OBSTETRICS

Previous prelabor or intrapartum cesarean delivery and risk of placenta previa

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OBJECTIVE: The purpose of this study was to examine the association between previous cesarean delivery and subsequent placenta previa while distinguishing cesarean delivery before the onset of labor from intrapartum cesarean delivery.

STUDY DESIGN: We conducted a retrospective cohort study of electronic medical records from 20 Utah hospitals (2002-2010) with restriction to the first 2 singleton deliveries of nulliparous women at study entry (n = 26,987). First pregnancy delivery mode was classified as (1) vaginal (reference), (2) cesarean delivery before labor onset (prelabor), or (3) cesarean delivery after labor onset (intrapartum). Risk of second delivery previa was estimated by previous delivery mode with the use of logistic regression and was adjusted for maternal age, insurance, smoking, comorbidities, previous pregnancy loss, and history of previa.

RESULTS: Most first deliveries were vaginal (82%; n = 22,142), followed by intrapartum cesarean delivery (14.6%; n = 3931), or prelabor cesarean delivery (3.4%; n = 914). Incidence of second delivery previa was 0.29% (n = 78) and differed by previous delivery mode: vaginal, 0.24%; prelabor cesarean delivery, 0.98%; intrapartum cesarean delivery, 0.38% ($P < .001$). Relative to vaginal delivery, previous prelabor cesarean delivery was associated with an increased risk of second delivery previa (adjusted odds ratio, 2.62; 95% confidence interval, 1.24–5.56). There was no significant association between previous intrapartum cesarean delivery and previa (adjusted odds ratio, 1.22; 95% confidence interval, 0.68–2.19).

CONCLUSION: Previous prelabor cesarean delivery was associated with a >2-fold significantly increased risk of previa in the second delivery, although the approximately 20% increased risk of previa that was associated with previous intrapartum cesarean delivery was not significant. Although rare, the increased risk of placenta previa after previous prelabor cesarean delivery may be important when considering nonmedically indicated prelabor cesarean delivery.

Key words: cesarean delivery, intrapartum, placenta previa, prelabor

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Placenta previa is observed in as many as 20% of transabdominal and 5% of transvaginal ultrasound scans at <20 weeks' gestational age,[1,2] but the majority (approximately 90%) resolve by term.[3] Approximately 1 in 200 pregnancies are complicated by persistent placenta previa at delivery, which is associated with medically indicated late-preterm and early-term delivery, increased risk of maternal intrapartum and postpartum hemorrhage, the need for blood transfusion, sepsis, and hysterectomy.[3-7] Placenta previa is also associated with prematurity, low Apgar scores, and fetal and neonatal death.[5,8,9]

The exact cause of placenta previa is unknown, but previous uterine surgery, including cesarean delivery, is associated with an increased risk.[10] Uterine scaring has been suggested to interfere with the process of natural growth of the placenta at more vascular sites and atrophy of the placental attachment site in the relatively less vascular lower uterus. Impaired migratory function has been postulated to result in a decreased likelihood of resolution of placenta previa before delivery.[3,8,10,11] Importantly, the incidence of placenta previa has been rising in parallel with the increasing rate of cesarean delivery in the United States.[12]

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Cesarean delivery suture type and closure method have been identified as modifiable characteristics of the surgery that may alter the risk of previa in subsequent pregnancies.[13,14] Similarly, labor may be an additional risk factor that could modify the previa risk that is associated with previous cesarean delivery because intrapartum factors may affect uterine repair after cesarean delivery.

The purpose of this study was to examine the association between the timing of previous cesarean delivery relative to labor onset (prelabor vs intrapartum) and the risk for placenta previa.

Materials and Methods

The Consecutive Pregnancies Study was a retrospective cohort study conducted by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health. Detailed information on 114,679 pregnancies from 51,086 women with at least 2 deliveries after 20 weeks of gestation at 20 Utah hospitals from 2002-2010 were extracted from the maternal and infant electronic medical records and supplemented with *International Classification of Diseases, ninth revision*, discharge codes. Pregnancies were linked across an individual woman with the use of a unique maternal identification code. Institutional review board gave approval for all participating institutions; the Office of Human Subjects Research (OHSR) at the National Institute of Health granted an exemption because all of the data that were transferred were deidentified.

Analyses were restricted to women who were nulliparous at study entry (n = 27,741) because of the established relationship between increasing parity and placenta previa risk.[8] The cohort was further limited to women with consecutive singleton pregnancies, because multiple gestation is also an established risk factor for placenta previa (n = 27,062).[3] We performed a complete-case analysis and excluded a total of 75 women with missing data on 1 of the following items: ethnicity (n = 56; 0.21%), marital status (n = 2; 0.01%), or smoking status (n = 18; 0.07%). The final sample consisted of the 26,987 women with consecutive singleton pregnancies.

First pregnancy delivery mode was categorized as vaginal or cesarean delivery. We further categorized cesarean delivery into either (1) cesarean delivery performed before labor onset (prelabor cesarean delivery) or (2) cesarean delivery performed after labor onset (intrapartum cesarean delivery). Prelabor cesarean delivery was designated if a trial of labor was absent and if none of the following were documented: induction of labor, augmentation of labor, episiotomy, intrapartum tocolytics, shoulder dystocia, vaginal lacerations, a cesarean delivery indication noting failure to progress or failed induction, or a date/time of full cervical dilation or onset of spontaneous labor. All other cesarean deliveries that did not meet the aforementioned conditions were classified as intrapartum. There were 102 women with cervix dilated $\geq$6 cm at the time of the first examination after admission to labor and delivery; we considered them to have been in active labor, so they were classified as intrapartum cesarean delivery.

Cases of placenta previa in the second pregnancy were identified through the diagnosis documented in the prenatal and labor and delivery medical records. No additional cases were detected by *International Classification of Diseases, ninth revision*, codes (641.00-641.03; 641.10-641.13). Women with a diagnosis of placenta previa who delivered vaginally (n = 26) were not considered to be cases for the purposes of this study because partial and complete placenta previa require cesarean delivery.[3,6]

Maternal race/ethnicity and second pregnancy age at delivery, insurance type, marital status, smoking during pregnancy, and gravidity were obtained from the medical record. Because of the homogenous nature of this cohort (>87% white), race/ethnicity was classified as white vs nonwhite. Maternal medical history of asthma, anemia, pregestational diabetes mellitus, chronic hypertension, kidney disease, thyroid disease, and chorioamnionitis in the second pregnancy were obtained from the medical record and supplemented with International Classification of Diseases, ninth revision, codes. Once classified with a chronic condition, women were considered to have the condition at all subsequent pregnancies. Given the reported association between a history of placenta previa and the risk of subsequent placenta previa,[6] we also included a diagnosis of placenta previa that occurred in the first pregnancy using the case definition described earlier. Last, gestational age was determined as recorded in the medical record according to the best obstetric estimate. Consistency checks were performed with the use of repeated pregnancy data on all relevant covariates and conditions.

Differences in participant characteristics at the second pregnancy according to previous delivery mode were determined with the χ^2 test, Fisher exact test, or the Student *t* test. The risk of placenta previa was estimated according to previous delivery mode by multivariable logistic regression with likelihood ratio tests. Serial models were constructed to explore the potential different confounders. Potential covariates for the adjusted models were explored based on previous literature, use of a directed acyclic graph, and evaluation of individual regression models; a probability value of $<$ .10 was considered significant.[15,16]

The first model (model A) was a multivariable logistic regression model with first pregnancy delivery mode as the independent variable and second pregnancy previa as the dependent variable that was adjusted for demographic and known baseline risk factors that included maternal age, insurance status, smoking status, history of pregnancy loss, and history of placenta previa. The second logistic regression model (model B) included all of the covariates in model A and further was adjusted for maternal comorbidities (anemia, pregestational diabetes mellitus, and thyroid disease) selected according to the aforementioned criteria. For the model interpretation, interest was focused on the assessment of the risk of previa and not on the risk of known confounding factors.