

## GYNECOLOGY

# Predicting obstetric anal sphincter injuries in a modern obstetric population



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**BACKGROUND:** Perineal lacerations are common at the time of vaginal delivery and may predispose patients to long-term pelvic floor disorders, such as urinary incontinence and pelvic organ prolapse. Obstetric anal sphincter injuries, which are the most severe form of perineal lacerations, result in disruption of the anal sphincter and, in some cases, the rectal mucosa during vaginal delivery. Long-term morbidity, including pain, pelvic floor disorders, fecal incontinence, and predisposition to recurrent injury at subsequent delivery may result. Despite several studies that have reported risk factors for obstetric anal sphincter injuries, no accurate risk prediction models have been developed.

**OBJECTIVE:** The purpose of this study was to identify risk factors and develop prediction models for perineal lacerations and obstetric anal sphincter injuries.

**STUDY DESIGN:** This was a nested case control study within a retrospective cohort of consecutive term vaginal deliveries at 1 tertiary care facility from 2004-2008. Cases were patients with any perineal laceration that had been sustained during vaginal delivery; control subjects had no lacerations of any severity. Secondary analyses investigated obstetric anal sphincter injury (3rd- to 4<sup>th</sup>-degree laceration) vs no obstetric anal sphincter injury (0 to 2<sup>nd</sup>-degree laceration). Baseline characteristics were compared between groups with the use of the chi-square and Student *t* test. Adjusted odds ratios and 95% confidence intervals were calculated with the use of multivariable logistic regression. Prediction models were created and model performance was estimated with receiver-operator characteristic curve analysis. Receiver-operator characteristic curves were validated internally with the use of the bootstrap method to correct for bias within the model.

**RESULTS:** Of the 5569 term vaginal deliveries that were recorded during the study period, complete laceration data were available in 5524 deliveries. There were 3382 perineal lacerations and 249 (4.5%) obstetric anal sphincter injuries. After adjusted analysis, significant predictors for laceration included nulliparity, non-black race, longer second stage, nonsmoking status, higher infant birthweight, and operative delivery. Private health insurance, labor induction, pushing duration, and regional anesthesia were not statistically significant in adjusted analyses. Significant risk factors for obstetric anal sphincter injury were similar to predictors for any laceration; nulliparity and operative vaginal delivery had the highest predictive value. Area under the curve for the predictive ability of the models was 0.70 for overall perineal laceration, and 0.83 for obstetric anal sphincter injury. When limited to primiparous patients, 1996 term vaginal deliveries were recorded. One hundred ninety-two women sustained an obstetric anal sphincter injury; 1796 women did not. After adjusted analysis, significant predictors for laceration included non-black race, age, obesity, and nonsmoking status. In secondary analyses, significant predictors for obstetric anal sphincter injury included non-black race, nonsmoking status, longer duration of pushing, operative vaginal delivery, and infant birthweight. Area under the curve for the predictive ability of the models was 0.60 for any laceration and 0.77 for obstetric anal sphincter injury.

**CONCLUSIONS:** Significant risk factors for sustaining any laceration and obstetric anal sphincter injury during vaginal deliveries were identified. These results will help identify clinically at-risk patients and assist providers in counseling patients about modifications to decrease these risks.

**Key words:** obstetric anal sphincter injury (OASI), perineal laceration, nulliparity

Obstetric anal sphincter injury (OASI) involves injury to the anal sphincter and rectal mucosa sustained at time of vaginal delivery and can result in significant long-term morbidity. Historically, these injuries have been defined as 3rd- and 4th-degree lacerations, those that involve disruption of the anal sphincter and rectal mucosa

respectively and are referred to as anal sphincter lacerations and severe perineal lacerations. Current estimates suggest that 3-5% of women who undergo a vaginal delivery experience an OASI.<sup>1</sup> Although numerous risk factors have been identified, accurate methods to predict which patients will experience any laceration or OASI have yet to be developed.

The long-term morbidity that is associated with lacerations is significant and includes pelvic and perineal pain, dyspareunia, pelvic floor disorders (including stress urinary incontinence, overactive bladder, prolapse symptoms, and objective pelvic organ prolapse), fecal urgency and incontinence,

rectovaginal fistulas, and risk of recurrent injury to the anal sphincter in subsequent deliveries.<sup>2-5</sup> Although these complications may result from any degree of perineal trauma,<sup>2</sup> the greatest morbidity primarily results from disruption of the anal sphincter. In fact, women who sustain a recognized 3rd- or 4th-degree laceration with their first vaginal delivery are at 3-4 times greater risk of experiencing a recurrent laceration in a subsequent pregnancy,<sup>6,7</sup> and many ultimately will experience some degree of anorectal dysfunction that includes fecal urgency, inability to control flatus, or overt fecal incontinence.<sup>8</sup>

The primary objective of this study was to investigate a modern obstetric

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cohort in an effort to develop models to predict perineal laceration and OASI at time of vaginal delivery. Our secondary objectives were to reevaluate the known risk factors, potentially to identify new risk factors for any perineal laceration and OASI, and to address the role of parity in the risk of sustaining any perineal laceration and OASI.

## Materials and Methods

This is a nested case control study within a retrospective cohort of consecutive term vaginal deliveries at a tertiary care institution from 2004-2008. Women included in the cohort had term ( $\geq 37$  weeks gestation), cephalic, non-anomalous singleton gestations and reached the second stage of labor. Deliveries were excluded from analysis if laceration data were unavailable or incomplete or if the patient had a cesarean delivery. The Washington University Human Research Protection Board approved the parent study (IRB# 081285, 12/18/08).

Trained research personnel collected detailed data from the medical record that included maternal sociodemographic data, medical and obstetric history, intrapartum course, complications, and neonatal characteristics. Sociodemographic and historical data, which included smoking status and maternal weight and body mass index (BMI), were recorded at the time of presentation to labor and delivery. Those patients who reported using tobacco at any point during their pregnancy were considered "tobacco users."

Two groups were created: patients who sustained a laceration during delivery and those who did not. Further analysis was performed that compared patients with an OASI with those without. *Laceration* was defined as any injury to the perineum including 1st-degree through 4th-degree lacerations. *OASI* was defined as a 3rd- or 4th-degree laceration.

Baseline characteristics were compared between the 2 groups with the use of chi-square and Student *t* test to determine risk factors for any laceration. Variables that included the duration of the second stage of labor (minutes),

duration of pushing (minutes), estimated fetal weight (EFW; grams), and infant birthweight (grams) were examined both as continuous and categorical variables. Normal distribution was tested by examination of the histogram as well as the Kolmogorov-Smirnov test; most variables approximated normal distribution. Multivariable logistic regression was then used to adjust for baseline differences between cases and control subjects. The analysis was adjusted for operative vaginal delivery (no/yes), nulliparity (no/yes), tobacco use (no/yes), EFW  $\geq 3500$  g (no/yes), and African American ethnic category (no/yes). Adjusted odds ratios and 95% confidence intervals (CIs) were calculated for each risk factor. From these adjusted odds ratios, prediction models were created; model performance was estimated with the use of receiver operator characteristic (ROC) curves.

We then performed a secondary analysis that was based on laceration severity. Those patients who sustained 3rd- or 4th-degree lacerations were categorized as OASI; all others were considered "no OASI." The analysis was adjusted for African American ethnic category (no/yes), operative vaginal delivery (no/yes), nulliparity (no/yes), tobacco use (no/yes), and EFW  $\geq 3500$  g (no/yes).

Finally, a subgroup analysis was performed that restricted the patient population to only primiparous patients. Statistical analysis was performed as mentioned earlier with the use of chi-square and Student *t* test to compare baseline characteristics and multivariable logistic regression to obtain adjusted odds ratios and 95% CIs. These comparisons were performed for patients with an OASI vs those with no OASI. The analysis was adjusted for African American ethnic category (no/yes), tobacco use (no/yes), duration of pushing  $>60$  min (no/yes), operative vaginal delivery (no/yes), maternal age (years), and EFW  $\geq 3500$  g (no/yes). Prediction models for OASI that were unique to primiparous patients were created. ROC curve analysis was then used to estimate the risk prediction model performance for all models.

The models that were obtained through logistic regression were validated internally through bootstrap analysis to obtain a more stable and robust model. Each model was assessed in 1000 bootstrap samples with replacement. Internal validation was assessed by calculation of the area under the curve (AUC) for the samples, which yielded an overall AUC for the bootstrapped model.

## Results

During the designated study period, there were 5569 term vaginal deliveries recorded at our institution. Laceration data were missing or incomplete in 45 patients (0.8%), which were excluded, for a total of 5524 patients included in the present study. Of those, 3382 patients (61.2%) sustained some degree of perineal laceration, with 249 patients (4.5%) experiencing an OASI. Baseline characteristics were compared between cases and control subjects (Table 1). Those patients who sustained any perineal laceration were more likely to be younger, primiparous, and nonsmokers and to have private health insurance. They were also more likely to undergo induction of labor, deliver at a greater gestational age, and have regional anesthesia. The groups did not differ in EFW. Infant birthweight was significantly different between tobacco users and nonusers ( $3137 \pm 533$  g vs  $3261 \pm 527$  g;  $P < .01$ ). There was a weak, linear relationship between EFW and infant birthweight ( $r = 0.34$ ;  $P < .0001$ ).

After adjusted analysis, significant predictors for any perineal laceration included nulliparity, operative vaginal delivery, and infant birthweight  $\geq 3500$  g. Because EFW is information that clinicians will have before delivery, models were run with EFW instead of infant birthweight, although the 95% CI for EFW crosses 1 in the multivariable analysis (Table 2). African American ethnicity and tobacco use were protective. Private health insurance, induction of labor, duration of pushing, and use of regional anesthesia did not remain significant in the adjusted analyses. When comparing OASI vs no OASI, significant risk factors for OASI were the same as the predictors for laceration in

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