35) of perineal lacerations after instrumental delivery beyond 3 h of second stage [21]. However, the risk was not calculated for each additional hour of second stage of labor.

In accordance with our results, it has been demonstrated that large head circumference and higher birth weight increase the risk of perineal lacerations [22].

In previous research, epidural use has been associated with both a protective effect and increased risk of lacerations. Thus, we considered epidural analgesia to be a potential confounder, which we adjusted for in the multivariable model [23–25].

Although literature agrees that routine midline episiotomy is associated with increased rates of severe perineal lacerations [17], recent studies suggest that use of medio lateral episiotomy protects against these injuries during instrumental delivery [26, 27]. Our results, similar to previously reported, emphasize that episiotomy may be a risk factor for perineal lacerations in non-instrumental vaginal deliveries, but reduces the risk in vaginal instrumental deliveries [28]. There is no reason to believe that this difference is caused by the type of episiotomy used, since the most usual used is medio lateral episiotomy.

Besides increased risk of severe perineal lacerations, a prolonged second stage of labor is also associated with other adverse maternal outcomes such as postpartum haemorrhage, fever, infection and urinary retention [11–16]. The question when to intervene should involve thorough evaluation of the ongoing risks from further expectant management.

### Table 2  Risk of severe perineal lacerations among nulliparous by duration of second stage of labor

| Time (h) | Severe perineal lacerations | N  | %   | OR  | 95% CI  | aOR | 95% CI |
|----------|----------------------------|----|-----|-----|---------|-----|--------|
| ≤2 h     | Crude                      |    |     |     |         |     |        |
| 0–1 h    |                           | 16972 | 5.3 | 1.00 | Ref     | 1.00 | Ref    |
| 1–2 h    |                           | 15238 | 7.3 | 1.40 | 1.28–1.54 | 1.25 | 1.13–1.38 |
| ≥2 h     |                           | 9424  | 9.0 | 1.76 | 1.59–1.94 | 1.42 | 1.28–1.58 |
| 3–4 h    |                           | 6217  | 10.5 | 2.09 | 1.88–2.32 | 1.45 | 1.29–1.64 |
| ≥4 h     |                           | 4368  | 12.1 | 2.46 | 2.20–2.76 | 1.41 | 1.24–1.61 |

*Perineal lacerations third and fourth degree. Adjusted for maternal age, BMI, maternal height, parental cohabitation, smoking, epidural analgesia, oxytocin augmentation, induction of labor, gestational age, episiotomy, occiput posterior position, head circumference, birthweight more than 4500 g and mode of delivery.

aTime from fully dilated cervix to birth.
| Time       | Instrumental delivery | Non-instrumental delivery |
|------------|-----------------------|---------------------------|
|            | n        | %     | aOR  | 95% CI | n    | %     | aOR  | 95% CI |
| 0–< 1 h    | 1507     | 10.9  | 1.00 | Ref    | 25465| 4.8   | 1.00 | Ref    |
| 1–< 2 h    | 2042     | 14.7  | 1.38 | 1.11–1.71 | 13196| 6.2   | 1.21 | 1.08–1.35 |
| 2–< 3 h    | 2066     | 16.3  | 1.62 | 1.31–1.99 | 7358 | 6.9   | 1.34 | 1.18–1.53 |
| 3–< 4 h    | 2164     | 16.6  | 1.61 | 1.32–2.02 | 4053 | 7.3   | 1.39 | 1.20–1.63 |
| ≥4 h       | 2171     | 16.3  | 1.51 | 1.22–1.86 | 2189 | 8.1   | 1.45 | 1.19–1.75 |
| Maternal age |         |       |     |         |     |       |     |         |
| < 24       | 1123     | 11.2  | 0.86 | 0.70–1.06 | 7723 | 18.3  | 0.73 | 0.63–0.84 |
| 25–30      | 3044     | 30.3  | 1.00 | Ref    | 14132| 33.6  | 1.00 | Ref    |
| 30–35      | 3918     | 39.0  | 1.05 | 0.91–1.21 | 14714| 34.9  | 1.22 | 1.11–1.36 |
| > 35       | 1953     | 19.5  | 0.95 | 0.80–1.12 | 5570 | 13.2  | 1.17 | 1.02–1.33 |
| BMI (kg/m2) |         |       |     |         |     |       |     |         |
| < 19.9     | 1329     | 14.1  | 1.16 | 0.98–1.38 | 5773 | 14.5  | 1.07 | 0.95–1.21 |
| 20–24.9    | 5718     | 60.6  | 1.00 | Ref    | 24303| 61.1  | 1.00 | Ref    |
| 25–29.9    | 1834     | 19.4  | 1.18 | 1.02–1.36 | 7265 | 18.2  | 1.10 | 0.95–1.21 |
| > 30       | 561      | 5.9   | 0.99 | 0.77–1.27 | 2460 | 6.2   | 1.18 | 0.99–1.40 |
| Maternal height |     |       |     |         |     |       |     |         |
| 130–154    | 325      | 3.3   | 1.44 | 1.05–1.97 | 996  | 2.4   | 1.48 | 1.13–1.95 |
| 155–159    | 1097     | 11.1  | 1.29 | 1.06–1.57 | 3714 | 8.9   | 1.42 | 1.22–1.66 |
| 160–164    | 2524     | 25.4  | 0.99 | 0.84–1.16 | 9877 | 23.7  | 1.15 | 1.03–1.30 |
| 165–169    | 2845     | 28.6  | 1.00 | Ref    | 11987| 28.7  | 1.00 | Ref    |
| 170–200    | 3154     | 31.7  | 0.83 | 0.71–0.96 | 15155| 36.3  | 0.95 | 0.86–1.06 |
| Daily smoking |         |       |     |         |     |       |     |         |
| Non-smoker | 9631     | 96.5  | 1.00 | Ref    | 39912| 95.4  | 1.00 | Ref    |
| smoker     | 352      | 3.5   | 0.89 | 0.64–1.24 | 1907 | 4.5   | 0.64 | 0.49–0.84 |
| Gestational age (weeks) |     |       |     |         |     |       |     |         |
| 37         | 339      | 9.1   | 0.59 | 0.39–0.88 | 1945 | 3.7   | 0.64 | 0.49–0.82 |
| 38         | 740      | 11.6  | 0.75 | 0.58–0.97 | 4365 | 4.5   | 0.75 | 0.64–0.88 |
| 39         | 1878     | 12.1  | 0.76 | 0.63–0.91 | 10078| 4.8   | 0.80 | 0.71–0.90 |
| 40         | 3158     | 15.5  | 1.00 | Ref    | 13617| 6.3   | 1.00 | Ref    |
| 41         | 2617     | 17.3  | 1.09 | 0.94–1.26 | 9085 | 7.4   | 1.09 | 0.98–1.23 |
| 42         | 1218     | 18.7  | 1.14 | 0.93–1.11 | 2001 | 7.9   | 1.14 | 0.96–1.35 |
| Induction of labor |     |       |     |         |     |       |     |         |
| 2204       | 16.3     | 0.95 | 0.82–1.11 | 6624 | 6.3   | 1.04 | 0.92–1.18 |
| Epidural analgesia | 7574 | 15.3  | 0.94 | 0.82–1.08 | 25182| 5.9   | 0.88 | 0.80–0.97 |
| Oxytocin augmentation | 7998 | 15.4  | 1.01 | 0.87–1.18 | 23097| 6.3   | 0.95 | 0.87–1.05 |
| Occiput posterior position | 685 | 20.7  | 1.89 | 1.54–2.32 | 973  | 8.9   | 1.45 | 1.13–1.85 |
| Episiotomy | 1893     | 13.9  | 0.81 | 0.70–0.94 | 28442| 9.1   | 1.46 | 1.27–1.69 |
| Birthweight > 4500 g | 242 | 31.4  | 2.22 | 1.65–2.99 | 525  | 16.2  | 2.27 | 1.77–2.93 |
| Head circumference >35.5 cm | 3970 | 18.8  | 1.48 | 1.31–1.67 | 10643| 8.6   | 1.51 | 1.37–1.66 |

*Perineal lacerations third- and fourth degree

*Adjusted for maternal age, BMI, maternal height, parental cohabitation, smoking, epidural analgesia, oxytocin augmentation, induction of labor, gestational age, episiotomy, occiput posterior position, head circumference, birthweight more than 4500 g and mode of delivery

*Time from fully dilated cervix to birth
Conclusion
We conclude that the risk of severe perineal lacerations increases during the first 3 hours of second stage of labor and thereafter remains relatively unchanged. Risk factors for perineal lacerations were instrumental delivery, large fetal size and occiput posterior position. This important information should be considered when weighing the risks and benefits of performing instrumental delivery, especially if the goal is to reduce the risk of maternal perineal trauma. We suggest that the decision to perform an instrumental vaginal delivery should be weighed against the option of continuing labor in the setting of reassuring maternal and fetal status. Unless there are signs of fetal distress or strong maternal discomfort, continuing labor may enable significant proportion of women to achieve spontaneous vaginal delivery, and thus lead to decrease in severe perineal lacerations.

References
1. van Delft K, Sultan AH, Thakar R, Schwertner-Tiepelmann N, Kluever K. The relationship between postpartum levator ani muscle avulsion and signs and symptoms of pelvic floor dysfunction. BJOG. 2014;121(9):1164–71. discussion 72.
2. Eason E, Labrecque M, Marcoux S, Mondor M. Anal incontinence after childbirth. CMAJ. 2002;166(3):326–30.
3. Fidler DE, Genberg B, Brahma P, Marek L, Delaney JQ. 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(6):1543–9. discussion 9–50.
4. Blomberg M. Maternal body mass index and risk of obstetric anal sphincter injury. Biomed Res Int. 2014;2014:395803.
5. Altman MR, Lydon-Rochelle MT. Prolonged second stage of labor and risk of adverse maternal and perinatal outcomes: a systematic review. Birth. 2006;33(4):315–22.
6. Baumann P, Hammond AO, McNeely SG, Derose E, Hendrix S. Factors associated with anal sphincter laceration in 40,923 primiparous women. Int Urogynecol J Pelvic Floor Dysfunct. 2007;18(9):985–90.
7. Benavides L, Wu JM, Hundley AF, Ivester TS, Visco AG. The impact of occult posterior fetal head position on the risk of anal sphincter injury in forceps-assisted vaginal deliveries. Am J Obstet Gynecol. 2005;192(2):1702–6.
8. 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(3):933–8.
9. 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(4):344 e1-5.
10. 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(2):525–8. discussion 8–9.
11. Cheng YW, Hopkins LM, Laros Jr RK, Caughey AB. Duration of the second stage of labor in multiparous women: maternal and neonatal outcomes. Am J Obstet Gynecol. 2007;196(6):585 e1-6.
12. Laughon SK, Bergolla V, Reddy UM, Sundaram R, Lu Z, Hoffman MK. Neonatal and maternal outcomes with prolonged second stage of labor. Obstet Gynecol. 2014;124(1):57–67.
13. Allen WM, Baskett TF, O’Connell CM, McKeen D, Allen AC. Maternal and perinatal outcomes with increasing duration of the second stage of labor. Obstet Gynecol. 2009;113(6):1248–58.
14. Janni W, Schiesl B, Peschers U, Huber S, Strobil B, Hanschmann P, et al. The prognostic impact of a prolonged second stage of labor on maternal and fetal outcome. Acta Obstet Gynecol Scand. 2002;81(3):214–21.
15. Rouse DJ, Weiner SJ, Bloom SL, Yamer MW, Spong CY, Ramin SM, et al. Second-stage labor duration in nulliparous women: relationship to maternal and perinatal outcomes. Am J Obstet Gynecol. 2009;200(4):357 e1–7.
16. Stephansson O, Sandstrom A, Petersson G, Wikstrom AC, Nattanings S. Prolonged second stage of labour, maternal infectious disease, urinary retention and other complications in the early postpartum period. BJOG. 2016;123(4):608–16.
17. Murphy DJ, Macleod M, Bahl R, Goyer K, Howarth L, Strachan B. A randomised controlled trial of routine versus restrictive use of episiotomy at operative vaginal delivery: a multicentre pilot study. BJOG. 2008;115(13):1695–702. discussion 702–3.
18. Socialstyrelsen. A. Indikation för vårdförsening med oxytocin under aktiv förlossning. Nationella medicinska indikationer. 2011.
19. Prager M, Anderson NL, Stephansson O, Marchionni M, Marions L. The incidence of obstetric anal sphincter rupture in primiparous women: a comparison between two European delivery settings. Acta Obstet Gynecol Scand. 2008;87(2):209–15.
20. Faltin DL, Bouvain M, Ironic O, Bretones S, Stan C, Weil A. Diagnosis of anal sphincter tears by postpartum endosonography to predict fecal incontinence. Obstet Gynecol. 2000;95(5):643–7.
21. Cheng YW, Shaffer BL, Bianco K, Caughey AB. Timing of operative vaginal delivery and associated perinatal outcomes in nulliparous women. J Matern Fetal Neonatal Med. 2011;24(5):692–7.
22. Valsky DV, Lipshutz M, Bord A, Eldar I, Messing B, Hochner-Celniker D, et al. Fetal head circumference and length of second stage of labor are risk factors for levator ani muscle injury, diagnosed by 3-dimensional...
transperineal ultrasound in primiparous women. Am J Obstet Gynecol. 2009;201(1):91 e1–7.

23. Loewenberg-Weisband Y, Grisaru-Granovsky S, Ioscovich A, Samueloff A, Calderon-Margalit R. Epidural analgesia and severe perineal tears: a literature review and large cohort study. J Matern Fetal Neonatal Med. 2014;27(18):1864–9.

24. Dahl C, Kjolhede P. Obstetric anal sphincter rupture in older primiparous women: a case–control study. Acta Obstet Gynecol Scand. 2006;85(10):1252–8.

25. Poen AC, Felt-Bersma RJ, Dekker GA, Deville W, Cuesta MA, Meuwissen SG. Third degree obstetric perineal tears: risk factors and the preventive role of mediolateral episiotomy. Br J Obstet Gynaecol. 1997;104(5):563–6.

26. de Vogel J, van der Leeuw van Beek A, Getelink D, Vujkovic M, de Leeuw JW, van Bavel J, et al. The effect of a mediolateral episiotomy during operative vaginal delivery on the risk of developing obstetrical anal sphincter injuries. Am J Obstet Gynecol. 2012;206(5):404 e1-5.

27. de Leeuw JW, de Wit C, Kuijken JP, Bruinse HW. Mediolateral episiotomy reduces the risk for anal sphincter injury during operative vaginal delivery. BJDG. 2008;115(1):104–8.

28. Rygh AB, Skjeldstad FF, Komer H, Eggebo TM. Assessing the association of oxytocin augmentation with obstetric anal sphincter injury in nulliparous women: a population-based, case–control study. BMJ Open. 2014;4(7):e004592.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at www.biomedcentral.com/submit