Original Research

Factors Influencing the Likelihood of Instrumental Delivery Success

Catherine E. Aiken, MB/BChir, PhD, *Abigail R. Aiken,* MB/BChir, MPH, *Jeremy C. Brockelsby,* MBBS, PhD, *and James G. Scott,* PhD

OBJECTIVE: To evaluate risk factors for unsuccessful instrumental delivery when variability between individual obstetricians is taken into account.

METHODS: We conducted a retrospective cohort study of attempted instrumental deliveries over a 5-year period (2008–2012 inclusive) in a tertiary United Kingdom center. To account for interobstetrician variability, we matched unsuccessful deliveries (case group) with successful deliveries (control group) by the same operators. Multivariate logistic regression was used to compare successful and unsuccessful instrumental deliveries.

RESULTS: Three thousand seven hundred ninety-eight instrumental deliveries of vertex-presenting, single, term newborns were attempted, of which 246 were unsuccessful (6.5%). Increased birth weight (odds ratio [OR] 1.11; $P<.001$), second-stage labor duration (OR 1.01; $P<.001$), rotational delivery (OR 1.52; $P<.05$), and use of ventouse compared with forceps (OR 1.33; $P<.05$) were associated with unsuccessful outcome. When interobstetrician variability was controlled for, instrument selection and decision to rotate were no longer associated with instrumental delivery success. More senior obstetricians had higher rates of unsuccessful deliveries (12% compared with 5%; $P<.05$) but were used to undertake more complicated cases. Cesarean delivery during the second stage of labor without previous attempt at instrumental delivery was associated with higher birth weight (OR 1.07; $P<.001$), increased maternal age (OR 1.03; $P<.01$), and epidural analgesia (OR 1.46; $P<.001$).

CONCLUSION: Results suggest that birth weight and head position are the most important factors in successful instrumental delivery, whereas the influence of instrument selection and rotational delivery appear to be operator-dependent. Risk factors for lack of instrumental delivery success are distinct from risk factors for requiring instrumental delivery, and these should not be conflated in clinical practice.

(Obstet Gynecol 2014;123:796–803)
DOI: 10.1097/AOG.0000000000000188

LEVEL OF EVIDENCE: II

Between 5% and 20% of newborns are delivered by instrumental (operative vaginal) delivery in developed countries.[1] Overall, approximately 5–10% of attempted instrumental deliveries will fail.[2] Unsuccessful attempts are associated with a higher risk of adverse maternal outcomes than that associated with proceeding directly to cesarean delivery, including increased rates of general anesthetic and wound infection,[3] as well as psychological trauma. Women who have experienced a previous failed attempt are likely to opt for an elective repeat cesarean delivery rather than another attempted vaginal birth.[4] When instrumental delivery is indicated because of fetal distress, neonatal outcomes also tend to be worse after an unsuccessful attempt.[3]

Established risk factors for requiring instrumental delivery include advanced maternal age,[5] high body mass index (BMI, calculated as weight (kg)/[height (m)]^2), epidural analgesia, and high birth weight.[6,7] It is uncertain, however, whether or how these factors influence the outcome of instrumental delivery. The

From the Department of Obstetrics and Gynaecology, University of Cambridge, NIHR Cambridge Comprehensive Biomedical Research Centre, Cambridge, United Kingdom; and the Population Research Center and LBJ School of Public Affairs, and Red McCombs School of Business and Division of Statistics and Scientific Computation, University of Texas at Austin, Austin, Texas.

Dr. Aiken is supported by a Eunice Kennedy Shriver *National Institute of Child Health and Human Development (NICHD) Ruth L. Kirschstein National Research Service Award under grant number T32 HD007081-35 and by grant 5 R24 HD042849 awarded to the Population Research Center at the University of Texas at Austin by the NICHD. Dr. Scott is partially funded by a CAREER grant from the U.S. National Science Foundation (DMS-1255187).*

Corresponding author: Catherine E. Aiken, MB/BChir, PhD, Department of Obstetrics and Gynaecology, University of Cambridge, NIHR Cambridge Comprehensive Biomedical Research Centre, Cambridge CB2 2SW, United Kingdom; e-mail: cema2@cam.ac.uk.

Financial Disclosure
The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/14

conflation of factors predicting the need for instrumental delivery with factors predicting the likelihood of success may be inappropriate and misleading in intrapartum decision-making. The alternative to attempting instrumental delivery, however, is to directly perform cesarean delivery during second-stage labor, which also has a high burden of morbidity.[8] A recent Cochrane review concluded that there is no evidence from randomized trials to guide the obstetrician in the decision to attempt an instrumental delivery compared with proceeding directly to cesarean delivery.[1] The aim of this study was to identify risk factors for unsuccessful instrumental delivery to aid the obstetrician in difficult decision-making.

MATERIALS AND METHODS

A cohort of 22,777 women with vertex-presenting, single, live born newborns at term (37–42 completed weeks of gestation) aiming for vaginal delivery was identified over a 5-year period in a single tertiary obstetrics center in the United Kingdom. Data regarding each woman's pregnancy, labor, and delivery were recorded by midwives soon after the birth and were subsequently obtained from the hospital's Protos maternity data-recording system. The database is regularly validated by a rolling program of audits whereby the original case notes are checked against the information recorded in the database. Deliveries were classified according to the final mode of delivery (Fig. 1). Unsuccessful instrumental deliveries were defined as those during which an instrument was applied to the fetal head, but the eventual mode of delivery was cesarean delivery. The use of sequential instruments, whereby any instrument was successful in delivering the newborn, was considered a successful delivery by the last instrument used. The rate of attempted instrumental delivery did not vary significantly by year during the study period, nor did the rate of unsuccessful instrumental delivery. The indications and procedures for instrumental delivery in our center are as defined in the operative vaginal delivery guidance from the Royal College of Obstetricians and Gynaecologists.[9]

Characteristics of the maternal–fetal dyad, including maternal age (at time of delivery), BMI (at first trimester prenatal booking), parity (before delivery), ethnicity, and the birth weight of the newborn, were extracted from the hospital database. Birth weight was recorded to the nearest gram. The following variables related to the delivery attempt were also noted: whether epidural analgesia was used before the delivery attempt; the length of time between diagnosis of second-stage labor and the time of delivery (time fully dilated); and the instrument selected. Gestational age was recorded to the nearest week. Only cases of birth occurring within the interval of 37–42 weeks of completed gestation were included. No adjustment was made for newborns found to be small or large for gestational age. No record of the station of the presenting part was available within our dataset. However, to our knowledge, no delivery was performed when the presenting part was above the level of the ischial spines, as recommended by Royal College of Obstetricians and Gynaecologists guidelines.[9]

The seniority of the obstetrician attempting delivery was also recorded and classified into four types. Type 1 obstetricians were doctors who have finished medical school within the past 4 years; this group conducted only 70 deliveries under supervision during the study period. Type 2 obstetricians are doctors with 3–5 years of obstetric training. Type 3 obstetricians are senior trainees with 5–10 years of obstetric training. Type 4 obstetricians typically have more

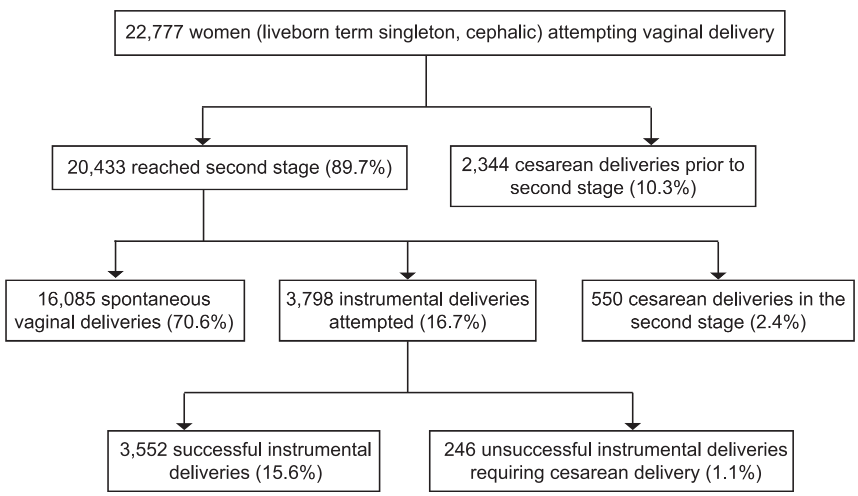

Fig. 1. Outcomes of all deliveries within the study period.

Aiken. Success in Instrumental Delivery. Obstet Gynecol 2014.

than 10 years of clinical obstetric experience. Our study was conducted in a unit where two obstetricians are available to perform instrumental deliveries or cesarean deliveries during a 12-hour shift. The first of these obstetricians is typically a type 2 obstetrician, and the second is a doctor with more than 5 years of obstetric training–a type 4 obstetrician during the day or a type 3 obstetrician overnight. All of the senior obstetricians (type 3 or 4) were willing to attempt fetal head rotation when they considered this to be safe. The method of fetal head rotation varied between different obstetricians but included manual rotation, ventouse (using the Kiwi Omnicup or rotational or posterior metal cup), and Kielland forceps. The position of the fetal head is not available within our database, but the majority of newborns who were not in the occipito-anterior position are most likely to have undergone an attempt at rotation in accordance with standard procedure. A small number may have been delivered in the direct occipito-posterior position, but this would be a highly unusual occurrence, and these data are not recorded.

In our statistical analyses, groupwise comparisons were performed using either Student t test or the Mann-Whitney test for numerical data and Pearson χ^2 test for categorical data. Several multivariate regression models were also fit as described herein. Findings were considered statistically significant at an alpha level of 0.05. All data analysis was conducted using the R statistical software package version 2.14.1.

Failed instrumental delivery was modeled using logistic regression with the following covariates: birth weight; maternal age; ethnicity; maternal BMI; seniority of obstetrician; parity; delivery during daylight hours; and use of epidural analgesia. Separate analyses were performed for two cohorts: the full cohort and a case-control subset. The full cohort comprised all successful and unsuccessful instrumental deliveries. The case-control subset comprised all unsuccessful instrumental deliveries (case group), together with only those successful deliveries that occurred within the same 12-hour shift as an unsuccessful delivery (control group). The goal of analyzing the case-control subset separately was to account for multiple sources of unobservable variation specific to a delivery unit that cannot be readily modeled. This includes the experience and clinical judgment of a particular obstetrician, the workload of the unit during a given shift, the clinician with overall responsibility for the unit, subtle variations in day shifts compared with night shifts or weekends, and other intangible environmental factors. The interobstetrician variability within the data are also significantly reduced by this strategy, because a maximum of two obstetricians are available for deliveries within any 12-hour shift. Analysis of the case-control subset is important for testing the robustness of our conclusions because differences among operators may account for significant variability in the full cohort.

A further consideration is that the more senior obstetricians are likely to have performed more difficult cases, thereby skewing the apparent success rates. To check the robustness of our findings, we performed separate analyses stratified by obstetrician type, examining the associations between failed instrumental delivery and those predictors that appeared significant in the full cohort model.

Given the influence of birth weight on the likelihood of success of instrumental delivery, we examined whether birth weight is predictable using only those covariates that are observable by the obstetrician before attempting instrumental delivery. This was performed using ordinary least squares, with predictors chosen using Bayesian information criterion.

As a final robustness check, we also used classification and regression trees[10] to build nonlinear predictive models for failed instrumental delivery and for birth weight. Classification and regression trees allow us to uncover nonlinear structure and interactions among the predictors, thereby relaxing the more stringent parametric assumptions of linear and logistic regression.

Finally, we sought to identify any systematic differences between women who underwent an attempted instrumental delivery (regardless of the outcome) compared with those who directly underwent cesarean delivery during the second stage of labor. We therefore examined the associations between first attempted mode of delivery and the covariates included in the original logistic regression analyses of successful instrumental delivery.

No patient-identifiable data were accessed in the course of this research, which was performed as part of a provision of service study for the obstetrics center. Institutional Review Board approval therefore was not required.

RESULTS

Three thousand seven hundred ninety-eight instrumental deliveries were attempted, representing 16.7% of all attempted vaginal deliveries. Two hundred forty-six (6.5%) attempts at instrumental delivery were unsuccessful. The overall number of instrumental deliveries performed did not differ between day and night shifts, nor did the rate of unsuccessful instrumental deliveries change between days and nights.

Characteristics of the maternal–fetal dyad were compared according to the outcome of attempted instrumental delivery (Table 1). Only gestational age (P<.01) and birth weight (P<.001) exhibited statistically significant differences between the two groups. Characteristics of the delivery attempt were also compared according to outcome (Table 1). The following statistically significant differences between the groups emerged: the instrumental selected (P<.05); need for rotation of the fetal head (P<.001); seniority of obstetrician (P<.001); epidural analgesia (P<.001); and time fully dilated (P<.001). Sequential instruments were used in 14 cases of unsuccessful instrumental delivery (0.36% of the study population); an attempt at forceps delivery was made after failed ventouse in 12 cases and the sequence was reversed in two cases. Because there were a small number of these cases, they were categorized according to the last instrument used.

Table 2 shows the results of the regression analysis for the full cohort. Unsuccessful instrumental delivery is associated with increased birth weight (odds ratio [OR] 1.11; P<.001), longer time fully dilated before instrumental delivery (OR 1.01; P<.001), need for rotation of the fetal head (OR 1.52; P<.05), and the use of ventouse rather than forceps (OR 1.33; P<.05).

Table 1. Characteristics of the Maternal–Fetal Dyad and the Delivery Attempt, for the Full Data Set and Stratified By Outcome

Characteristic	All Patients (N=3,798)	Successful Instrumental Deliveries (n=3,552)	Unsuccessful Instrumental Deliveries (n=246)
Maternal age (y)	30.1 (19–40)	30.1 (19–40)	30.0 (18–40)
Maternal BMI (kg/m^2)	25.0 (18–36)	25.0 (18–36)	25.2 (19–40)
Birth weight (g)	**3,487 (2,610–4,440)**	**3,460 (2,600–4,430)**	**3,709 (2,945–4,654)***
Gestation (wk)	**39.9 (37–42)**	**39.9 (37–42)**	**40.1 (38–42)†**
Ethnicity			
White	3,352	3,131	221
Southeast Asian	210	197	13
Black	43	41	2
Chinese	59	58	1
Other or unknown	134	125	9
Parity			
0	2,008	1,879	130
1	1,545	1,438	105
2	198	189	8
3	29	27	3
4 or more	18	19	0
Time fully dilated (min)	**132.3 (12–282)**	**128.8 (12–275)**	**132.5 (32–327)***
Rotation required			
Yes	**365**	**317**	**48***
No	3,433	3,235	198
Instrument used			
Forceps	2,212	2,076	136
Ventouse	1572	1,476	96
Both	14	0	14
Epidural			
Yes	**2,338**	**2,173**	**165***
No	1,146	1,076	70
Unknown	314	303	11
Obstetrician type			
1	70	70	0
2	**2,760**	**2,632**	**128***
3	718	629	89
4	236	208	28
Unknown	14	13	1

Data are mean (95% coverage interval) or n.

Numeric data are summarized by the mean and a coverage interval (in parentheses) spanning the 2.5–97.5 percentiles. Associations that meet the threshold for statistical significance (alpha level=0.05) are shown in bold.

* P<.001.

† P<.01.

Table 2. All Cases of Successful Instrumental Delivery Compared With All Cases of Unsuccessful Instrumental Delivery Using Multivariate Analysis With a Binomial Logistic Regression Model

Variable	Odds Ratio (95% CI)
Rotation (not required)	Reference
Rotation (required)	1.52 (1.02–2.36)*
Birth weight (per 100-g increase)	**1.11 (1.08–1.15)**†
Time fully dilated	**1.01 (1.00–1.01)**†
Parity	0.91 (0.75–1.24)
Maternal age	1.01 (0.98–1.04)
Day shift	Reference
Night shift	0.93 (0.75–1.23)
Instrument (forceps)	Reference
Instrument (ventouse)	1.33 (1.01–1.77)*
Ethnicity	
White	Reference
Black	1.06 (0.17–3.57)
Southeast Asian	1.45 (0.74–2.58)
Chinese	0.10 (0.00–21.38)
Other or unknown	1.30 (0.59–2.50)
No epidural	Reference
Epidural	1.23 (0.92–1.67)

CI, confidence interval.
Model coefficients are expressed as odds ratios and 95% CIs.
Associations that meet the threshold for statistical significance (alpha level=0.05) are shown in bold.
* $P<.05$.
† $P<.001$.

Table 3 shows the results of the regression analysis for the case-control subset. Increased birth weight ($P<.001$) and longer time fully dilated ($P<.001$) remained statistically significant, even after accounting for interobstetrician variability. The need for rotation and the instrument used were no longer significant at the 0.05 level.

Table 4 shows the results of using linear regression to predict birth weight. Factors associated with higher birth weight are gestational age ($P<.001$) and higher parity ($P<.01$). Southeast Asian ethnicity is associated with lower birth weight ($P<.01$). After refining the model using stepwise selection, approximately 22% of the variance in birth weight could be accounted for. This figure is not an artifact of linear regression; when using classification and regression trees, a fully nonlinear method, only 24% of the variance in birth weight could be accounted for. This suggests that birth weight is difficult to predict accurately using information available at the time of delivery (Fig. 2A).

Women who underwent cesarean delivery without a previous attempt at instrumental delivery had larger newborns (OR 1.07; $P<.001$), were older (OR 1.03; $P<.01$), and were more likely to have

Table 3. Multivariate Analysis Using a Binomial Logistic Regression Model of Matched Cases and Controls

Variable	Odds Ratio (95% CI)
Rotation (not required)	Reference
Rotation (required)	2.24 (0.97–5.26)
Birth weight (per 100-g increase)	**1.14 (1.08–1.22)***
Time fully dilated	**1.01 (1.00–1.01)***
Parity	0.87 (0.58–1.27)
Maternal age	1.02 (0.97–1.07)
Day shift	Reference
Night shift	1.24 (0.75–2.06)
Instrument (forceps)	Reference
Instrument (ventouse)	0.90 (0.54–1.50)
Ethnicity	
White	Reference
Black	0.73 (0.03–6.35)
Southeast Asian	1.99 (0.69–5.57)
Other/unknown	5.29 (1.27–24.59)
No epidural	Reference
Epidural	1.20 (0.70–2.06)

CI, confidence interval.
Associations that meet the threshold for statistical significance (alpha-level=0.05) are shown in bold.
All cases of unsuccessful instrumental delivery are matched to cases of successful instrumental delivery within the same shift, when such a case exists. When an unsuccessful instrumental delivery had no successful delivery within the same shift, it was not included in the analysis. When multiple successful deliveries occurred within the same shift as an unsuccessful delivery, all matches were included in the analysis.
Model coefficients are expressed as odds ratios and 95% CIs.
* $P<.001$.

Table 4. Influence of Parameters Known to the Obstetrician Before Instrumental Delivery Attempt on Birth Weight

Variable	Odds Ratio (95% CI)
Gestational age	4.88 (4.35–5.48)*
Ethnicity	
White	Reference
Black	0.72 (0.20–2.63)
Southeast Asian	**0.10 (0.05–0.18)**†
Chinese	0.47 (0.15–1.51)
Other	0.55 (0.23–1.33)
Parity	**1.37 (1.11–1.69)**†
Maternal BMI	0.10 (0.10–1.20)
Maternal age	0.98 (0.96–1.01)

CI, confidence interval; BMI, body mass index.
Associations that meet the threshold for statistical significance (alpha level=0.05) are shown in bold.
Multivariate analysis was performed using a logistic regression model.
Model coefficients are expressed as odds ratios and 95% CIs.
* $P<.001$.
† $P<.01$.

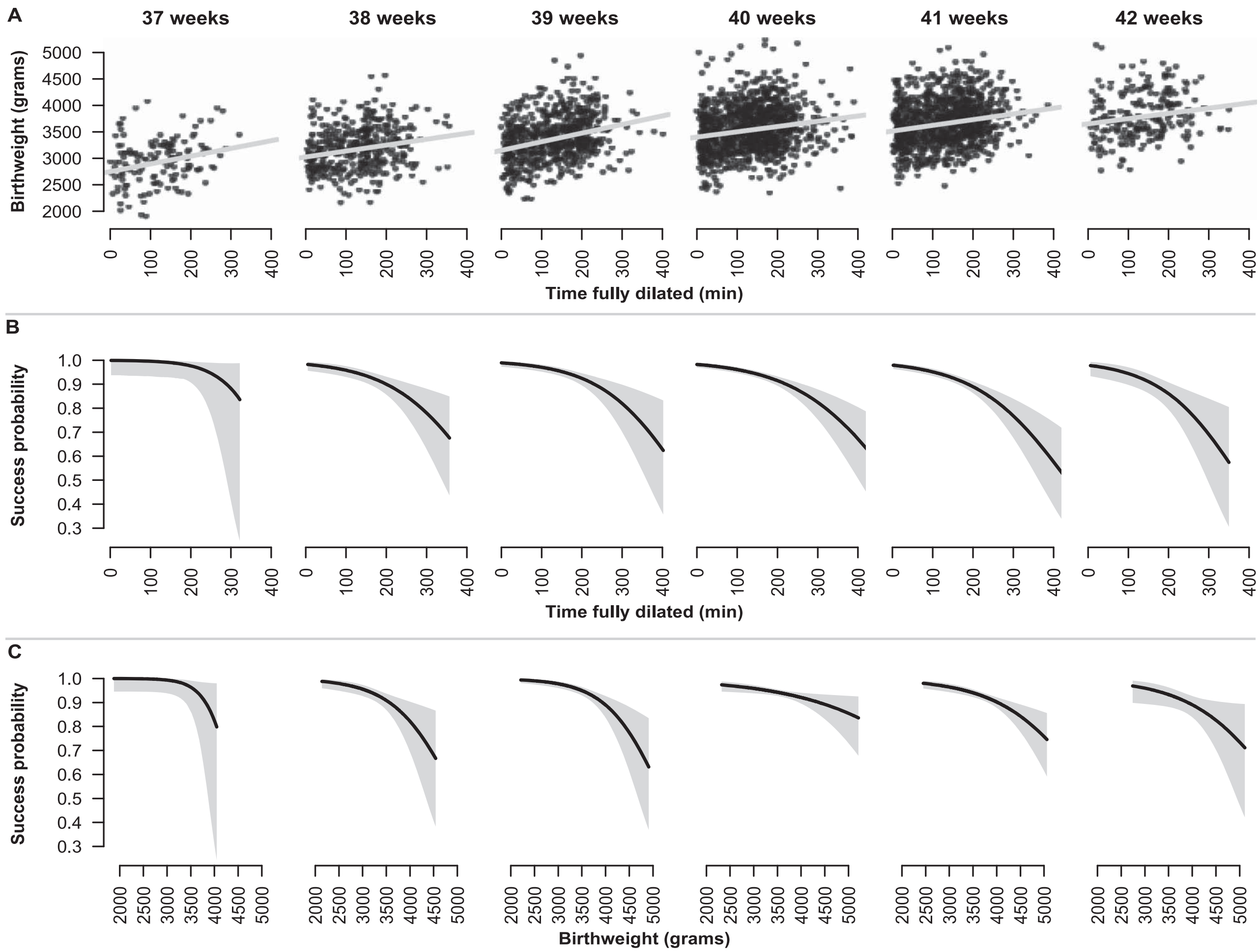

Fig. 2. A. Scatterplot and least-squares fit for birth weight compared with time fully dilated, stratified by gestational age. Estimated probability of successful instrumental delivery compared with time fully dilated (B) and birth weight (C), stratified by gestational age. The *black line* shows the logistic regression estimate; the *grey area* shows 95% confidence interval.
Aiken. Success in Instrumental Delivery. Obstet Gynecol 2014.

had epidural analgesia (OR 1.46; $P<.001$) (Table 5). Newborns delivered by direct cesarean delivery, however, were not as large as those who underwent a failed instrumental delivery (3,616 g compared with 3,711 g; $P<.01$).

Greater seniority of the obstetrician appeared to adversely influence the chance of a successful instrumental delivery; type 2 obstetricians had an overall failure rate of 5% compared with 12% for type 3 or type 4 obstetricians ($P<.05$). However, further analysis of the deliveries performed by each obstetrician type demonstrated that the deliveries performed by type 3 or type 4 (more experienced) obstetricians were more likely to have higher birth weight ($P<.05$) and to require rotation ($P<.001$). After adjustment for these factors, type 3 obstetricians were significantly more likely to succeed at instrumental delivery than type 2 obstetricians, their junior counterparts (Fig. 3). There was no difference in the use of forceps compared with ventouse depending on seniority of obstetrician.

Finally, the analysis of the case-control subset identified birth weight and time fully dilated as the only significant predictors of failed instrumental delivery, regardless of whether logistic regression or classification and regression trees was used. We therefore reperformed the logistic regression model on the full cohort, first using only birth weight as a predictor and then using only time fully dilated as a predictor (Fig. 2). This allows us to estimate the overall probability of success compared with the two major covariates (something that the case-control analysis cannot estimate properly). In Figure 2, the estimated probability of successful instrumental delivery is plotted against time fully dilated (Fig. 2B) and birth weight (Fig. 2C). In both panels, the models are

Table 5. Cases of Instrumental Delivery Compared With Cases of Direct Cesarean Delivery During Second-Stage Labor When No Instrument Was Applied

Variable	Odds Ratio (95% CI)
Birth weight (per 100-g increase)	1.07 (1.05–1.09)*
Maternal age	1.03 (1.01–1.05)†
Ethnicity	
White	Reference
Black	0.81 (0.24–2.03)
Southeast Asian	1.34 (0.86–2.00)
Chinese	0.93 (0.35–2.21)
Other/unknown	0.88 (0.42–1.64)
Time at full dilation	0.1 (0.1–1.00)
Maternal BMI	1.00 (0.1–1.00)
Parity	1.08 (0.94–1.24)
Obstetrician	1.11 (0.95–1.30)
Delivery during daylight hours	0.86 (0.70–1.04)
Epidural anesthesia	**1.46 (1.18–1.81)***

CI, confidence interval; BMI, body mass index.
Associations that meet the threshold for statistical significance (alpha level=0.05) are shown in bold.
Multivariate analysis was performed using a binomial logistic regression model.
Model coefficients are expressed as odds ratios and 95% CIs.
* $P<.001$
† $P<.01$.

stratified by gestational age, demonstrating that the same broad trends hold across 37–42 weeks of gestation. They show a clinically significant decline in the likelihood of success for larger newborns and for those with a long duration of being fully dilated.

DISCUSSION

We observed that increased birth weight and increased duration of second-stage labor are strongly associated with lack of success in instrumental delivery in the unmatched and case-control analyses. Use of ventouse rather than forceps and attempted rotation of the fetal head are associated with lack of success in the unmatched analysis only.

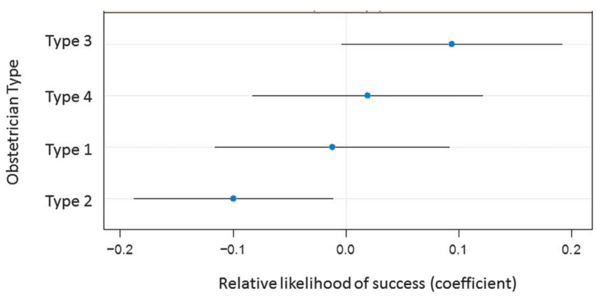

Fig. 3. Likelihood of success in instrumental delivery classified by obstetrician type.

Aiken. Success in Instrumental Delivery. Obstet Gynecol 2014.

One possible interpretation of the associations between instrument selection, rotation, and instrumental delivery outcome is that their influence may be operator-dependent. It is recognized that fetal head malposition in the second stage of labor is a risk factor for adverse labor outcomes.[11] However, rotation of the fetal head is considered a controversial procedure by many obstetricians, despite data showing low complication rates.[12,13] Although rotational instrumental delivery in our study had a higher rate of failure than nonrotational delivery, this was not the case for individual experienced operators, suggesting that more extensive experience with operative vaginal delivery would benefit trainee obstetricians. Previous studies have concluded, as we do here in the full cohort analysis, that overall forceps delivery is more likely to achieve successful vaginal delivery than ventouse[14,15]; however, there is also evidence that operator preference for a particular instrument can affect the delivery outcome.[16]

Although more experienced obstetricians had the highest unadjusted rates of unsuccessful instrumental attempts, this is likely to be because more difficult deliveries are usually handled by more senior obstetricians. After adjusting for birth weight and the need for rotation, junior obstetrics trainees had the highest adjusted rates of unsuccessful instrumental delivery, indicating that increased training and experience are imperative.

Our data show that instrumental delivery is no less likely to be successful in older mothers. Despite this, we found an increased likelihood of progression directly to cesarean delivery in older mothers in the second stage of labor. This may reflect obstetrician uncertainty regarding the likelihood of success of instrumental delivery in older mothers, because no data have previously been available to demonstrate success rates.[17] It may also be considered less important to avoid cesarean delivery in older women, who are less likely to have further pregnancies.

A small number of previous studies have examined risk factors for failed instrumental delivery, yet none has been able to control for interobstetrician variability. A major strength of our study is its novel methodologic approach, which reduces variation in individual obstetrician skill, differential thresholds in abandoning instrumental delivery for cesarean delivery, and "technique-dependent" variations, including choice of instrument and need for rotation of the fetal head. Whereas our findings are in general agreement with the current literature,[15,18–20] our study population showed several important differences from those previously reported. In particular, our population had a higher rate of instrumental delivery (16.6%) compared with other studied populations (5–6%).[15,18,20] The use of forceps was also much higher in our study (58.2% compared with 16.0%),[15] and rotational delivery was conducted within our study. This implies greater experience and willingness to perform instrumental delivery within our center. The cesarean delivery rate of all attempted vaginal deliveries in our population was 13.8% (including 10.3% performed during the first stage of labor) (Fig. 1). The main limitations of our study include the difficulty in classifying deliveries when sequential instruments were used and the inability of our database to identify a small number of newborns presenting in the occipito-posterior position who may have been delivered by instrument without rotation. Additionally, it is possible that the longer duration of second-stage labor during unsuccessful instrumental deliveries may be partially explained by the extra time required to perform cesarean delivery, but we are unable to distinguish this possibility from a clinical effect of having a prolonged second stage of labor using the data available.

Experience from cohorts like ours with high rates of instrumental delivery and low rates of intrapartum cesarean delivery is especially important in light of current concerns regarding increasing cesarean delivery rates worldwide and the drive to reverse this trend. We demonstrate that once the need for instrumental delivery has been determined, the factors involved are reduced to a simple problem of mass and orientation to achieve delivery. Birth weight is difficult to estimate before delivery; however, it is the major determinant of likelihood of success. Continued training in instrumental delivery for obstetricians is invaluable, and our study demonstrates significant improvement in success rates with increasing experience, ability to select the appropriate instrument, and ability to rotate the fetal head. Future research could focus on better methods of birth weight prediction and on safe, effective training strategies for resident obstetricians.

REFERENCES

1. Majoko F, Gardener G. Trial of instrumental delivery in theatre versus immediate caesarean section for anticipated difficult assisted births. The Cochrane Database of Systematic Reviews 2012;CD005545. doi: 10.1002/14651858.CD005545.pub3.
2. Schiff E, Friedman SA, Zolti M, Avraham A, Kayam Z, Mashiach S, et al. A matched controlled study of Kielland's forceps for transverse arrest of the fetal vertex. J Obstet Gynaecol 2001;21:576–9.
3. Alexander JM, Leveno KJ, Hauth JC, Landon MB, Gilbert S, Spong CY, et al. Failed operative vaginal delivery. Obstet Gynecol 2009;114:1017–22.
4. Melamed N, Segev M, Hadar E, Peled Y, Wiznitzer A, Yogev Y. Outcome of trial of labor after cesarean section in women with past failed operative vaginal delivery. Am J Obstet Gynecol 2013;209:49.e1–7.
5. Wang Y, Tanbo T, Abyholm T, Henriksen T. The impact of advanced maternal age and parity on obstetric and perinatal outcomes in singleton gestations. Arch Gynecol Obstet 2011;284:31–7.
6. Schuit E, Kwee A, Westerhuis ME, Van Dessel HJ, Graziosi GC, Van Lith JM, et al. A clinical prediction model to assess the risk of operative delivery. BJOG 2012;119:915–23.
7. Sharma V, Colleran G, Dineen B, Hession MB, Avalos G, Morrison JJ. Factors influencing delivery mode for nulliparous women with a singleton pregnancy and cephalic presentation during a 17-year period. Eur J Obstet Gynecol Reprod Biol 2009;147:173–7.
8. McKelvey A, Ashe R, McKenna D, Roberts R. Caesarean section in the second stage of labour: a retrospective review of obstetric setting and morbidity. J Obstet Gynaecol 2010;30: 264–7.
9. Bahl R, Strachan B, Murphy DJ. Greentop guideline 62; operative vaginal delivery. UK: Royal College of Obstetricians and Gynaecologists; 2011.
10. Breiman L, Friedman J, Stone CJ, Olshen RA. Classification and regression trees. 2nd ed. Belmont (CA): Chapman and Hall/CRC; 1984.
11. Senecal J, Xiong X, Fraser WD. Effect of fetal position on second-stage duration and labor outcome. Obstet Gynecol 2005;105:763–72.
12. Al-Suhel R, Gill S, Robson S, Shadbolt B. Kjelland's forceps in the new millennium. Maternal and neonatal outcomes of attempted rotational forceps delivery. Aust N Z J Obstet Gynaecol 2009;49:510–4.
13. Tempest N, Hart A, Walkinshaw S, Hapangama D. A re-evaluation of the role of rotational forceps: retrospective comparison of maternal and perinatal outcomes following different methods of birth for malposition in the second stage of labour. BJOG 2013;120:1277–84.
14. O'Mahony F, Hofmeyr GJ, Menon V. Choice of instruments for assisted vaginal delivery. The Cochrane Database of Systematic Reviews 2010;CD005455. doi: 10.1002/14651858.CD005455.pub2.
15. Ben-Haroush A, Melamed N, Kaplan B, Yogev Y. Predictors of failed operative vaginal delivery: a single-center experience. Am J Obstet Gynecol 2007;197:308e1–5.
16. Abenhaim HA, Morin L, Benjamin A, Kinch RA. Effect of instrument preference for operative deliveries on obstetrical and neonatal outcomes. Eur J Obstet Gynecol Reprod Biol 2007;134:164–8.
17. Dhanjal MK, Kenyon A. Scientific impact paper no. 34: Induction of labour at term in older mothers. London (UK): Royal College of Obstetricians and Gynaecologists; 2013.
18. Al-Kadri H, Sabr Y, Al-Saif S, Abulaimoun B, Ba'Aqeel H, Saleh A. Failed individual and sequential instrumental vaginal delivery: contributing risk factors and maternal-neonatal complications. Acta Obstet Gynecol Scand 2003;82:642–8.
19. Gopalani S, Bennett K, Critchlow C. Factors predictive of failed operative vaginal delivery. Am J Obstet Gynecol 2004;191: 896–902.
20. Sheiner E, Shoham-Vardi I, Silberstein T, Hallak M, Katz M, Mazor M. Failed vacuum extraction. Maternal risk factors and pregnancy outcome. J Reprod Med 2001;46:819–24.