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Evaluation of delivery options for second stage events

Jennifer L. Bailit, M.D., M.P.H.[1], **William A. Grobman, M.D., M.B.A.**[2], **Madeline Murguia Rice, Ph.D.**[3], **Ronald J. Wapner, M.D.**[4], **Uma M. Reddy, M.D., M.P.H.**[5], **Michael W. Varner, M.D.**[6], **John M. Thorp Jr., M.D.**[7], **Steve N. Caritis, M.D.**[8], **Jay D. Iams, M.D.**[9], **George Saade, M.D.**[10], **Dwight J. Rouse, M.D.**[11], and **Jorge E. Tolosa, M.D., M.S.C.E.**[12] **for the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units (MFMU) Network**

[1]Department of Obstetrics and Gynecology, MetroHealth Medical Center-Case Western Reserve University-, Cleveland, OH (J.L.B.)

[2]Department of Obstetrics and Gynecology, Prentice Women's Hospital, Northwestern University, Chicago, IL (W.A.G.)

[3]George Washington University Biostatistics Center, Washington, DC (M.M.R)

[4]Department of Obstetrics and Gynecology, Columbia University, New York, NY (R.J.W.)

[5]*Eunice Kennedy Shriver* National Institute of Child Health and Human Development, Bethesda, MD (U.M.R.)

[6]Department of Obstetrics and Gynecology, University of Utah Health Sciences Center, Salt Lake City, UT (M.W.V.)

[7]Department of Obstetrics and Gynecology, University of North Carolina at Chapel Hill, Chapel Hill, NC (J.M.T.)

[8]Department of Obstetrics and Gynecology, University of Pittsburgh, Pittsburgh, PA (S.N.C.)

[9]Department of Obstetrics and Gynecology, The Ohio State University, Columbus, OH (J.D.I.)

[10]Department of Obstetrics and Gynecology, University of Texas Medical Branch, Galveston, TX (G.S.)

[11]Department of Obstetrics and Gynecology, Brown University, Providence, RI (D.J.R.)

[12]Department of Obstetrics and Gynecology, Oregon Health & Science University, Portland, OR (J.E.T.)

Abstract

Background—Cesarean delivery in the second stage of labor is common, whereas the frequency of operative vaginal delivery has been declining. However, data comparing outcomes for attempted

Corresponding author: Jennifer Bailit, MD, MPH, 2500 MetroHealth Dr, Cleveland, OH 44107, Phone 216-778-3550, Fax 216-778-8847, jbailit@metrohealth.org.

operative vaginal delivery in the second stage versus cesarean in the second stage are scant. Previous studies that examine operative vaginal delivery have compared it to a baseline risk of complications from a spontaneous vaginal delivery and cesarean delivery. However, when a woman has a need for intervention in the second stage, spontaneous vaginal delivery is not an option she or the provider can choose. Thus, the appropriate clinical comparison is cesarean versus operative vaginal delivery.

Objective—Our objective was to compare outcomes by the first attempted operative delivery (vacuum, forceps versus cesarean delivery) in patients needing second stage assistance at a fetal station of +2 or below.

Study Design—Secondary analysis of an observational obstetric cohort in 25 academically-affiliated U.S. hospitals over a three-year period. A subset of ≥37 weeks, non-anomalous, vertex, singletons, with no prior vaginal delivery who reached a station of +2 or below and underwent an attempt at an operative delivery were included. Indications included for operative delivery were: failure to descend, non-reassuring fetal status, labor dystocia or maternal exhaustion. The primary outcomes included a composite neonatal outcome (death, fracture, length of stay ≥3 days beyond mother's, low Apgar, subgaleal hemorrhage, ventilator support, hypoxic encephalopathy, brachial plexus injury, facial nerve palsy) and individual maternal outcomes (postpartum hemorrhage, third and fourth degree tears [severe lacerations], and postpartum infection). Outcomes were examined by the three attempted modes of delivery. Odds ratios were calculated for primary outcomes adjusting for confounders. Final mode of delivery was quantified.

Results—2531 women met inclusion criteria. Vacuum attempt was associated with the lowest frequency of the neonatal composite (4.2% vs. 6.1% vaginal forceps vs. 6.9% cesarean) and maternal complications (Postpartum infection 0.2% vs. 0.9% forceps vs. 5.3% cesarean, Postpartum hemmorhage 1.4% vs. 2.8% forceps vs. 3.8% cesarean), except for severe lacerations (19.1% vs. 33.8% forceps vs. 0% cesarean). When confounders were taken into account, both forceps (odds ratio 0.16, 95%CI 0.05-0.49) and vacuum (odds ratio 0.04, 95%CI 0.01-0.17) were associated with a significantly lower odds of Post partuminfection. The neonatal composite and Postpartum hemmorhage were not significantly different between modes of attempted delivery. Cesarean occurred in 6.4% and 4.4% of attempted vacuum and forceps groups (P=.04).

Conclusion—In patients needing second stage delivery assistance with a station of +2 or below, attempted operative vaginal delivery was associated with a lower frequency of Postpartum infection, but higher frequency of severe lacerations.

Keywords

Forceps; Vacuum; second stage of labor; operative vaginal delivery

Introduction

Cesarean delivery in the second stage of labor is common in the United Staters and represents 23% of primary cesarean deliveries. [1]The high frequency of cesarean deliveries could potentially be offset by first attempting an operative vaginal delivery. However in recent years, the frequency of operative vaginal delivery has been declining. Operative vaginal deliveries dropped from 9.01% in 1990 to 3.30% in 2013. [2]While opinions have

been published on the pros and cons of second stage modes of delivery, there is no consensus on which mode is better.[3, 4]

Previous studies that examine operative vaginal delivery have compared it to a baseline risk of complications from a spontaneous vaginal delivery and cesarean delivery. [56, 7] However, when a woman has a need for intervention in the second stage, spontaneous vaginal delivery is not an option she or the provider can choose. The appropriate clinical comparison is cesarean versus operative vaginal delivery. Furthermore, previous large studies have relied upon administrative data and thus were limited to evaluating final mode of delivery rather than attempted mode of delivery .[5] Because successful operative delivery may have different outcomes than non-successful vaginal operative attempts, it is important to assess attempted delivery and not assign outcomes of failed operative attempts to the cesarean group.

There have been several small trials of operative vaginal delivery, but these compared forceps to vacuum or to spontaneous vaginal delivery. [8,9,10,11] In an arrest of labor or need for urgent delivery due to fetal tracing issues, spontaneous delivery is not a choice. In the studies that compared vacuum with forceps, there were a wide variety of stations as entry criteria, and because complications can vary with higher stations, these trials may not be directly applicable.

In the present day, a clinically relevant question is what to do when a patient has arrest of decent or has non-reassuring fetal status at fetal station of +2 or below. At these stations, with rare exception, most women are candidates for any of the three modes of delivery though the data are limited for clinicians to make informed decisions.

Our study sought to compare the maternal and neonatal complications with cesarean, vaginal vacuum, or vaginal forceps for women with a need for intervention in the second stage of labor and at a fetal station of +2 or below.

Materials and Methods

Between 2008 and 2011, we assembled a cohort of women and their neonates born at 25 academically-affiliated hospitals in the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network. This study, the Assessment of Perinatal EXcellence (APEX), designed to develop quality measures for intrapartum obstetrical care, was approved by the Institutional Review Board at each participating institution under a waiver of informed consent. Details regarding the APEX study have been previously described. [12] Briefly, patients eligible for data collection were those who delivered within the institution, were at least 23 weeks of gestation, and had a live fetus on admission. The medical records of all eligible women and their newborns were abstracted by trained and certified research personnel at the hospital and entered into a web-based data entry system. Data recorded included demographic characteristics, details of the medical and obstetrical history, information about intrapartum and postpartum events and patients' race and ethnicity as reported in the chart. Maternal data were collected until discharge and neonatal data were collected up until discharge or until 120 days of age, whichever came first. This was a planned secondary analysis of the APEX data set.

We created a subset of term (≥37 weeks) women with non-anomalous, vertex, singleton gestations, with no previa and no prior vaginal delivery, who had reached complete cervical dilation with a fetal station of +2 or below and were operatively delivered. The pelvic examination documenting station had to be within one hour of the decision to proceed with delivery. To be included women had to have one of the following indications for labor intervention: failure to descend, labor dystocia, maternal exhaustion, or non-reassuring fetal status. Because failure of operative vaginal delivery and need to proceed to cesarean is a known possibility, women were classified by whether they had an attempted vaginal vacuum or forceps delivery, not by whether that attempt was successful, i.e., not by final delivery mode. Women undergoing attempts at both vacuum and forceps vaginally were excluded from the main analysis, as that strategy need not be chosen by an operator, and its inclusion in could unfairly bias the results against an initial attempt at operative vaginal delivery. Because ACOG generally advises against two modes of operative attempt, these patients may be different in some unmeasurable way.[13] Conversely, if an attempt at operative vaginal delivery was unsuccessful and proceeded to a cesarean delivery, it was included.

A subsequent supplemental analysis was performed to assess outcomes of women who failed the first attempt at operative vaginal delivery and went on to have a second attempt at a vaginal operative delivery with a different instrument

Maternal and neonatal outcomes were set *a priori*. A composite neonatal outcome was created that included the occurrence of any of the following: death, fracture other than clavicular, length of stay ≥3 days beyond mother's hospital stay, Apgar < 4 at 5 minutes, subgaleal hemorrhage, ventilator support within 24 hours of birth on at least two days, hypoxic encephalopathy (HIE), brachial plexus injury, and facial nerve palsy. Secondary neonatal outcomes included skin laceration and brain bleed (intracranial or intraventricular hemorrhage (all grades)). Maternal outcomes included postpartum hemorrhage (defined as occurrence of any of the following: an estimated blood loss ≥1500 mL at delivery or the immediate postpartum period, a blood transfusion, or a hysterectomy for hemorrhage, placenta accreta, or atony), postpartum infection (defined as occurrence of any of the following: endometritis, wound cellulitis requiring antibiotics, wound reopened for fluid collection or infection, or wound dehiscence during the delivery hospitalization), and severe perineal laceration (defined as the occurrence of a third or fourth degree perineal laceration). Outcomes were examined by the three attempted modes of delivery. The final mode of delivery was also quantified.

Univariate comparisons of the patient population and outcomes were performed using chi-square, Fisher's exact and Kruskal-Wallis tests. Odds ratios were calculated adjusting for appropriate confounders using multivariable logistic regression. The c statistic was computed for each of the multivariable adjusted models. Model fit was assessed using the Hosmer-Lemeshow test. To determine whether associations varied by station or by birthweight, models with interaction terms (attempted mode of delivery × station and attempted mode of delivery × birthweight) were assessed. Because these tests for interaction were planned a priori, tests of interaction are generally underpowered, and our sample size was relatively small, P<.15 was used to define statistical significance for the interaction terms. P<.05 was used to define statistical significance for all other analyses. All tests were

two-tailed and no imputation for missing data was performed. All analyses were performed using SAS.

Results

Of the 115,502 women in the APEX data set, there were 2531 women who met criteria for the main analysis of this secondary analysis (Supplemental Figure). Demographic characteristics are shown in Table 1. Of the women included in this analysis, 16% were of Hispanic ethnicity and 11% were non-Hispanic black. The largest percent had an attempted vaginal vacuum delivery (54.6%) followed by attempted vaginal forceps (40.2%) and cesarean (5.2%). There were significant differences between women in age, race/ethnicity, smoking, BMI, intrapartum chorioamnionitis and birthweight, with larger babies more likely to be delivered by cesarean. Rotations were a minority of the forceps cases. Some vacuum deliveries were noted to have a rotation >45 degrees, despite the contraindication of applying torque with a vacuum. [14] It is unknown whether these were rotations that truly occurred with the vacuum on or inadvertently during the attempted delivery. Episiotomies were more frequent with vacuum than forceps deliveries (p<.001). Operator experience shows that the majority of operative deliveries were by an attending with more than 10 years of experience.

Table 2 shows the difference between delivery attempts by indication for operative delivery. Women undergoing an attempted operative vaginal delivery had more fetal indications than maternal indications. The majority of operative delivery attempts were low and not outlet as defined by ACOG.[13] Lastly, vaginal vacuums had a higher frequency of failure and subsequent need for cesarean than vaginal forceps (p=.04).

Unadjusted frequencies of neonatal and maternal outcomes are shown in Table 3. There were no differences in the neonatal composite or its components between attempted modes of delivery with the exception of low Apgar score which was highest at cesarean delivery. Maternal outcomes showed significant differences with severe perineal lacerations being more frequent with vaginal forceps. Cesarean deliveries had the highest frequency of postpartum infections, as well as postpartum hemorrhages.

When potential confounding factors were taken into account, vaginal forceps and vacuum were associated with lower odds of postpartum infection (odds ratio 0.16, 95%CI 0.05-0.49; odds ratio 0.04, 95%CI 0.01-0.17, respectively), compared with cesarean delivery. The neonatal composite outcome and postpartum hemorrhage were not significantly different between the attempted operative vaginal and cesarean modes of delivery. Although postpartum hemorrhage was not significantly different between operative vaginal and cesarean modes of attempted delivery, an interaction at a p=.08 was observed between attempted mode of delivery and birthweight in an unadjusted model with interaction terms (due to small cell sizes, no other potentially confounding factors could be adjusted for). In those with birthweight<4000 grams, the frequency of postpartum hemorrhage was 1.0% in vaginal vacuum, 2.7% in vaginal forceps and 4.5% in cesarean. Correspondingly, vaginal vacuum (odds ratio 0.20, 95%CI 0.07-0.59), but not vaginal forceps (odds ratio 0.58, 95%CI 0.22-1.54), were associated with a lower odds of postpartum hemorrhage compared with cesarean. In those with birthweight ≥4000 grams, the frequency of postpartum hemorrhage

was 8.8% in vaginal vacuum, 4.3% in vaginal forceps and 0.0% in cesarean; odds ratios not computed due to 0 cases in the cesarean group. No other significant interaction was observed. No third and fourth degree lacerations was observed in those whose first attempt was cesarean; therefore the multivariable model compared the two methods of operative vaginal deliveries (vaginal forceps odds ratio 2.20, 95%CI 1.80-2.70 compared with vaginal vacuum). Due to zero or small cells, the following outcomes were not assessed in multivariable analysis: neonatal skin laceration and neonatal intracranial or intraventricular hemorrhage.

The c-statistics for the multivariable adjusted models for the neonatal composite, maternal postpartum infection and maternal postpartum hemorrhage outcomes were 0.69 (95%CI 0.64-0.73), 0.83 (95%CI 0.73-0.93), and 0.79 (95%CI 0.73-0.85), respectively. When comparing the c-statistics of multivariable models without and with attempted mode of delivery, a significant improvement was observed for the outcome of postpartum infection (0.74 vs. 0.83, p=.03). Based on the Hosmer-Lemeshow test, there was no evidence of a lack of fit in the multivariable adjusted models.

Of interest, there were 45 women who underwent both a vaginal vacuum and a vaginal forceps attempt. The characteristics and unadjusted outcomes show a 13.3% frequency of failure and need for cesarean delivery as well as a frequency of 28.9% for third or fourth degree tears and 6.8% for the neonatal composite outcome (Supplemental Table 1). Supplemental Table 2 shows the comparison between the frequency of outcomes in these 45 women who underwent both a vaginal vacuum and a vaginal forceps attempt with the 133 women who underwent one operative vaginal attempt followed by cesarean. Women undergoing a second operative vaginal attempt, compared with women who underwent a cesarean, had a higher frequency of a third or fourth degree tear. Small numbers of outcomes prevented an attempt to adjust for confounders with multivariate models.

Discussion

In many areas of the country, vacuum and forceps deliveries have decreased, likely due to legal concerns and the fact that fewer and fewer residents have extensive training in operative vaginal delivery. [15, 16] Our data suggest that for woman needing assistance in the second stage of labor at a fetal station of +2 or below, operative vaginal delivery is associated with the least infectious morbidity. Compared with forceps delivery, vacuum delivery is associated with fewer third and fourth degree tears, although it also is more likely to result in a failed attempt and cesarean delivery.

Our study is an important advancement over previous studies in that it examines attempted mode of delivery rather than ultimate mode of delivery. When assessing ultimate mode of delivery, only the unsuccessful and more complicated cases will proceed to cesarean and the easier cases will be successful operative vaginal deliveries. By assessing attempted mode of delivery, we can evaluate outcomes regardless of whether the attempt was successful, a design that is analogous to an intent to treat analysis in a clinical trial.

While cesarean was not significantly associated with the adverse neonatal composite, cesarean was associated with a higher odds of maternal postpartum infection. After adjusting for confounders, attempted mode of delivery was not associated with postpartum hemorrhage; however, our data suggest that the association may vary by the size of the baby with vaginal vacuum deliveries associated with a lower frequency of postpartum hemorrhage in babies < 4000 grams, but with a higher frequency of postpartum hemorrhage in babies ≥ 4000 grams.

Our study is not without limitations. Patients in this study were from hospitals that are affiliated with academic institutions, and may not be generalizable to non-academic institutions. Even when adjusting for confounders, the possibility of unmeasured baseline differences between the populations remains. As with any cohort, there may be a selection bias when deciding which mode of delivery is attempted first, such as concern regarding the fetus, that is unmeasurable and not accounted for in the analysis. Additionally, some infant outcomes of interest were too rare to compare between groups and some are specific to a mode of delivery, for example severe vaginal tears do not occur with cesarean deliveries. While some types of clinical problems are amenable to study by randomized trial, it is unlikely that a trial comparing vaginal vacuum, vaginal forceps and cesarean for second stage arrest at a fetal station of +2 or below will be performed. Thus, an evaluation of an obstetric cohort from multiple centers with high quality clinical data takes on new importance.

Our study suggests that operative vaginal delivery is a reasonable first choice in the second stage at fetal station of +2 or below. While there may be specific situations when cesarean is an appropriate clinical choice, the risks and benefits of any attempted mode of delivery must be considered, discussed with the family and documented.

Conclusions

In patients needing second stage delivery assistance who have a fetal station of +2 or below, attempted operative vaginal delivery was associated with the least infectious morbidity. Vacuum delivery was associated with fewer third and fourth degree tears compared with forceps but had a higher rate of failure resulting in cesarean delivery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

In addition to the authors, other members of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network are as follows:

Columbia University, New York, NY – M. Talucci, M. Zylfijaj, Z. Reid (Drexel U.), R. Leed (Drexel U.), J. Benson (Christiana H.), S. Forester (Christiana H.), C. Kitto (Christiana H.), S. Davis (St. Peter's UH.), M. Falk (St. Peter's UH.), C. Perez (St. Peter's UH.)

University of Utah Health Sciences Center, Salt Lake City, UT – K. Hill, A. Sowles, J. Postma (LDS Hospital), S. Alexander (LDS Hospital), G. Andersen (LDS Hospital), V. Scott (McKay-Dee), V. Morby (McKay-Dee), K. Jolley (UVRMC), J. Miller (UVRMC), B. Berg (UVRMC)

University of North Carolina at Chapel Hill, Chapel Hill, NC – K. Dorman, J. Mitchell, E. Kaluta, K. Clark (WakeMed), K. Spicer (WakeMed), S. Timlin (Rex), K. Wilson (Rex)

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University of Alabama at Birmingham, Birmingham, AL – A. Tita, M. Wallace, A. Northen, J. Grant, C. Colquitt, D. Rouse, W. Andrews

Northwestern University, Chicago, IL – G. Mallett, M. Ramos-Brinson, A. Roy, L. Stein, P. Campbell, C. Collins, N. Jackson, M. Dinsmoor (NorthShore University HealthSystem), J. Senka (NorthShore University HealthSystem), K. Paychek (NorthShore University HealthSystem), A. Peaceman

University of Texas Medical Branch, Galveston, TX – J. Moss, A. Salazar, A. Acosta, G. Hankins

Wayne State University, Detroit, MI – Y. Sorokin, N. Hauff, L. Palmer, P. Lockhart, D. Driscoll, L. Wynn, C. Sudz, D. Dengate, C. Girard, S. Field

Brown University, Providence, RI – P. Breault, F. Smith, N. Annunziata, D. Allard, J. Silva, M. Gamage, J. Hunt, J. Tillinghast, N. Corcoran, M. Jimenez

The University of Texas Health Science Center at Houston-Children's Memorial Hermann Hospital, Houston, TX – S. Blackwell, F. Ortiz, P. Givens, B. Rech, C. Moran, M. Hutchinson, Z. Spears, C. Carreno, B. Heaps, G. Zamora

Oregon Health & Science University, Portland, OR – J. Seguin, M. Rincon, J. Snyder, C. Farrar, E. Lairson, C. Bonino, W. Smith (Kaiser Permanente), K. Beach (Kaiser Permanente), S. Van Dyke (Kaiser Permanente), S. Butcher (Kaiser Permanente)

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Eunice Kennedy Shriver National Institute of Child Health and Human Development, Bethesda, MD – C. Spong, S. Tolivaisa

MFMU Network Steering Committee Chair (*Medical University of South Carolina, Charleston, SC*) – J. P. VanDorsten, M.D.

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Table 1

Demographic characteristics by attempted mode of delivery

Characteristics, n (%) unless otherwise indicated	First Operative Attempt			P-value*
	Vaginal trial of vacuum n=1382	Vaginal trial of forceps n=1018	Cesarean n=131	
Age , years				<.001
<25	502 (36.3)	331 (32.5)	27 (20.6)	
25-29.9	385 (27.9)	252 (24.8)	37 (28.2)	
30-34.9	346 (25.0)	299 (29.4)	43 (32.8)	
≥35	149 (10.8)	136 (13.4)	24 (18.3)	
Race/ethnicity				<.001
Non-Hispanic white	776 (56.2)	602 (59.1)	74 (56.5)	
Non-Hispanic black	198 (14.3)	80 (7.9)	8 (6.1)	
Hispanic	201 (14.5)	171 (16.8)	25 (19.1)	
Other	207 (15.0)	165 (16.2)	24 (18.3)	
Diabetes (pre-gestational or gestational)	68 (4.9)	46 (4.5)	10 (7.6)	.30
Smoking	116 (8.4)	57 (5.6)	6 (4.6)	.02
PROM	34 (2.5)	28 (2.8)	4 (3.1)	.87
Hypertension (chronic or preeclampsia)	139 (10.1)	109 (10.7)	14 (10.7)	.86
BMI, kg/m^2				.02
<25	240 (17.5)	169 (16.8)	9 (7.0)	
25-29.9	583 (42.6)	465 (46.3)	56 (43.8)	
30-34.9	364 (26.6)	252 (25.1)	42 (32.8)	
35-39.9	126 (9.2)	70 (7.0)	14 (10.9)	
≥40	56 (4.1)	48 (4.8)	7 (5.5)	
Cocaine/meth	5 (0.4)	5 (0.5)	1 (0.8)	.48
Prior cesarean	42 (3.0)	32 (3.1)	5 (3.8)	.89
Intrapartum chorioamnionitis	162 (11.7)	188 (18.5)	32 (24.4)	<.001
Gestational age, weeks				.10

Characteristics, n (%) unless otherwise indicated	First Operative Attempt			P-value*
	Vaginal trial of vacuum n=1382	Vaginal trial of forceps n=1018	Cesarean n=131	
37^0-37^6	94 (6.8)	67 (6.6)	6 (4.6)	
38^0-38^6	222 (16.1)	143 (14.1)	17 (13.0)	
39^0-39^6	417 (30.2)	269 (26.4)	42 (32.1)	
40^0+	649 (47.0)	539 (53.0)	66 (50.4)	
Length of second stage, hours†	2.2 ± 1.6	2.5 ± 1.6	3.8 ± 1.7	<.001
Birthweight ≥4000 grams	83 (6.0)	71 (7.0)	21 (16.0)	<.001
Birthweight, grams, mean ± sd	3338 ± 422	3370 ± 426	3537 ± 442	<.001
Rotation >45^0 when vacuum or forceps applied†	53 (4.1)	61 (6.5)		.01‡
Episiotomy	514 (37.2)	288 (28.3)	2 (1.5)	<.001
Cystotomy	1 (0.1)	1 (0.1)	0 (0.0)	1.00
Bowel injury	0 (0.0)	1 (0.1)	0 (0.0)	§
Ureteral injury	0 (0.0)	0 (0.0)	0 (0.0)	§
Accreta	1 (0.1)	0 (0.0)	0 (0.0)	§
Attending years since graduation				<.001
< 10	320 (23.5)	174 (17.2)	46 (35.9)	
10.0-14.9	273 (20.0)	219 (21.6)	26 (20.3)	
15.0-19.9	239 (17.5)	179 (17.7)	13 (10.2)	
20.0-9.9	224 (16.4)	142 (14.0)	16 (12.5)	
≥ 25.0	307 (22.5)	298 (29.5)	27 (21.1)	

PROM, premature rupture of membranes; BMI, body mass index

*based on chi-square, Fisher's exact or Kruskal-Wallis

†length of second stage missing in 2.8%; rotation >45^0 missing in 6.7% of vaginal operative attempts

‡p-value comparing vaginal trial of vacuum and vaginal trial of forceps as this was not applicable in cesarean as first operative attempt

§p-value not computed due to zero observations in two or more groups

Table 2

Description of operative attempts

Information about the first operative attempt, n (%)	First Operative Attempt			P-value*
	Vaginal trial of vacuum n=1382	Vaginal trial of forceps n=1018	Cesarean n=131	
Fetal indication for first operative attempt (non-reassuring fetal status)	703 (50.9)	441 (43.3)	23 (17.6)	<.001
Station at first operative attempt was outlet†	607 (43.9)	274 (26.9)	12 (9.2)	<.001
Final delivery mode was cesarean	88 (6.4)	45 (4.4)	131 (100.0)	<.001‡

*based on chi-square

†defined as a fetal station of +3 when using the 3rds scale or +5 when using the 5ths scale

‡p=.04 comparing vaginal trial of vacuum with vaginal trial of forceps

Table 3

Outcomes by attempted mode of delivery (unadjusted)

Outcomes, n (%)	First Operative Attempt			P-value*
	Vaginal trial of vacuum n=1382	Vaginal trial of forceps n=1018	Cesarean n=131	
Neonatal outcomes				
Primary neonatal composite outcome	58 (4.2)	61 (6.1)	9 (6.9)	.09
Components of the composite				
Stillbirth after admission	0 (0.0)	0 (0.0)	0 (0.0)	†
Neonatal death	0 (0.0)	1 (0.1)	0 (0.0)	†
Fracture other than clavicular	2 (0.1)	0 (0.0)	0 (0.0)	†
Skull	1 (0.1)	0 (0.0)	0 (0.0)	†
Depressed skull	0 (0.0)	0 (0.0)	0 (0.0)	†
Other	1 (0.1)	0 (0.0)	0 (0.0)	†
Stay > mom by 3+ days	40 (2.9)	47 (4.6)	6 (4.6)	.07
Low Apgar	5 (0.4)	5 (0.5)	3 (2.3)	.01
Subgaleal	6 (0.4)	1 (0.1)	0 (0.0)	.33
Vent support	4 (0.3)	3 (0.3)	1 (0.8)	.44
HIE	11 (0.8)	11 (1.1)	3 (2.3)	.24
Brachial plexus injury	4 (0.3)	3 (0.3)	0 (0.0)	1.00
Facial nerve palsy	0 (0.0)	5 (0.5)	0 (0.0)	†
Secondary neonatal outcomes				
Skin laceration	30 (2.2)	29 (2.9)	1 (0.8)	.26
Bleed	14 (1.0)	5 (0.5)	0 (0.0)	.20
Maternal outcomes				
Severe perineal laceration	263 (19.1)	344 (33.8)	0 (0.0)	<.001
Postpartum infection	3 (0.2)	9 (0.9)	7 (5.3)	<.001
Postpartum hemorrhage‡	19 (1.4)	28 (2.8)	5 (3.8)	.03

[*] based on chi-square or Fisher's exact

[†] p-value not computed due to zero observations in two or more groups

[‡] Postpartum hemorrhage missing in 2.8%

Table 4

Outcomes by attempted mode of delivery accounting for confounders

Outcomes, odds ratio (95%CI)	Vaginal trial of vacuum n=1382	Vaginal trial of forceps n=1018	Cesarean n=131
Neonatal composite *	0.64 (0.29-1.39)	0.90 (0.42-1.93)	referent
Maternal postpartum infection †	0.04 (0.01-0.17)	0.16 (0.05-0.49)	referent
Maternal postpartum hemorrhage *	0.56 (0.19-1.68)	0.79 (0.28-2.25)	referent

*adjusted for operative delivery indication, station, length of second stage, maternal age, diabetes, smoking, premature rupture of membranes, hypertension, prior cesarean, body mass index, chorioamnionitis, birthweight

†adjusted for operative delivery indication, station, length of second stage, maternal age, smoking, premature rupture of membranes, intrapartum chorioamnionitis, birthweight