Original Research

Maternal and Neonatal Morbidity After Attempted Operative Vaginal Delivery According to Fetal Head Station

Guillaume Ducarme, MD, MSc, Jean-François Hamel, MD, PhD, Pierre-Emmanuel Bouet, MD, Guillaume Legendre, MD, Laurent Vandenbroucke, MD, and Loic Sentilhes, MD, PhD

OBJECTIVE: To compare severe short-term maternal and neonatal morbidity associated with midpelvic and low pelvic attempted operative vaginal delivery.

METHODS: Prospective study of 2,138 women with live singleton term fetuses in vertex presentation who underwent an attempted operative vaginal delivery in a tertiary care university hospital. We used multivariate logistic regression and propensity score methods to compare outcomes associated with midpelvic and low pelvic delivery. Severe maternal morbidity was defined as third- or fourth-degree perineal laceration, perineal hematoma, cervical laceration, extended uterine incision for cesarean delivery, postpartum hemorrhage greater than 1,500 mL, surgical hemostatic procedures, uterine artery embolization, blood transfusion, infection, thromboembolic events, admission to the intensive care unit, and maternal death; severe neonatal morbidity was defined as 5-minute Apgar score less than 7, umbilical artery pH less than 7.00, need for resuscitation or intubation, neonatal trauma, intraventricular hemorrhage greater than grade 2, neonatal intensive care unit admission for more than 24 hours, convulsions, sepsis, and neonatal death.

RESULTS: From December 2008 through October 2013 there were 2,138 attempted operative vaginal deliveries; 18.3% (n=391) were midpelvic, 72.5% (n=1,550) low, and 9.2% (n=197) outlet. Severe maternal morbidity occurred in 10.2% (n=40) of midpelvic, 7.8% (n=121) of low, and 6.6% (n=13) of outlet attempts (P=.21); and severe neonatal morbidity in 15.1% (n=59), 10.2% (n=158), and 10.7% (n=21) (P=.02), respectively. Multivariable logistic regression analysis found no significant difference between midpelvic and low attempted operative vaginal delivery for either composite severe maternal (adjusted odds ratio [OR] 1.01, 95% confidence interval [CI] 0.66–1.55) or neonatal morbidity (adjusted OR 1.25, 95% CI 0.84–1.86). Similarly, propensity score matching found no significant difference between midpelvic and low operative vaginal delivery for either severe maternal (adjusted OR 0.69, 95% CI 0.39–1.22) or neonatal morbidity (adjusted OR 0.88, 95% CI 0.53–1.45).

CONCLUSION: In singleton term pregnancies, midpelvic attempted operative vaginal delivery compared with low pelvic attempted operative vaginal delivery was not associated with an increase in severe short-term maternal or neonatal morbidity.

(Obstet Gynecol 2015;126:521–9)

DOI: 10.1097/AOG.0000000000001000

LEVEL OF EVIDENCE: II

Worldwide, approximately 12–15% of births use one of the three methods of operative vaginal delivery: vacuum extraction, Thierry's spatulas, or forceps,[1,2] although in the United States the rate in 2010 was 3.62% of all deliveries.[3] Several studies have suggested that midpelvic operative vaginal delivery might significantly increase both maternal and neonatal morbidity and that cesarean delivery might therefore be the preferred mode of delivery when the fetal head is at the midpelvic station.[4–9] However, these

From the Departments of Obstetrics and Gynecology, General Hospital, La Roche sur Yon, and Rennes University Hospital, Rennes, and the Clinical Research Center and the Department of Obstetrics and Gynecology, Angers University Hospital, Angers, France; and the Department of Obstetrics and Gynecology, St. Luc Hospital University of Montreal, Montreal, Quebec, Canada.

Supported by Angers University Hospital.

The authors thank the women who participated in this study and the midwives and obstetricians involved in their care.

Corresponding author: Guillaume Ducarme, MD, MSc, Department of Obstetrics and Gynecology, Centre Hospitalier Departemental, 85000 La Roche sur Yon, France; e-mail: g.ducarme@gmail.com.

Financial Disclosure

The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/15

studies, all published at least 25 years ago, have severe limitations[10]: the study population most often had both midpelvic operative vaginal delivery and forceps rotation rather than simply the former,[5,6] the study designs were retrospective, and obstetric practices are likely to have changed since then. For instance, fetal heart rate monitoring was not routinely performed in some of the studies.[4,11]

Guidelines from the American College of Obstetricians and Gynecologists (the College), the Royal College of Obstetricians and Gynaecologists, and the Society of Obstetricians and Gynaecologists of Canada allow the use of midpelvic operative vaginal delivery only by experienced operators,[12–15] whereas the French National College of Obstetricians and Gynecologists considers that the available data do not justify a strong contraindication of this specific type of delivery and that a case-by-case analysis is necessary.[10,16]

Our main and secondary aims were to assess severe maternal and neonatal morbidity after attempted operative vaginal delivery according to its classification (defined by fetal head station at instrument application) and to compare morbidity after midpelvic and low pelvic delivery attempts using propensity score matching to ensure comparability of the study groups.

MATERIALS AND METHODS

This prospective study took place from December 2008 to October 2013 at a tertiary care university hospital with more than 4,000 annual deliveries. It included all women carrying a live singleton fetus who underwent an attempted operative vaginal delivery, defined by the placement of at least one blade for forceps or spatula, or an attempt to place a vacuum, regardless of its success. Exclusion criteria were small for gestational age, defined as less than the 10th centile for gestational age on Hadlock curves,[17,18] a known congenital anomaly, noncephalic presentation, and the absence of fetal station information according to the College classification.[19] Specifically, station was defined by the level of the leading bony point of the fetal head in centimeters at or below the level of maternal ischial spines (0 and +1=midpelvic, +2 and +3=low, +4 and +5=outlet). All women received information about our study and consented to the collection of their data. The Research Ethics Committee of the University of Angers, France, approved the study (No. 2008).

The decision to perform operative vaginal delivery, the choice of instrument (forceps, Kiwi OmniCup vacuum, or Thierry's spatulas), and the place of delivery (operating room or not) were left to the obstetrician's discretion. Operative vaginal deliveries were performed by either the attending obstetrician (who had 5 years or more of experience with operative vaginal delivery) or the obstetric registrar (who had less than 5 years of such experience) under supervision. In all cases, an experienced obstetrician was present in the delivery room. All women were offered epidural analgesia. The bladder was emptied by catheter before delivery.

The medical records of women with attempted operative vaginal delivery were assessed and discussed on working days at the daily morning staff meeting. Attending obstetricians regularly reviewed with registrars the College classification, academic knowledge about operative vaginal delivery, and the French National College of Obstetricians and Gynecologists clinical practice guidelines for operative vaginal delivery: rotational forceps–assisted deliveries (greater than 90° rotation) are not recommended; available data do not fully justify contraindication of midpelvic delivery, which can be performed in appropriate selected cases by trained, experienced obstetricians.[10,16]

Indications for attempted operative vaginal delivery included nonreassuring scalp pH and fetal heart rate (defined by any of prolonged deceleration, bradycardia, decreased variability, or thick meconium[20]) and prolongation of active second stage resulting from inadequate expulsive efforts or failure to progress.[10,16] All women underwent continuous fetal heart rate monitoring. Episiotomy was left to the discretion of the practitioner. All episiotomies were mediolateral. A pediatrician examined the newborn in all cases in the 2 hours after delivery.

The details of the procedures used to manage the labor as well as all clinical outcomes identified during the immediate postpartum period were prospectively collected by the midwife or obstetrician and pediatrician responsible for the delivery and the neonate. Other data were collected by a research assistant, independent of the local medical team, from a prospectively maintained database of women who underwent attempted operative vaginal delivery. Maternal characteristics collected included age, body mass index (BMI, calculated as [weight (kg)/[height (m)]^2, based on height and the first weight noted in the obstetric record), parity, and medical history. Intrapartum variables recorded included gestational age at delivery (determined by the craniocaudal length at a first-trimester ultrasound examination or by the date of last menstrual period, a second- or third-trimester ultrasonogram, or both if the first-trimester ultrasonogram was not performed),[21] prenatal

suspicion of macrosomia (determined by fundal height measurement at delivery greater than 37 cm, ultrasonographic fetal abdominal circumference greater than 90th percentile for gestational age on Hadlock curves,[17] or both), type of labor (spontaneous or induced by prostaglandins, amniotomy, or oxytocin), analgesia (intravenous, local, or regional), fetal head position at crowning (occiput posterior or anterior or transverse), duration of the entire second stage of labor (complete dilatation to birth) and of the active second stage (from the beginning of expulsive efforts to birth [pushing time]),[22] indication for attempted operative vaginal delivery, station at attempted delivery, instrument, delivery by attending obstetrician or registrar, place of delivery (operating room or not), and birth weight.

The endpoints were composite variables of severe maternal and neonatal morbidity. Severe short-term maternal morbidity was defined by at least one of the following criteria: third- or fourth-degree perineal laceration, perineal hematoma, cervical laceration, extended uterine incision for cesarean delivery, postpartum hemorrhage greater than 1,500 mL (blood loss was routinely assessed with a collector bag [MVF Merivaara] placed just after birth),[23] surgical hemostatic procedures, uterine artery embolization, blood transfusion, infection, thromboembolic events, admission to the intensive care unit, and maternal death.

Severe neonatal morbidity was defined by at least one of the following criteria: 5-minute Apgar score less than 7, umbilical artery pH less than 7.00 (umbilical artery blood gas values were routinely measured), need for resuscitation or intubation, neonatal trauma, intraventricular hemorrhage greater than grade 2, neonatal intensive care unit admission for more than 24 hours, convulsions, sepsis, and neonatal death.[24]

Continuous data were described by their means±standard deviations and compared by *t* tests (or Mann-Whitney tests when appropriate), and categorical data were described by percentages and compared by χ^2 tests (or Fisher's exact tests when appropriate). The relations between attempted operative vaginal delivery classification and severe maternal and neonatal morbidity were studied with multivariate logistic regressions and propensity score matching analyses. The multivariate logistic regression allowed us to analyze together the effect of other risk factors and potential confounders (maternal age, parity, BMI before pregnancy, gestational age, induction of labor, epidural use, persistent occiput position, attempted operative vaginal delivery classification, delivery by attending obstetrician or registrar, instrument type, active phase of second stage longer than 30 minutes, indications for attempted operative vaginal delivery, birth weight, and episiotomy).[25–28] The propensity score analyses were performed as sensitivity analyses to confirm the results of the multivariate logistic regressions. The propensity score was based on a logistic regression model that included all the covariates that were significantly differently distributed according to whether the attempt was midpelvic or low pelvic.[29] STATA 13.1 was used for all analyses. *P* values $<.05$ were considered to be statistically significant.

RESULTS

During the study period, the hospital had 19,786 deliveries: 15,836 (80.0%) were vaginal, including 2,153 (13.6%) successful operative vaginal deliveries, and 3,950 (20.0%) were cesarean deliveries, including 39 (0.2% of all deliveries and 1% of all cesarean deliveries) after failed operative vaginal delivery. There were thus 2,192 deliveries with an attempted operative vaginal delivery: successes 98.2% and failures 1.8%. However, 28 neonates were twins (n=14 women), 26 were preterm, and 14 were small for gestation age and were therefore excluded. Therefore, our final sample comprised 2,138 deliveries with an attempted operative vaginal delivery: 18.3% (n=391) midpelvic, 72.5% (n=1,550) low, and 9.2% (n=197) outlet. Among all women with a fetus at midpelvic station at delivery, only 17 (4.2%) had a cesarean delivery without an operative vaginal attempt.

Table 1 details the maternal and labor characteristics and maternal and neonatal outcomes according to the operative vaginal delivery classification. There were no maternal or perinatal deaths. Persistent occiput posterior or transverse, forceps and spatulas, manual rotation, attempted delivery performed by the attending senior obstetrician, and operating room delivery were significantly more frequent in midpelvic compared with attempted low pelvic delivery (Table 1).

The rate of severe maternal morbidity after attempted operative vaginal delivery was 8.3% (n=161) and did not differ significantly among the three groups (midpelvic, low, and outlet) (Table 1). Women with severe morbidity were compared with a pooled group of women with either no morbidity or morbidity considered not severe. These groups differed according to previous cesarean delivery, prepregnancy BMI, gestational age 41 weeks or greater, spatula application, and birth weight, but not according to midpelvic compared with low

Table 1. Maternal and Labor Characteristics and Maternal and Neonatal Outcomes According to the American College of Obstetricians and Gynecologists' Classification[19]

	Mid [n=391 (18.3)]	Low [n=1,550 (72.5)]	Outlet [n=197 (9.2)]	*P*
Maternal and labor characteristics				
Age (y)	28.6±5.4	28.2±5.0	27.2±5.2	.01
BMI before pregnancy (kg/m^2)	23.2±4.4	23.1±11.1	21.8±3.4	.19
Nulliparity	277 (70.8)	1,151 (74.2)	155 (78.7)	.12
Previous cesarean delivery	48 (12.3)	160 (10.3)	18 (9.1)	.83
Previous birth weight more than 4,000 g	6 (5.4)	17 (4.3)	0	.33
Gestational diabetes mellitus	24 (6.2)	91 (5.9)	7 (3.6)	.18
Prenatal suspicion of macrosomia*	37 (9.5)	121 (7.8)	10 (5.1)	.17
Gestational age at delivery (wk)	39.4±1.6	39.4±1.5	39.4±1.3	.64
Induced labor	83 (21.2)	273 (17.6)	23 (11.7)	.02
Second stage longer than 3 h	61 (15.6)	218 (14.1)	21 (10.7)	.26
Active phase of second stage longer than 30 min	104 (26.6)	527 (34.0)	69 (35.0)	.02
Dose of oxytocin (milli-international units)	2,084.9±2,630.3	1,682.7±2,206.6	1,351.8±2,031.5	<.001
Epidural analgesia	372 (95.1)	1,455 (93.9)	170 (86.3)	<.001
Manual rotation	69 (17.9)	156 (10.2)	7 (3.6)	<.001
Persistent occiput				<.001
Anterior	314 (80.3)	1,380 (89.4)	182 (92.9)	
Posterior	63 (16.1)	119 (7.7)	12 (6.1)	
Transverse	14 (3.6)	44 (2.8)	2 (1.0)	
Indication for operative vaginal delivery				.004
Nonreassuring FHR only	199 (50.9)	637 (41.1)	77 (39.1)	
Arrested progress only	110 (28.1)	604 (38.9)	80 (40.6)	
Nonreassuring FHR and arrested progress	81 (20.7)	308 (19.9)	40 (20.3)	
Operative vaginal delivery in OR	35 (8.9)	4 (0.3)	0	<.001
Obstetrician performing delivery				<.001
Senior attending obstetrician	201 (53.5)	313 (20.3)	21 (10.7)	
Obstetric registrar	175 (46.5)	1,228 (79.7)	175 (89.3)	
Instrument type				<.001
Vacuum	38 (9.8)	525 (33.9)	165 (83.8)	
Forceps	35 (9.0)	85 (5.5)	1 (0.5)	
Spatula	324 (83.7)	994 (64.1)	35 (17.8)	
Sequential use of 2 instruments	18 (4.6)	56 (3.6)	6 (3.1)	.55
Rotational forceps delivery	1 (0.3)	1 (0.1)	0	.49
Maternal outcome				
Cesarean delivery after failed operative vaginal delivery	35 (8.9)	4 (0.3)	0	<.001
Extended uterine incision for cesarean delivery	6 (12.2)	1 (16.7)	0	.76
Episiotomy	325 (85.5)	1,356 (87.4)	171 (86.8)	.61
Third- or fourth-degree perineal laceration	8 (2.1)	45 (2.9)	3 (1.5)	.41
Perineal hematoma	1 (0.3)	1 (0.1)	0	.48
Manual removal of retained placenta	77 (33.2)	180 (20.3)	17 (14.9)	<.001
PPH	78 (20.0)	249 (16.1)	20 (10.2)	.009
Severe PPH (blood loss greater than 1,500 mL)	10 (2.6)	25 (1.6)	3 (1.5)	.43
Need for an additional uterotonic agent	10 (4.3)	30 (3.4)	4 (3.5)	.80
Second-line therapies†	2 (0.9)	4 (0.5)	0	.54
Blood transfusion	12 (3.1)	24 (1.6)	4 (2.0)	.14
Infection‡	6 (1.5)	18 (1.2)	5 (2.5)	.27
Thromboembolic event	1 (0.3)	3 (0.2)	0	.79
Admission to ICU	0	1 (0.6)	1 (0.5)	.13
Maternal death	0	0	0	—
Severe maternal morbidity§	40 (10.2)	121 (7.8)	13 (6.6)	.21
Neonatal outcome				
Birth weight 4,000 g or more	20 (5.1)	80 (5.2)	7 (3.6)	.62
5-min Apgar score less than 7	2 (0.5)	17 (1.1)	2 (1.0)	.58
pH less than 7.00	10 (2.6)	21 (1.4)	2 (1.0)	.20

(*continued*)

Table 1. Maternal and Labor Characteristics and Maternal and Neonatal Outcomes According to the American College of Obstetricians and Gynecologists' Classification[19] (*continued*)

	Mid [n=391 (18.3)]	Low [n=1,550 (72.5)]	Outlet [n=197 (9.2)]	*P*
Transfer to NICU	28 (7.2)	101 (6.5)	13 (6.6)	.90
NICU hospitalization longer than 24 h	24 (6.1)	88 (5.7)	13 (6.6)	.84
Respiratory distress syndrome	13 (3.3)	59 (3.8)	7 (3.6)	.90
Scalp laceration	37 (9.5)	78 (5.0)	2 (1.0)	<.001
Scalp hematoma	23 (5.9)	25 (1.6)	6 (3.1)	<.001
Pain necessitating drugs	51 (13.1)	161 (10.4)	8 (4.1)	.003
Neonatal trauma‖	3 (0.8)	10 (0.6)	0	.50
Fracture of the clavicle	2 (0.5)	5 (0.3)	0	
Fracture of a long bone	0	0	0	
Brachial plexus injury	1 (0.3)	5 (0.3)	0	
Cephalhematoma	1 (0.3)	7 (0.5)	0	
Intraventricular hemorrhage greater than grade 2	0	0	0	—
Need for resuscitation or intubation	2 (0.5)	11 (0.7)	1 (0.5)	.88
Sepsis	9 (2.3)	12 (0.8)	1 (0.5)	.02
Seizures	0	5 (0.3)	0	.39
Neonatal death	0	0	0	—
Severe neonatal morbidity¶	59 (15.1)	158 (10.2)	21 (10.7)	.02

BMI, body mass index; FHR, fetal heart rate; OR, operating room; PPH, postpartum hemorrhage; ICU, intensive care unit; NICU, neonatal intensive care unit.

Data are mean±standard deviation or n (%) unless otherwise specified.

Student's *t* test, χ^2 test, nonparametric Mann-Whitney test, and Fisher's exact test were used as appropriate. A *P* value of .05 was considered significant.

* Prenatal suspicion of macrosomia: fundal height measurement at delivery greater than 37 cm, ultrasonographic fetal abdominal circumference greater than 90th percentile for gestational age on Hadlock curves, or both.

† Second-line therapies: uterine compression sutures, uterine artery embolization, and peripartum hysterectomy for management of massive primary postpartum hemorrhage after failure of uterine massage and uterotonic agents to stop bleeding.

‡ Infections were defined by at least one of the following: endometritis, episiotomy infection, or wound infection requiring surgery.

§ Severe maternal morbidity was defined by at least one of the following criteria: third- or fourth-degree perineal lacerations, perineal hematomas, cervical laceration, extended uterine incision at cesarean delivery, PPH greater than 1,500 mL, surgical hemostatic procedure, uterine artery embolization, blood transfusion, infections (endometritis, episiotomy infection, wound infection needed surgery), thromboembolic event (deep vein thrombophlebitis or pulmonary embolism), admission to intensive care unit, and maternal death.

‖ Neonatal trauma was defined by the existence of at least one of the following criteria: fracture of the clavicle or a long bone, brachial plexus injury, and cephalhematoma.

¶ Severe neonatal morbidity was defined by at least one of the following criteria: 5-minute Apgar score less than 7, umbilical artery pH less than 7.00, need for resuscitation or intubation, neonatal trauma, intraventricular hemorrhage greater than grade 2, admission to the NICU for greater than 24 hours, convulsions, sepsis, and neonatal death.

pelvic attempted operative vaginal delivery (Table 2). In the multivariable logistic regression analysis adjusted for potential confounders, midpelvic (compared with low pelvic) attempted delivery was not significantly associated with severe maternal morbidity (adjusted odds ratio [OR] 1.01, 95% confidence interval [CI] 0.66–1.55) (Table 3). Use of forceps (adjusted OR 3.55, 95% CI 1.53–8.20) and of the spatula (adjusted OR 2.75, 95% CI 1.58–4.78), compared with the vacuum device, was significantly associated with severe maternal morbidity (Table 3).

The rate of severe neonatal morbidity was 11.1% (n=217) and differed significantly among the midpelvic, low, and outlet groups (Table 1). In the univariate analysis, attempted midpelvic delivery was associated with a higher rate of severe neonatal morbidity than low attempted low pelvic (Table 2). After adjustment for confounding factors in the multivariate logistic regression analysis, this association was not significant (adjusted OR 1.25, 95% CI 0.84–1.86) (Table 3).

The propensity score was based on all variables that differed significantly in the univariate analysis according to the delivery classification (midpelvic compared with low pelvic) (Table 4). The matching process resulted in 618 cases that could be analyzed: 309 matched women in each group, including 31.8% of the original cohort of midpelvic (79%) and 19.9% of the attempted low pelvic deliveries. After propensity score matching, attempted midpelvic delivery was not significantly associated with severe maternal (adjusted OR 0.69, 95% CI 0.39–1.22) or neonatal morbidity (adjusted OR 0.88, 95% CI 0.53–1.45).

Table 2. Univariate Analysis of Severe Maternal and Neonatal Morbidity After Midpelvic or Low Pelvic Attempted Operative Vaginal Delivery

	Severe Maternal Morbidity*			Severe Neonatal Morbidity†		
Variable	No (n=1,780)	Yes (n=161)	*P*	No (n=1,724)	Yes (n=217)	*P*
Maternal age (y)	28.2±5.1	28.3±5.1	.87	28.3±5.1	28.0±5.1	.42
BMI before pregnancy (kg/m^2)	22.9±4.2	25.3±32.2	.004	22.8±4.2	25.5±27.8	<.003
Nulliparity	1,306 (73.3)	122 (75.8)	.50	1,270 (73.6)	158 (72.8)	.80
Previous cesarean delivery	182 (38.5)	26 (66.7)	<.001	184 (40.6)	24 (40.7)	.99
Gestational age at delivery (wk)	39.4±1.5	39.7±1.4	.02	39.5±1.3	38.6±2.6	<.001
Gestational age 41 wk or greater	397 (22.3)	50 (31.1)	.01	394 (22.8)	53 (24.4)	.60
Induced labor	325 (18.3)	31 (19.3)	.75	304 (17.6)	52 (24.0)	.02
Second stage longer than 3 h	250 (14.0)	29 (18.1)	.16	258 (15.0)	21 (9.7)	.04
Length of active phase of second stage (min)	24.4±13.0	24.5±11.9	.93	24.5±12.9	23.4±12.8	.24
Active phase of second stage longer than 30 min	583 (32.7)	48 (29.8)	.45	562 (32.6)	69 (31.8)	.82
Epidural analgesia	1,678 (94.3)	149 (92.6)	.37	1,621 (94.0)	206 (94.9)	.59
General anesthesia	4 (0.2)	3 (1.9)	<.001	7 (0.4)	0	.35
Persistent occiput			.70			.24
Anterior	1,557 (87.8)	137 (85.6)		1,512 (88.0)	182 (84.7)	
Posterior	164 (9.2)	18 (11.3)		159 (9.3)	23 (10.7)	
Transverse	53 (3.0)	5 (3.1)		48 (2.8)	10 (4.7)	
Indication for operative vaginal delivery						
Nonreassuring FHR only	778 (43.7)	58 (36.0)	.06	745 (43.2)	91 (41.9)	.72
Arrested progress only	649 (36.4)	68 (42.2)	.14	651 (37.7)	66 (30.4)	.04
Nonreassuring FHR and arrested progress	357 (20.0)	32 (19.9)	.96	330 (19.1)	59 (27.2)	.005
Cesarean delivery after failed operative vaginal delivery	29 (1.6)	10 (6.2)	<.001	31 (1.8)	8 (3.7)	.06
Obstetrician performing delivery			.14			<.001
Senior attending obstetrician	464 (26.4)	50 (31.9)		431 (25.2)	83 (39.7)	
Obstetric registrar	1,296 (73.6)	107 (68.2)		1,277 (74.8)	126 (60.7)	
College classification			.12			.006
Mid	351 (19.7)	40 (24.8)		332 (19.3)	59 (27.2)	
Low	1,429 (80.3)	121 (75.2)		1,393 (80.8)	158 (72.8)	
Instrument type						
Vacuum	533 (30.0)	30 (18.7)	.002	507 (29.5)	56 (25.8)	.26
Forceps	104 (5.9)	16 (9.9)	.04	94 (5.5)	26 (12.0)	<.001
Spatula	1,193 (67.2)	124 (77.0)	.02	1,166 (67.8)	152 (70.0)	.50
Sequential use of 2 instruments	66 (3.7)	8 (4.9)	.43	59 (3.4)	15 (6.9)	.01
Rotational forceps delivery	2 (0.1)	0	.67	2 (0.1)	0	.62
Episiotomy	1,546 (87.3)	135 (84.4)	.29	1,505 (87.7)	176 (81.9)	.02
Birth weight (g)	3,281.0±451.9	3,397.0±422.7	.002	3,310.2±416.5	3,133.5±644.0	<.001
Birth weight 4,000 g or more	90 (5.1)	10 (6.3)	.51	86 (5.0)	14 (6.5)	.34

BMI, body mass index; FHR, fetal heart rate; College, American College of Obstetricians and Gynecologists.
Data are mean±standard deviation or n (%) unless otherwise specified.
Student's *t* test, χ^2 test, nonparametric Mann-Whitney test, and Fisher's exact test were used as appropriate. A *P* value of .05 was considered significant.
* Severe maternal morbidity was defined by at least one of the following criteria: third- or fourth-degree perineal lacerations, perineal hematomas, cervical laceration, extended uterine incision on cesarean delivery, postpartum hemorrhage greater than 1,500 mL, surgical hemostatic procedure, uterine artery embolization, blood transfusion, infection (endometritis, episiotomy infection, wound infection), thromboembolic event (deep vein thrombophlebitis or pulmonary embolism), admission to intensive care unit, and maternal death.
† Severe neonatal morbidity was defined by at least one of the following criteria: 5-minute Apgar score less than 7, umbilical artery pH less than 7.00, need for resuscitation or intubation, neonatal trauma, intraventricular hemorrhage greater than grade 2, admission to the neonatal intensive care unit for greater than 24 hours, convulsions, sepsis, and neonatal death.

DISCUSSION

In our study, midpelvic attempted operative vaginal delivery was not associated with a higher rate of severe maternal and neonatal morbidity than attempted low pelvic delivery. In the univariate analysis, postpartum hemorrhage, scalp laceration, scalp hematoma, sepsis, and composite severe neonatal morbidity were more frequent in the midpelvic group, but these differences did not persist after multivariate analysis or propensity score analysis.

Table 3. Multivariate Analysis of Severe Maternal and Neonatal Morbidity After Midpelvic or Low Pelvic Attempted Operative Vaginal Delivery

	Severe Maternal Morbidity (n=161)		Severe Neonatal Morbidity (n=217)	
Variable*	Adjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Maternal age (/y)	0.99 (0.96–1.03)	.94	0.99 (0.95–1.02)	.40
Nulliparity	1.03 (0.68–1.56)	.90	1.04 (0.70–1.55)	.86
Multiparity	Reference	—	Reference	—
BMI before pregnancy				
BMI (kg/m^2) less than 25	Reference	—	Reference	—
25 to less than 30	0.98 (0.64–1.52)	.95	1.52 (1.05–2.21)	.03
BMI 30 or higher	1.45 (0.54–3.88)	.46	1.76 (0.70–4.47)	.23
Gestational weight gain more than 20 kg	1.18 (0.69–1.64)	.45	0.86 (0.49–1.50)	.59
Prenatal suspicion of macrosomia†	1.53 (0.81–2.89)	.19	0.85 (0.43–1.67)	.64
Gestational age (wk)				
Less than 39 wk	0.94 (0.59–1.49)	.80	2.61 (1.78–3.81)	<.001
39 to less than 41	Reference	—	Reference	—
Greater than 41	1.48 (0.98–2.25)	.06	1.30 (0.85–1.99)	.23
Induced labor	0.86 (0.55–1.36)	.53	1.35 (0.91–2.00)	.14
Epidural analgesia	0.51 (0.25–1.06)	.07	1.36 (0.60–3.10)	.46
Persistent occiput position				
Anterior	Reference	—	Reference	—
Posterior	1.13 (0.64–1.98)	.67	1.03 (0.60–1.75)	.92
Transverse	0.90 (0.31–2.58)	.85	1.95 (0.90–4.20)	.09
College classification				
Mid	1.01 (0.66–1.55)	.97	1.23 (0.82–1.83)	.32
Low	Reference	—	Reference	—
Obstetrician performing delivery				
Senior attending obstetrician	Reference	—	Reference	—
Obstetric registrar	1.00 (0.66–1.51)	.99	0.59 (0.41–0.85)	.005
Instrument type				
Vacuum	Reference	—	Reference	—
Forceps	3.44 (1.49–7.99)	.004	1.85 (0.91–3.76)	.09
Spatula	2.69 (1.55–4.67)	<.001	1.15 (0.73–1.81)	.55
Sequential use of instruments	2.36 (0.82–6.81)	.11	2.10 (0.93–4.75)	.08
Active phase of second stage longer than 30 min	0.57 (0.36–0.91)	.02	1.12 (0.72–1.76)	.61
Indication for attempted operative vaginal delivery				
Nonreassuring FHR only	0.48 (0.23–0.76)	.002	1.17 (0.72–1.89)	.53
Arrested progress only	Reference	—	Reference	—
Nonreassuring FHR and arrested progress	0.65 (0.39–1.09)	.10	1.59 (0.99–2.57)	.06
Episiotomy	0.57 (0.33–0.99)	.05	0.53 (0.32–0.86)	.01
Birth weight more than 4,000 g	0.77 (0.35–1.72)	.53	1.62 (0.81–3.25)	.17

OR, odds ratio; CI, confidence interval; BMI, body mass index; College, American College of Obstetricians and Gynecologists; FHR, fetal heart rate.

* Adjusted for maternal age, parity, BMI before pregnancy, gestational age, induction of labor, epidural use, persistent occiput position, College classification, obstetrician performing delivery, instrument type, active phase of second stage greater than 30 minutes, indications for attempted operative vaginal delivery, birth weight, and episiotomy.

† Prenatal suspicion of macrosomia: fundal height measurement at delivery greater than 37 cm, ultrasonographic fetal abdominal circumference greater than 90th percentile for gestational age on Hadlock curves, or both.

It is difficult to compare our results with the literature because previous studies of midpelvic deliveries are all retrospective cohorts that pooled midpelvic with rotational forceps (greater than 90° rotation, used only once in our study).[4–9]

Our data are robust: a collector bag was routinely used to estimate blood loss after delivery, and all neonates were routinely examined by a qualified neonatologist after delivery. They are consistent with other well-established findings in the literature: severe maternal morbidity was higher with the use of forceps and spatula, compared with vacuum, and was also associated with a longer active second stage of labor; severe neonatal morbidity was associated with deliveries before 39 weeks of gestation.[25,28] Level of training and episiotomy were found to be associated with

Table 4. Matched Covariates Before and After Propensity Score Stratification

Characteristic	Mid (n=391)	Low (n=1,550)	*P*	Mid (n=309)	Low (n=309)	*P*
Active phase of second stage longer than 30 min	104 (26.6)	527 (34.0)	.005	85 (27.5)	89 (28.8)	.72
Dose of oxytocin (milli-international units)	2,084.9±2,630.3	1,682.7±2,206.6	.002	2,002.4±2,512.2	2,007.4±2,574.3	.98
Indication for operative vaginal delivery						
Arrested progress only	110 (28.1)	607 (39.1)	<.001	92 (29.8)	89 (28.8)	.79
Nonreassuring FHR only	199 (50.9)	637 (41.1)	<.001	153 (49.5)	151 (48.9)	.87
Cesarean delivery after failed operative vaginal delivery	35 (9.0)	4 (0.3)	<.001	5 (1.6)	3 (1.0)	.48
Manual rotation	69 (17.9)	156 (10.2)	<.001	49 (15.9)	54 (17.5)	.59
Persistent occiput			<.001			.86
Anterior	314 (80.3)	1,380 (89.4)		262 (84.8)	261 (84.5)	
Posterior	63 (16.1)	119 (7.7)		35 (11.3)	38 (12.3)	
Transverse	14 (3.6)	44 (2.9)		12 (3.9)	10 (3.2)	
Obstetrician performing delivery			<.001			.94
Senior attending obstetrician	201 (53.5)	313 (20.3)		150 (48.5)	149 (48.2)	
Obstetric registrar	175 (46.5)	1,128 (79.7)		159 (51.5)	160 (51.8)	
Instrument type						
Vacuum	38 (9.8)	525 (33.9)	<.001	32 (10.4)	27 (8.7)	.49
Forceps	35 (9.0)	85 (5.5)	.009	26 (8.4)	25 (8.1)	.88
Spatula	324 (83.7)	994 (64.1)	<.001	257 (83.2)	265 (85.8)	.37

FHR, fetal heart rate.
Data are n (%) or mean±standard deviation unless otherwise specified.

severe neonatal morbidity; although we could not identify likely explanations, these results might have been influenced by other hidden confounders that were unfortunately not recorded such as chorioamnionitis and day and hour of delivery. Our results must be interpreted in light of certain limitations. First, our study reflects the experience of one tertiary university hospital and its results can be generalized only to other perinatal centers using the same practices (skilled obstetricians, senior supervising staff, daily morning staff meetings). Second, we reported a low rate of failed operative vaginal delivery (1.8%), consistent with other French and robust European studies (1.5%)[30,31] but lower than those reported in the last Cochrane review (3.6%).[32] This too may limit generalizability. Third, although the sample size of this prospective cohort was large (n=2,138), including a substantial number of midpelvic attempted operative vaginal deliveries (n=391) and comparable in size to other published studies of maternal or neonatal outcomes after operative vaginal delivery,[25–28] the limited number of severe maternal (n=161) and neonatal (n=217) complications in our sample might not have been high enough to reveal a statistically significant effect of the intervention. Nonetheless, we would like to underline that our sample size was sufficient to show an increase in severe maternal and neonatal morbidity related to midpelvic attempted operative vaginal delivery corresponding to an OR of 1.78 with a power of 80% assessed according to the observed incidence of severe maternal or neonatal complications. Fourth, determination of the station of the fetal head and thus classification of the operative vaginal deliveries is quite subjective and is influenced by fetal head position, molding, and time of assessment (before or after regional analgesia). These limitations notwithstanding, our study supports the continued use of midpelvic delivery in appropriately selected candidates.

REFERENCES

1. Vidal F, Simon C, Cristini C, Arnaud C, Parant O. Instrumental rotation for persistent fetal occiput posterior position: a way to decrease maternal and neonatal injury? PLoS One 2013;8:e78124.
2. Daly N, Bonham S, O'Dwyer V, O'Connor C, Kent E, Turner MJ. National variations in operative vaginal deliveries in Ireland. Int J Gynaecol Obstet 2014;125:210–3.
3. Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Wilson EC, Mathews TJ. Births: final data for 2010. Natl Vital Stat Rep 2012;61:1–72.
4. Hauth JC, Gilstrap LC III, Hankins GD. Examination of data base in midforceps delivery study. Am J Obstet Gynecol 1985; 153:814.
5. Dierker LJ Jr, Rosen MG, Thompson K, Debanne S, Linn P. The midforceps: maternal and neonatal outcomes. Am J Obstet Gynecol 1985;152:176–83.

6. Dierker LJ Jr, Rosen MG, Thompson K, Linn P. Midforceps deliveries: long-term outcome of infants. Am J Obstet Gynecol 1986;154:764–8.
7. Bashore RA, Phillips WH Jr, Brinkman CR III. A comparison of the morbidity of midforceps and cesarean delivery. Am J Obstet Gynecol 1990;162:1428–34.
8. Baerthlein WC, Moodley S, Stinson SK. Comparison of maternal and neonatal morbidity in midforceps delivery and midpelvis vacuum extraction. Obstet Gynecol 1986;67:594–7.
9. Robertson PA, Laros RK Jr, Zhao RL. Neonatal and maternal outcome in low-pelvic and midpelvic operative deliveries. Am J Obstet Gynecol 1990;162:1436–42.
10. Sentilhes L, Gillard P, Descamps P, Fournié A. Indications and prerequisites for operative vaginal delivery: when, how and where? [in French]. J Gynecol Obstet Biol Reprod (Paris) 2008;37(suppl 8):S188–201.
11. Friedman EA, Sachtleben-Murray MR, Dahrough D, Neff RK. Long-term effects of labor and delivery on offspring: a matched pair analysis. Am J Obstet Gynecol 1984;150:941–5.
12. Safe prevention of the primary cesarean delivery. Obstetric Care Consensus No. 1. American College of Obstetricians and Gynecologists. Obstet Gynecol 2014;123:693–711.
13. American College of Obstetricians and Gynecologists. Operative vaginal delivery: use of forceps and vacuum extractors for operative vaginal delivery. ACOG Practice Bulletin No. 17. Washington, DC: ACOG; 2000.
14. Cargill YM, MacKinnon CJ, Arsenault MY, Barellas E, Daniels S, Gleason T, et al. Guidelines for operative vaginal birth. J Obstet Gynaecol Can 2004;26:747–61.
15. Royal College of Obstetricians and Gynaecologists. Operative vaginal delivery. Guideline No. 26, revised January 2011. Available at: www.rcog.org.uk. Retrieved April 10, 2015.
16. Vayssière C, Beucher G, Dupuis O, Feraud O, Simon-Toulza C, Sentilhes L, et al. Instrumental delivery: clinical practice guidelines from the French College of Gynaecologists and Obstetricians. Eur J Obstet Gynecol Reprod Biol 2011;159:43–8.
17. Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements–a prospective study. Am J Obstet Gynecol 1985;151:333–7.
18. French College of Gynecologists and Obstetricians. Intra-uterine growth retardation: guidelines for clinical practice–short text [in French]. J Gynecol Obstet Biol Reprod 2013;42:1018–25.
19. American College of Obstetricians and Gynecologists. Obstetrics forceps. ACOG Committee Opinion No. 59. Washington, DC: ACOG; 1988.
20. Intrapartum fetal heart rate monitoring. ACOG Practice Bulletin No. 70. American College of Obstetricians and Gynecologists. Obstet Gynecol 2005;106:1453–60.
21. Vayssière C, Haumonte JB, Chantry A, Coatleven F, Debord MP, Gomez C, et al. Prolonged and post-term pregnancies: guidelines for clinical practice from the French College of Gynecologists and Obstetricians (CNGOF). Eur J Obstet Gynecol Reprod Biol 2013;169:10–6.
22. American College of Obstetricians and Gynecologists (College), Society for Maternal-Fetal Medicine, Caughey AB, Cahill AG, Guise JM, Rouse DJ. Safe prevention of the primary cesarean delivery. Am J Obstet Gynecol 2014;210:179–93.
23. Deneux-Tharaux C, Sentilhes L, Maillard F, Closset E, Vardon D, Lepercq J, et al. Effect of routine controlled cord traction as part of the active management of the third stage of labour on postpartum haemorrhage: multicentre randomised controlled trial (TRACOR). BMJ 2013;346:f1541.
24. Boers KE, Vijgen SM, Bijlenga D, van der Post JA, Bekedam DJ, Kwee A, et al. Induction versus expectant monitoring for intrauterine growth restriction at term: randomised equivalence trial (DIGITAT). BMJ 2010;341:c7087.
25. Murphy DJ, Liebling RE, Verity L, Swingler R, Patel R. Early maternal and neonatal morbidity associated with operative delivery in second stage of labour: a cohort study. Lancet 2001;358:1203–7.
26. Bahl R, Van de Venne M, Macleod M, Strachan B, Murphy DJ. Maternal and neonatal morbidity in relation to the instrument used for mid-cavity rotational operative vaginal delivery: a prospective cohort study. BJOG 2013;120:1526–32.
27. Macleod M, Strachan B, Bahl R, Howarth L, Goyder K, Van de Venne M, et al. A prospective cohort study of maternal and neonatal morbidity in relation to use of episiotomy at operative vaginal delivery. BJOG 2008;115:1688–94.
28. Murphy DJ, Liebling RE, Patel R, Verity L, Swingler R. Cohort study of operative delivery in the second stage of labour and standard of obstetric care. BJOG 2003;110:610–5.
29. Rubin DB. On principles for modeling propensity scores in medical research. Pharmacoepidemiol Drug Saf 2004;13:855–7.
30. Langeron A, Mercier G, Chauleur C, Varlet MN, Patural H, Lima S, et al. Failed forceps extraction: risk factors and maternal and neonatal morbidity [in French]. J Gynecol Obstet Biol Reprod (Paris) 2012;41:333–8.
31. Ramphul M, Kennelly MM, Burke G, Murphy DJ. Risk factors and morbidity associated with suboptimal instrument placement at instrumental delivery: observational study nested within the Instrumental Delivery & Ultrasound randomised controlled trial ISRCTN 72230496. BJOG 2015;122:558–63.
32. O'Mahony F, Hofmeyr GJ, Menon V. Choice of instruments for assisted vaginal delivery. The Cochrane Database of Systematic Reviews 2010, Issue 11. Art. No.: CD005455. DOI: 10.1002/14651858.CD005455.pub2.