RESEARCH

Perinatal and maternal morbidity and mortality after attempted operative vaginal delivery at midpelvic station

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ABSTRACT

BACKGROUND: Increased use of operative vaginal delivery (i.e., forceps or vacuum application), of which 20% occurs at midpelvic station, has been advocated to reduce the rate of cesarean delivery. We aimed to quantify severe perinatal and maternal morbidity and mortality associated with attempted midpelvic operative vaginal delivery.

METHODS: We studied all term singleton deliveries in Canada between 2003 and 2013, by attempted midpelvic operative vaginal or cesarean delivery with labour (with and without prolonged second stage). The primary outcomes were composite severe perinatal morbidity and mortality (e.g., convulsions, assisted ventilation, severe birth trauma and perinatal death), and composite severe maternal morbidity and mortality (e.g., severe postpartum hemorrhage, shock, sepsis, cardiac complications, acute renal failure and death).

RESULTS: The study population included 187 234 deliveries. Among women with dystocia and prolonged second stage of labour, midpelvic operative vaginal delivery was associated with higher rates of severe perinatal morbidity and mortality compared with cesarean delivery (forceps, adjusted odds ratio [AOR] 1.81, 95% confidence interval [CI] 1.24 to 2.64; vacuum, AOR 1.81, 95% CI 1.17 to 2.80; sequential instruments, AOR 3.19, 95% CI 1.73 to 5.88), especially with higher rates of severe birth trauma. Rates of severe maternal morbidity and mortality were not significantly different after operative vaginal delivery, although rates of obstetric trauma were higher (forceps, AOR 4.51, 95% CI 4.04 to 5.02; vacuum, AOR 2.70, 95% CI 2.35 to 3.09; sequential instruments, AOR 4.24, 95% CI 3.46 to 5.19). Among women with fetal distress, similar associations were seen for severe birth trauma and obstetric trauma, although vacuum was associated with lower rates of severe maternal morbidity and mortality (AOR 0.52, 95% CI 0.33 to 0.80). Associations tended to be stronger among women without a prolonged second stage.

INTERPRETATION: Midpelvic operative vaginal delivery is associated with higher rates of severe birth trauma and obstetric trauma, whereas overall rates of severe perinatal and maternal morbidity and mortality vary by indication and operative instrument.

When there is an arrest in the descent of the fetal head at midpelvic station during the second stage of labour, mode of delivery and perinatal and maternal outcomes are largely dependent on the urgency to expedite delivery and operator skill with midpelvic operative vaginal delivery.[1,2] Operative vaginal delivery provides a temporal advantage over cesarean delivery, although midpelvic forceps or vacuum application requires skill and experience. Although cesarean delivery generally decreases the risk of birth trauma compared with instrument use, engagement of the fetal head in the pelvis means the risk of trauma is not eliminated by an emergency cesarean delivery.[3,4] Assessments of the balance of risks and benefits between midpelvic operative vaginal delivery and cesarean delivery have tended to favour the latter option in recent decades, and this has contributed to a rising rate of cesarean delivery worldwide.[1] In 2014, a consensus statement by the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine[5] recommended operative vaginal delivery as a strategy to reduce the rate of cesarean delivery. In Canada, midpelvic operative vaginal delivery accounts for over 20% of all operative vaginal deliveries and about 2%–3% of term singleton deliveries.[6]

The literature on perinatal and maternal mortality and morbidity after operative vaginal delivery compared with cesarean delivery is inconsistent.[7–16] In addition, studies on the risks and benefits of these

2 options have been compromised by a lack of information on pelvic station, a key determinant of perinatal and maternal outcomes.[17] Therefore, we carried out a study aimed at quantifying the perinatal and maternal morbidity and mortality associated with attempted operative vaginal delivery at midpelvic station (compared with cesarean delivery in labour), the point when the decision between cesarean delivery and operative vaginal delivery is uncertain.

Methods

Setting and data source

The study population included hospital deliveries in Canada between April 2003 and March 2013. We obtained data from the Discharge Abstract Database (Canadian Institute for Health Information). This database contains information on about 98% of all deliveries in Canada (excluding Quebec).[18] Maternal and perinatal information in the database includes maternal characteristics, labour and delivery, neonatal condition, and diagnoses and procedures. Diagnoses and procedures in medical charts made by physicians were coded using the enhanced Canadian version of the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10-CA) and the Canadian Classification of Health Interventions. The accuracy of the perinatal information in the database has been shown in previous validation studies.[19,20]

Study design

We included all deliveries by midpelvic operative vaginal delivery or cesarean delivery with labour between 37 and 41 weeks gestation that resulted in a singleton live birth or stillbirth. We excluded deliveries if the infant had any congenital anomaly or if the mother had a hypertensive disorder, diabetes mellitus or a placental abnormality. Analyses contrasting midpelvic operative vaginal deliveries with cesarean deliveries were carried out after stratifying by indication (i.e., dystocia or fetal distress).

Deliveries at midpelvic station included operative vaginal delivery in cases where the head was engaged and the leading point of the fetal skull was above station +2 cm but below 0 station.[1] We used an intention-to-treat framework (i.e., both successful and failed forceps or vacuum deliveries were included in the attempted midpelvic forceps or vacuum category).

Outcomes following midpelvic operative vaginal delivery are ideally compared with cesarean delivery carried out in the second stage of labour. Our data source identified cesarean deliveries with and without labour, but not cesarean deliveries carried out in the second stage of labour (except for those carried out after a prolonged second stage). Because second stage cesarean delivery is generally associated with greater morbidity than cesarean delivery in the active phase of labour,[4] we conducted analyses that compared midpelvic operative vaginal delivery with cesarean delivery in labour after stratifying the analyses based on prolonged second stage of labour (using ICD-10-CA code O631). We anticipated that the comparison between operative vaginal and cesarean delivery among women with a prolonged second stage of labour would potentially favour operative vaginal delivery because a deeply engaged head can complicate cesarean delivery. However, comparisons between women without prolonged second stage of labour would potentially favour cesarean delivery because of the inclusion of women not in second stage.

Our study had 2 primary outcomes: composite severe perinatal morbidity and mortality, and composite severe maternal morbidity and mortality. We defined severe perinatal morbidity and mortality to include neonatal convulsions, assisted ventilation by endotracheal intubation, severe birth trauma (e.g., intracranial laceration and hemorrhage, skull fracture, severe injury to the central or peripheral nervous systems, long bone injury, subaponeurotic hemorrhage and injury to the liver or spleen), stillbirth and neonatal death. We defined severe maternal morbidity and mortality to include severe postpartum hemorrhage (postpartum hemorrhage requiring transfusion), obstetric shock, sepsis, cardiac complications (cardiac arrest, cardiac failure, myocardial infarction and pulmonary embolism), acute renal failure, obstetric embolism and evacuation of incisional hematoma. Secondary outcomes included the components of the composite outcomes, as well as respiratory morbidity, outcomes related to asphyxia, severe cerebral morbidity, all birth trauma, maternal postpartum infection, maternal postpartum hemorrhage and obstetric trauma. Diagnosis and procedure codes used to define the study cohort are listed in Appendix 1 (Supplementary Table 1), available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.161156/-/DC1.

Statistical analyses

We used multivariable logistic regression models to estimate adjusted odds ratios (AORs) and 95% confidence intervals (CIs) expressing the relation between mode of delivery and composite outcomes. The final models controlled for maternal age, parity, birth weight, previous cesarean delivery, maternal province of residence and year of birth. We examined modification of the effect of mode of delivery on composite perinatal and maternal morbidity and mortality by fiscal year, provider type (obstetrician/nonobstetrician), success or failure of operative vaginal delivery attempt and institutional delivery volume (high, medium or low) by introducing interaction terms into a mixed-effects regression model with a logit link function that accounted for clustered observations within institutions. We quantified the size of absolute effects by calculating adjusted rate differences and adjusted number needed to treat (NNT). Adjusted NNT reflects the average number of operative vaginal deliveries that would have had to be delivered by cesarean to avoid 1 case of the outcome of interest

We conducted sensitivity analyses by estimating the association between attempted mode of delivery and composite perinatal and maternal morbidity and mortality, assuming that all sequential instrument applications involved a failed vacuum delivery attempt followed by an attempted forceps delivery. All statistical analyses were performed using SAS 9.4.

Ethics approval

The study was approved by the Clinical Research Ethics Board of the University of British Columbia.

Results

The study population included 187 234 deliveries: 76 755 midpelvic operative vaginal or cesarean deliveries for dystocia and

110 479 for fetal distress (Figure 1). Of these, 28 923 deliveries occurred after a prolonged second stage of labour (17 484 with dystocia and 11 439 with fetal distress). Nulliparous women, older women (≥ 35 yr) and those who delivered at later gestational ages were more likely to have had a cesarean delivery. Midpelvic forceps delivery was more commonly used in nulliparous women than midpelvic vacuum, whereas the reverse was true among parous women (Table 1). Operative vaginal delivery was more common in institutions with high delivery volumes, whereas cesarean delivery was more frequent in centres with low delivery volumes (Appendix 1, Supplementary Table 2).

Operative vaginal compared with cesarean delivery among women with prolonged second stage of labour

Perinatal outcomes for deliveries with dystocia

Midpelvic operative vaginal delivery was associated with higher rates of composite severe perinatal morbidity and mortality compared with cesarean delivery (forceps: AOR 1.81, 95% CI 1.24 to 2.64; NNT 188, 95% CI 93 to 635; vacuum: AOR 1.81, 95% CI 1.17 to 2.80; NNT 188, 95% CI 85 to 897; sequential instrumentation: AOR 3.19, 95% CI 1.73 to 5.88; NNT 70, 95% CI 31 to 209; Table 2). Although forceps delivery and vacuum delivery had simliar rates of severe birth trauma (forceps: AOR 5.01, 95% CI 2.75 to 9.15; NNT 145, 95% CI 71 to 332; and vacuum: AOR 4.47, 95% CI 2.27 to 8.80; NNT 168, 95% CI 75 to 458, respectively), the rate was higher with sequential instrumentation (AOR 9.46, 95% CI 4.11 to 21.8; NNT 69, 95% CI 28 to 187). Midpelvic forceps delivery was also associated with significantly higher rates of respiratory distress, severe cerebral morbidity and bacterial sepsis.

Midpelvic vacuum delivery was associated with significantly higher rates of birth asphyxia, intracranial hemorrhage due to hypoxia and meconium aspiration syndrome. Delivery by sequential instrumentation was associated with higher rates of respiratory distress, cardiac failure or dysrhythmia and severe cerebral morbidity (Table 2). Birth trauma rates were significantly higher in all midpelvic operative vaginal delivery groups compared with cesarean delivery (Table 2 and Appendix 1 [Supplementary Table 3]).

Maternal outcomes for deliveries with dystocia

Rates of composite severe maternal morbidity and mortality were not significantly different among women after operative

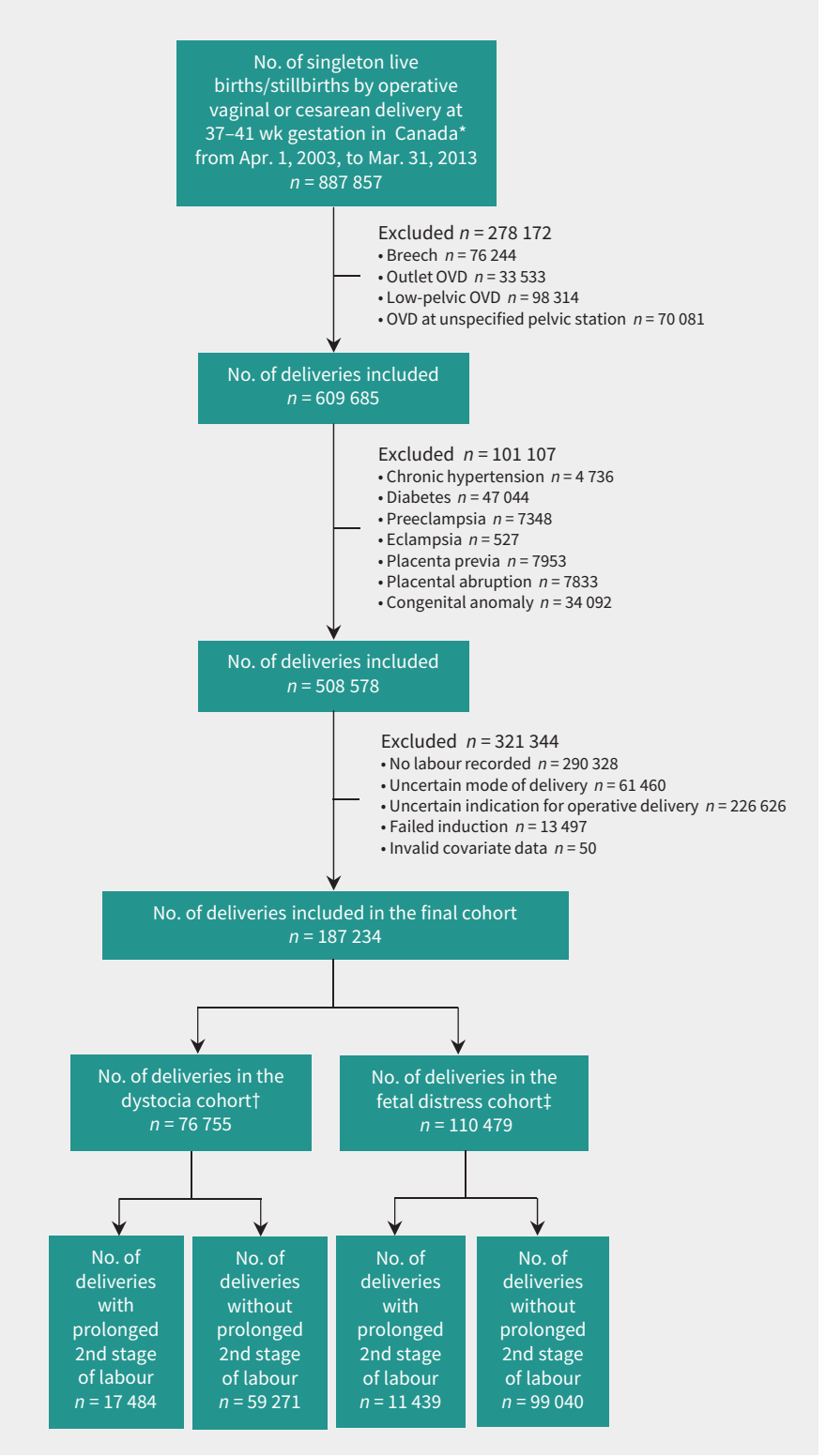

Figure 1: Derivation of the cohort for this study. The sum of individual exclusions may exceed the total at each point because some deliveries were excluded for multiple reasons. *Excluding Quebec. †Midpelvic OVD v. cesarean delivery indicated for dystocia. ‡Midpelvic OVD v. cesarean delivery indicated for fetal distress. OVD = operative vaginal delivery.

Table 1: No. of deliveries by mode, and by maternal, infant and obstetric characteristics among women delivering term singletons by midpelvic operative vaginal delivery or cesarean delivery with labour in Canada* from 2003 to 2013

Maternal/neonatal characteristic	No. of deliveries (% of total no. of deliveries per characteristic level)† *n* = 187 234					*p* value
	Attempted midpelvic forceps *n* = 24 274	Attempted midpelvic vacuum *n* = 23 525	Attempted midpelvic sequential *n* = 4012	Cesarean *n* = 135 423	Total no. of deliveries per characteristic level	
Maternal age, yr						< 0.001
< 20	888 (11.3)	1001 (12.8)	199 (2.5)	5758 (73.4)	7846	
20–24	3359 (11.8)	3545 (12.5)	676 (2.4)	20 821 (73.3)	28 401	
25–29	7850 (13.6)	7242 (12.6)	1376 (2.4)	41 198 (71.4)	57 666	
30–34	8144 (13.5)	7670 (12.7)	1236 (2.1)	43 194 (71.7)	60 244	
35–39	3447 (12.6)	3413 (12.5)	437 (1.6)	20 070 (73.3)	27 367	
≥ 40	586 (10.3)	654 (11.5)	88 (1.5)	4382 (76.7)	5710	
Parity						< 0.001
0	15 881 (13.6)	13 905 (11.9)	2673 (2.3)	84 561 (72.3)	117 020	
1	2310 (10.8)	4765 (22.2)	415 (1.9)	13 970 (65.1)	21 460	
2–3	577 (8.6)	1783 (26.5)	128 (1.9)	4253 (63.1)	6741	
≥ 4	67 (6.0)	282 (25.1)	17 (1.5)	759 (67.5)	1125	
Missing	5439 (13.3)	2790 (6.8)	779 (1.9)	31 880 (78.0)	40 888	
Previous cesarean						< 0.001
Yes	51 (2.1)	49 (2.0)	17 (0.7)	2297 (95.2)	2414	
No	24 223 (13.1)	23 476 (12.7)	3995 (2.2)	133 126 (72.0)	184 820	
Gestational age, wk						< 0.001
37–38	4007 (14.5)	4347 (15.7)	587 (2.1)	18 675 (67.6)	27 616	
39–41	20 267 (12.7)	19 178 (12.0)	3425 (2.1)	116 748 (73.1)	159 618	
Birth weight, g						< 0.001
< 2500	208 (8.1)	354 (13.8)	26 (1.0)	1979 (77.1)	2567	
2500–2999	2671 (14.1)	3310 (17.3)	367 (1.9)	12 641 (66.6)	18 989	
3000–3999	17 868 (13.8)	16 927 (13.1)	3001 (2.3)	91 849 (70.8)	129 645	
≥ 4000	3527 (9.8)	2934 (8.1)	618 (1.7)	28 954 (80.4)	36 033	
Epidural						< 0.001
Yes	20 924 (15.3)	16 747 (12.2)	3159 (2.3)	95 941 (70.2)	136 771	
No	3350 (6.6)	6778 (13.4)	853 (1.7)	39 482 (78.2)	50 463	
Indication						< 0.001
Dystocia	10 017 (13.1)	6401 (8.3)	1572 (2.1)	58 765 (76.6)	76 755	
Fetal distress	14 257 (12.9)	17 124 (15.5)	2440 (2.2)	76 658 (69.4)	110 479	
Prolonged 2nd stage of labour						< 0.001
Yes	7855 (27.2)	4887 (16.9)	1147 (4.0)	15 034 (52.0)	28 923	
No	16 419 (10.4)	18 638 (11.8)	2865 (1.8)	120 389 (76.0)	158 311	
Successful OVD‡ trial (% of all OVD)						< 0.001
Dystocia	8611 (86.0)	4849 (75.8)	1094 (69.6)	–	–	
Fetal distress	12 836 (90.0)	15 549 (90.8)	1874 (76.8)	–	–	

Note: OVD = operative vaginal delivery.
*Excludes the province of Quebec.
†Unless specified otherwise.
‡Successful OVDs express the no. (%) of successful OVDs in a specific category divided by the no. of attempted OVDs in that category stratified by indication (dystocia or fetal distress).

Table 2: Perinatal and maternal outcomes by attempted midpelvic operative vaginal and cesarean deliveries with dystocia and prolonged second stage of labour (*n* = 17 484)*†

Outcome	No. (%) of cesarean deliveries *n* = 9300	Attempted midpelvic forceps delivery *n* = 4741		Attempted midpelvic vacuum delivery *n* = 2780		Attempted midpelvic sequential operative vaginal delivery *n* = 663	
		No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)
Severe perinatal morbidity/mortality	61 (0.7)	52 (1.1)	1.81 (1.24 to 2.64)	32 (1.2)	1.81 (1.17 to 2.80)	13 (2.0)	3.19 (1.73 to 5.88)
Stillbirth	0 (0.0)	0 (0.0)	–	< 5 (< 0.2)	–	0 (0.0)	–
Neonatal death	0 (0.0)	< 5 (< 0.1)	–	< 5 (< 0.2)	–	0 (0.0)	–
Neonatal convulsion	16 (0.2)	8 (0.2)	0.98 (0.42 to 2.29)†††	6 (0.2)	1.26 (0.49 to 3.21)†††	< 5 (< 0.8)	1.76 (0.40 to 7.65)†††
Assisted ventilation (endotracheal)	35 (0.4)	10 (0.2)	0.55 (0.27 to 1.13)	9 (0.3)	0.80 (0.38 to 1.67)	< 5 (< 0.8)	0.74 (0.18 to 3.08)
Severe birth trauma‡	16 (0.2)	35 (0.7)	5.01 (2.75 to 9.15)	19 (0.7)	4.47 (2.27 to 8.80)	9 (1.4)	9.46 (4.11 to 21.8)
Respiratory distress§	302 (3.3)	188 (4.0)	1.25 (1.04 to 1.51)	116 (4.2)	1.29 (1.03 to 1.61)	47 (7.1)	2.29 (1.66 to 3.16)
Assisted ventilation¶	140 (1.5)	63 (1.3)	0.81 (0.60 to 1.10)	37 (1.3)	0.79 (0.54 to 1.14)	12 (1.8)	1.12 (0.61 to 2.05)
Fetal asphyxia	23 (0.3)	9 (0.2)	0.77 (0.36 to 1.66)†††	< 5 (< 0.2)	0.44 (0.13 to 1.45)†††	< 5 (< 0.8)	1.22 (0.29 to 5.19)†††
Birth asphyxia	19 (0.2)	8 (0.2)	0.83 (0.36 to 1.89)†††	12 (0.4)	2.12 (1.03 to 4.37)†††	< 5 (< 0.8)	1.48 (0.34 to 6.36)†††
Intracranial hemorrhage due to hypoxia	< 5 (< 0.1)	< 5 (< 0.1)	1.96 (0.28 to 13.9)†††	8 (0.3)	13.4 (2.85 to 63.2)†††	< 5 (< 0.8)	14.1 (1.98 to 100)†††
Cardiac failure/dysrhythmia	120 (1.3)	67 (1.4)	1.09 (0.80 to 1.47)	47 (1.7)	1.14 (0.80 to 1.62)	18 (2.7)	1.91 (1.15 to 3.18)
Severe cerebral morbidity**	16 (0.2)	18 (0.4)	2.21 (1.13 to 4.34)†††	< 5 (< 0.2)	0.42 (0.10 to 1.82)†††	< 5 (< 0.8)	3.52 (1.17 to 10.6)†††
Birth trauma††	194 (2.1)	304 (6.4)	3.23 (2.68 to 3.88)	307 (11.0)	5.40 (4.47 to 6.52)	100 (15.1)	7.92 (6.11 to 10.3)
Meconium aspiration syndrome	11 (0.1)	9 (0.2)	1.61 (0.67 to 3.88)†††	10 (0.4)	3.05 (1.29 to 7.19)†††	< 5 (< 0.8)	2.56 (0.57 to 11.6)†††
Bacterial sepsis	29 (0.3)	28 (0.6)	1.90 (1.13 to 3.20)†††	6 (0.2)	0.69 (0.29 to 1.67)†††	0 (0.0)	–
Severe maternal morbidity/mortality	153 (1.7)	83 (1.8)	1.19 (0.91 to 1.57)	38 (1.4)	0.87 (0.60 to 1.25)	13 (2.0)	1.26 (0.71 to 2.25)
Maternal death	0 (0.0)	0 (0.0)	–	0 (0.0)	–	0 (0.0)	–
Severe postpartum hemorrhage‡‡	97 (1.0)	64 (1.4)	1.51 (1.09 to 2.09)	26 (0.9)	0.92 (0.59 to 1.44)	13 (2.0)	2.00 (1.10 to 3.62)
Shock	< 5 (< 0.1)	< 5 (< 0.1)	0.98 (0.18 to 5.36)†††	< 5 (< 0.2)	0.84 (0.09 to 7.49)†††	0 (0.0)	–
Sepsis	20 (0.2)	8 (0.2)	0.78 (0.35 to 1.78)†††	5 (0.2)	0.84 (0.31 to 2.23)†††	0 (0.0)	–
Cardiac complication§§	36 (0.4)	7 (0.2)	0.38 (0.17 to 0.86)†††	6 (0.2)	0.56 (0.23 to 1.32)†††	0 (0.0)	–
Acute renal failure	< 5 (< 0.1)	< 5 (< 0.1)	–	< 5 (< 0.2)	–	0 (0.0)	–
Obstetric embolism	5 (0.1)	0 (0.0)	–	< 5 (< 0.2)	–	0 (0.0)	–
Evacuation incisional hematoma	< 5 (< 0.1)	< 5 (< 0.1)	–	0 (0.0)	–	0 (0.0)	–
Obstetric trauma¶¶	589 (6.3)	1085 (22.9)	4.51 (4.04 to 5.02)	427 (15.4)	2.70 (2.35 to 3.09)	147 (22.2)	4.24 (3.46 to 5.19)
Perineal laceration 3rd/4th degree	< 5 (< 0.1)	888 (18.7)	–	341 (12.3)	–	135 (20.4)	–
Uterine incision extension	268 (2.9)	13 (0.3)	0.11 (0.06 to 0.19)	21 (0.8)	0.29 (0.18 to 0.46)	< 5 (< 0.8)	0.06 (0.01 to 0.40)
Postpartum infection***	126 (1.4)	34 (0.7)	0.54 (0.37 to 0.79)	22 (0.8)	0.60 (0.38 to 0.95)	8 (1.2)	0.87 (0.42 to 1.80)
Postpartum hemorrhage	668 (7.2)	792 (16.7)	2.77 (2.48 to 3.10)	323 (11.6)	1.61 (1.39 to 1.86)	111 (16.7)	2.54 (2.03 to 3.17)

Note: AOR = adjusted odds ratio, CI = confidence interval, CNS = central nervous system, PNS = peripheral nervous system.
*Adjusted odds ratios were estimated using logistic regression, with cesarean delivery as the reference group.
†All models were adjusted for maternal age, parity, birth weight, previous cesarean delivery, province and fiscal year.
‡We included intracranial laceration and hemorrhage, skull fracture, severe injury to the CNS, severe injury to the PNS, long bone injury, subaponeurotic (subgaleal) hemorrhage, and injury to the liver and spleen.
§We included respiratory distress syndrome, transient tachypnea of the newborn and other neonatal respiratory distress.
¶We included resuscitation, chest compression, endotracheal respiratory assistance, mechanical respiratory assistance, forced oxygenation, intubation, mechanical ventilation and drugs for resuscitation.
**We included hypoxic ischemic encephalopathy, cerebral ischemia, cerebral irritability and cerebral depression.
††We included intracranial hemorrhage/laceration, and injury to the CNS/PNS, scalp and skeleton.
‡‡We included a combination of postpartum hemorrhage and transfusion codes.
§§We included cardiac arrest, cardiac failure, myocardial infarction and pulmonary embolism.
¶¶We included severe perineal lacerations (3rd/4th degree), cervical laceration, high vaginal laceration, injury to pelvic organ/joint, pelvic hematoma and extension of uterine incision.
***We included sepsis, infection of obstetric surgical wound, infection of the genital tract following delivery, infection of the urinary tract following delivery, infections of the genitourinary tract following delivery, pyrexia of unknown origin following delivery and other specified puerperal infection.
†††Crude OR is reported because AOR was undefined owing to small numbers.

vaginal delivery compared with cesarean delivery (Table 2). However, midpelvic forceps delivery was associated with significantly higher rates of severe postpartum hemorrhage (AOR 1.51, 95% CI 1.09 to 2.09) and significantly lower rates of cardiac complications (AOR 0.38, 95% CI 0.17 to 0.86) and postpartum infection (AOR 0.54, 95% CI 0.37 to 0.79). Midpelvic vacuum delivery was associated with higher rates of postpartum hemorrhage (AOR 1.61, 95% CI 1.39 to 1.86) and lower rates of postpartum infection (AOR 0.60, 95% CI 0.38 to 0.95).

Obstetric trauma rates were significantly higher after operative vaginal delivery (forceps: AOR 4.51, 95% CI 4.04 to 5.02; NNT 4, 95% CI 4 to 5; vacuum: AOR 2.70, 95% CI 2.35 to 3.09; NNT 9, 95% CI 8 to 12; sequential instrumentation: AOR 4.24, 95% CI 3.46 to 5.19; NNT 5, 95% CI 4 to 6). Rates of third- and fourth-degree perineal lacerations were high (about 19% after midpelvic forceps, 12% after midpelvic vacuum and 20% after sequential instrumentation). Extension of the uterine incision occurred in 2.9% of cesarean deliveries (Table 2 and Appendix 1 [Supplementary Table 3]).

Perinatal outcomes for deliveries with fetal distress

Rates of composite severe perinatal morbidity and mortality were higher among women with fetal distress compared with women who had dystocia (Table 3). Deliveries by sequential midpelvic instrumentation were associated with higher rates of composite severe perinatal morbidity and mortality than cesarean delivery (AOR 2.62, 95% CI 1.15 to 4.06; NNT 34, 95% CI 18 to 371). Rates of assisted ventilation by endotracheal intubation were lower after midpelvic forceps delivery (AOR 0.64, 95% CI 0.42 to 0.98) and midpelvic vacuum delivery (AOR 0.44, 95% CI 0.25 to 0.76).

Severe birth trauma was substantially higher after all types of operative vaginal delivery (forceps: AOR 10.4, 95% CI 4.84 to 22.5; NNT 68, 30–166; vacuum: AOR 9.05, 95% CI 3.97 to 20.6; NNT 79, 95% CI 33 to 215; sequential instrumentation: AOR 24.3, 95% CI 9.72 to 60.8; NNT 27, 95% CI 11 to 73; Table 3). Midpelvic forceps deliveries were associated with lower rates of fetal asphyxia (AOR 0.53, 95% CI 0.32 to–0.91) and higher rates of cardiac failure or dysrhythmia (AOR 1.54, 95% CI 1.25 to 1.90).

Maternal outcomes for deliveries with fetal distress

Composite severe maternal morbidity and mortality in deliveries with fetal distress was lower for the midpelvic vacuum group than for cesarean delivery (AOR 0.52, 95% CI 0.33 to 0.80; NNT –96, 95% CI –229 to –68 ; Table 3). Midpelvic operative vaginal deliveries were associated with significantly higher rates of obstetric trauma (forceps: AOR 3.34, 95% CI 2.94 to 3.80; NNT 5, 95% CI 4 to 6; vacuum: AOR 1.99, 95% CI 1.71 to 2.33; NNT 12, 95% CI 9 to 17; sequential instrumentation: AOR 3.23, 95% CI 2.55 to 4.08; NNT 6, 95% CI 4 to 8), as well as higher rates of postpartum hemorrhage and lower rates of postpartum infection than for cesarean delivery. Rates of severe perineal laceration after operative vaginal delivery were high, ranging from 13% to 18%, depending on instrument(s) applied (Appendix 1, Supplementary Table 3).

Modifiers of the effect of mode of delivery

Effect of mode of delivery on composite severe perinatal and maternal morbidity and mortality was not modified by institutional delivery volume, type of practitioner, success of the instrumentation or the inclusion of sequential instrumentation in the attempted midpelvic vacuum delivery group (Appendix 1, Supplementary Tables 4–7).

Operative vaginal versus cesarean delivery among women without a prolonged second stage of labour

Outcomes for deliveries with dystocia

Among women with dystocia and without prolonged second stage of labour, associations between midpelvic operative vaginal delivery and composite severe perinatal morbidity and mortality were significantly stronger (forceps: AOR 3.57, 95% CI 2.72 to 4.69; vacuum: AOR 3.83, 95% CI 2.83 to 5.18; sequential instrumentation: AOR 4.89, 95% CI 3.00 to 7.99) than the same associations among women with a prolonged second stage of labour (p values of 0.004, 0.004 and 0.3 for differences in AORs between women with and without a prolonged second stage of labour by forceps, vacuum and sequential instrumentation, respectively; Figure 2 and Appendix 1 [Supplementary Table 8]).

There was no significant difference in the association between midpelvic instrumentation and composite maternal morbidity and mortality between women with and without a prolonged second stage of labour (p values of 0.9, 0.4 and 0.9 for differences in AORs between women with and without a prolonged second stage of labour delivered by forceps, vacuum and sequential instrumentation, respectively; Figure 2). The associations between midpelvic operative vaginal delivery and severe birth trauma and obstetric trauma after operative vaginal delivery were significantly stronger among women without a prolonged second stage of labour (Figure 2).

Outcomes for deliveries with fetal distress

Among women with deliveries involving fetal distress, the association between midpelvic operative vaginal delivery and composite severe perinatal morbidity and mortality was similar among women with and without a prolonged second stage of labour. However, the associations between midpelvic forceps and sequential instrumentation deliveries and composite severe maternal morbidity and mortality were significantly stronger among women without a prolonged second stage (p values for differences in AORs were 0.007 and 0.04, respectively; Figure 2). Associations between operative vaginal delivery and obstetric trauma were significantly stronger in deliveries without a prolonged second stage compared with those with a prolonged second stage of labour (Figure 2).

Interpretation

Our study showed that rates of severe perinatal morbidity and mortality were higher after cesarean delivery among deliveries with dystocia, whereas rates of severe maternal morbidity and mortality were similar. Among deliveries with fetal distress, rates of severe perinatal morbidity and mortality were higher after attempted midpelvic sequential instrumentation than for cesarean delivery, whereas rates of severe maternal morbidity and mortality were lower after attempted midpelvic vacuum delivery. This difference by indication appears to reflect the greater fetal jeopardy associated with fetal distress and the consequent higher baseline rate of adverse outcomes

Table 3: Perinatal and maternal outcomes by attempted midpelvic operative vaginal and cesarean deliveries with fetal distress and prolonged second stage of labour (*n* = 11 439)*†

Outcome	No. (%) of cesarean deliveries *n* = 5734	Attempted midpelvic forceps delivery *n* = 3114		Attempted midpelvic vacuum delivery *n* = 2107		Attempted midpelvic sequential operative vaginal delivery *n* = 484	
		No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)
Severe perinatal morbidity/mortality	103 (1.8)	68 (2.2)	1.26 (0.92 to 1.72)	39 (1.9)	1.01 (0.69–1.48)	21 (4.3)	2.62 (1.15 to 4.06)
Stillbirth	0 (0.0)	0 (0.0)	–	0 (0.0)	–	0 (0.0)	–
Neonatal death	< 5 (< 0.1)	< 5 (< 0.2)	–	0 (0.0)	–	0 (0.0)	–
Neonatal convulsions	23 (0.4)	7 (0.2)	0.56 (0.24 to 1.31)†††	6 (0.3)	0.71 (0.29 to 1.74)†††	< 5 (< 1.0)	1.03 (0.24 to 4.38)†††
Assisted ventilation (endotracheal)	80 (1.4)	29 (0.9)	0.64 (0.42 to 0.98)	15 (0.7)	0.44 (0.25 to 0.76)	8 (1.7)	1.13 (0.54 to 2.37)
Severe birth trauma‡	9 (0.2)	37 (1.2)	10.4 (4.84 to 22.5)	22 (1.0)	9.05 (3.97 to 20.6)	12 (2.5)	24.3 (9.72 to 60.8)
Respiratory distress§	386 (6.7)	197 (6.3)	0.95 (0.79 to 1.13)	133 (6.3)	0.97 (0.79 to 1.20)	48 (9.9)	1.54 (1.12 to 2.12)
Assisted ventilation¶	198 (3.5)	67 (2.2)	0.59 (0.45 to 0.79)	49 (2.3)	0.57 (0.41 to 0.78)	17 (3.5)	0.91 (0.55 to 1.51)
Fetal asphyxia	63 (1.1)	18 (0.6)	0.53 (0.32 to 0.91)	17 (0.8)	0.69 (0.40 to 1.19)	7 (1.5)	1.33 (0.60 to 2.94)
Birth asphyxia	26 (0.5)	12 (0.4)	0.85 (0.43 to 1.69)†††	6 (0.3)	0.63 (0.26 to 1.53)†††	< 5 (< 1.0)	0.91 (0.22 to 3.85)†††
Intracranial hemorrhage due to hypoxia	< 5 (< 0.1)	< 5 (< 0.2)	0.92 (0.17 to 5.03)†††	< 5 (< 0.2)	1.36 (0.25 to 7.44)†††	< 5 (< 1.0)	2.97 (0.33 to 26.6)†††
Cardiac failure/dysrhythmia	209 (3.6)	172 (5.5)	1.54 (1.25 to 1.90)	80 (3.8)	0.90 (0.69 to 1.18)	38 (7.9)	2.09 (1.45 to 3.00)
Severe cerebral morbidity**	17 (0.3)	7 (0.2)	0.76 (0.31 to 1.83)†††	7 (0.3)	1.12 (0.46 to 2.71)†††	5 (1.0)	3.51 (1.29 to 9.56)†††
Birth trauma††	154 (2.7)	253 (8.1)	3.26 (2.65 to 4.02)	269 (12.8)	5.09 (4.13 to 6.28)	99 (20.5)	9.47 (7.18 to 12.5)
Meconium aspiration syndrome	92 (1.6)	34 (1.1)	0.70 (0.47 to 1.04)	43 (2.0)	1.33 (0.91 to 1.94)	7 (1.5)	1.02 (0.47 to 2.24)
Bacterial sepsis	43 (0.8)	23 (0.7)	0.99 (0.59 to 1.64)	12 (0.6)	0.76 (0.40 to 1.44)	< 5 (< 1.0)	0.55 (0.13 to 2.27)
Severe maternal morbidity/mortality	125 (2.2)	53 (1.7)	0.78 (0.56 to 1.09)	26 (1.2)	0.52 (0.33 to 0.80)	7 (1.5)	0.62 (0.29 to 1.35)
Maternal death	0 (0.0)	0 (0.0)	–	0 (0.0)	–	0 (0.0)	–
Severe postpartum hemorrhage‡‡	72 (1.3)	42 (1.4)	1.09 (0.74 to 1.61)	21 (1.0)	0.73 (0.44 to 1.22)	< 5 (< 1.0)	0.61 (0.22 to 1.69)
Shock	< 5 (< 0.1)	0 (0.0)	–	0 (0.0)	–	0 (0.0)	–
Sepsis	21 (0.4)	5 (0.2)	0.44 (0.17 to 1.16)†††	< 5 (< 0.2)	0.13 (0.02 to 0.96)†††	< 5 (< 1.0)	0.56 (0.08 to 4.20)†††
Cardiac complication§§	28 (0.5)	6 (0.2)	0.41 (0.17 to 1.00)	< 5 (< 0.2)	0.36 (0.12 to 1.04)	< 5 (< 1.0)	0.90 (0.21 to 3.86)
Acute renal failure	< 5 (< 0.1)	0 (0.0)	–	< 5 (< 0.2)	–	0 (0.0)	–
Obstetric embolism	5 (0.1)	0 (0.0)	–	0 (0.0)	–	0 (0.0)	–
Evacuation incisional hematoma	< 5 (< 0.1)	< 5 (< 0.2)	–	0 (0.0)	–	0 (0.0)	–
Obstetric trauma¶¶	464 (8.1)	710 (22.8)	3.34 (2.94 to 3.80)	329 (15.6)	1.99 (1.71 to 2.33)	111 (22.9)	3.23 (2.55 to 4.08)
Perineal laceration 3rd/4th degree	< 5 (< 0.1)	567 (18.2)	–	270 (12.8)	–	88 (18.2)	–
Uterine incision extension	219 (3.8)	16 (0.5)	0.13 (0.08 to 0.22)†††	7 (0.3)	0.08 (0.04 to 0.18)†††	11 (2.3)	0.59 (0.32 to 1.08)†††
Postpartum infection***	112 (2.0)	28 (0.9)	0.46 (0.30 to 0.70)	16 (0.8)	0.42 (0.25 to 0.72)	5 (1.0)	0.53 (0.21 to 1.31)
Postpartum hemorrhage	491 (8.6)	533 (17.1)	2.20 (1.92 to 2.51)	262 (12.4)	1.41 (1.19 to 1.66)	73 (15.1)	1.77 (1.35 to 2.31)

Note: AOR = adjusted odds ratio, CI = confidence interval, CNS = central nervous system, PNS = peripheral nervous system.
*Adjusted odds ratios were estimated using logistic regression, with cesarean delivery as the reference group.
†All models were adjusted for maternal age, parity, birth weight, previous cesarean delivery, province and fiscal year.
‡We included intracranial laceration and hemorrhage, skull fracture, severe injury to the CNS, severe injury to the PNS, long bone injury, subaponeurotic (subgaleal) hemorrhage, and injury to the liver and spleen.
§We included respiratory distress syndrome, transient tachypnea of the newborn and other neonatal respiratory distress.
¶We included resuscitation, chest compression, endotracheal respiratory assistance, mechanical respiratory assistance, forced oxygenation, intubation, mechanical ventilation and drugs for resuscitation.
**We included hypoxic ischemic encephalopathy, cerebral ischemia, cerebral irritability and cerebral depression.
††We included included intracranial hemorrhage/laceration, and injury to the CNS/PNS, scalp and skeleton.
‡‡We included a combination of postpartum hemorrhage and transfusion codes.
§§We included cardiac arrest, cardiac failure, myocardial infarction and pulmonary embolism.
¶¶We included severe perineal lacerations (3rd/4th degree), cervical laceration, high vaginal laceration, injury to pelvic organ/joint, pelvic hematoma and extension of uterine incision.
***We included sepsis, infection of obstetric surgical wound, infection of the genital tract following delivery, urinary tract infection following delivery, genitourinary tract infections following delivery, pyrexia of unknown origin following delivery and other specified puerperal infection.
†††Crude OR is reported because AOR was undefined owing to small numbers.

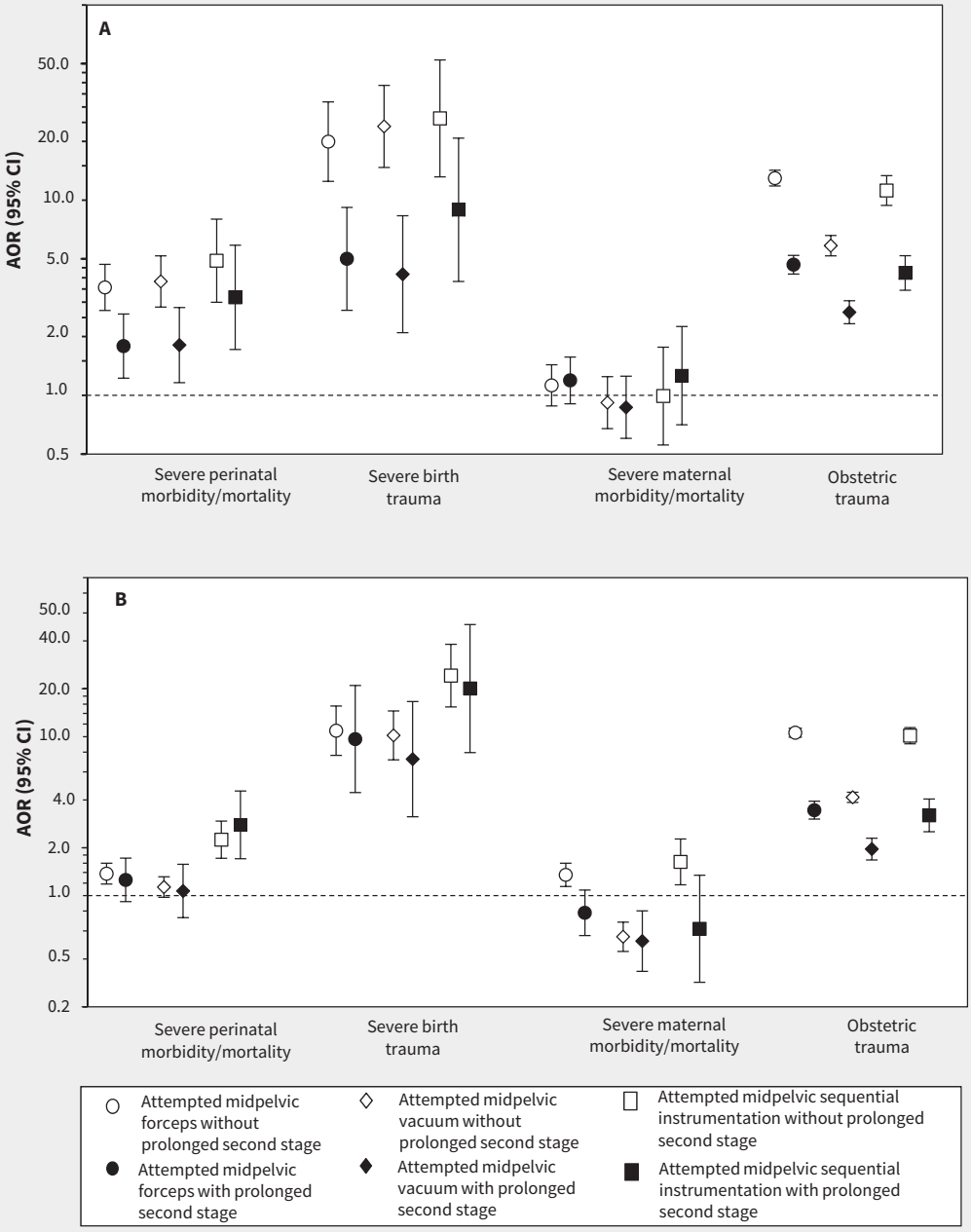

Figure 2: Effects of midpelvic operative vaginal delivery (compared with cesarean delivery in labour) on composite severe perinatal and maternal morbidity and mortality, and trauma among women with and without a prolonged second stage of labour. (A) Women with dystocia and (B) women with fetal distress. AOR = adjusted odds ratio, CI = confidence interval.

even in the cesarean delivery group. Attempted midpelvic operative vaginal delivery was associated with substantially higher rates of severe birth trauma and obstetric trauma than cesarean delivery.

In contrast to the conflicting results in the existing literature,[10,13–15] our study showed higher rates of neurologic injury following midpelvic operative delivery with forceps and sequential instrumentation. Reasons for this difference likely include limited power and lack of adjustment in previous studies[10,13] and considerations related to pelvic station and indication for delivery. Existing literature also does not provide clarity regarding blood loss after midpelvic operative vaginal delivery.[7,8,15,21–23] Our study showed higher rates of postpartum hemorrhage after attempted midpelvic forceps delivery and attempted sequential instrumentation deliveries compared with cesarean delivery. Although uterine atony appeared to contribute the most, increased rates of hemorrhage likely also reflect perineal and vaginal trauma.[24]

High rates of third- and fourth degree perineal lacerations following attempted midpelvic operative vaginal delivery (12%–20%) are

cause for concern. Rates ranging from 14% to 45% have been reported previously but are discounted because they reflect obstetric practice in the late 20th century.[8,9,17] Nevertheless, recent studies continue to show high rates,[25] and operative vaginal delivery is known to increase the risk of disorders of the pelvic floor 5–10 years after a first delivery.[26] Women should be informed about the substantially increased risk of trauma to the anal sphincter after midpelvic instrumental delivery and the relevant long-term implications for quality of life.

Limitations

Limitations of our study include our inability to account for the skill of the operator. However, women delivering in hospital have little understanding of the relevant issues about expertise in midpelvic operative vaginal delivery, and our data reflect the experience and skills of contemporary practitioners. Although we excluded women with common pregnancy complications, some uncommon complications may have been overrepresented in the cesarean delivery group. Such confounding by indication would have resulted in a bias favouring operative vaginal delivery. Finally, errors and omissions in coding are inevitable in large administrative databases; however, these would have resulted in nondifferential misclassification.

Conclusion

Our study showed that attempted midpelvic operative vaginal delivery is associated with substantially higher rates of severe birth trauma and obstetric trauma. Rates of severe perinatal and maternal morbidity and mortality after midpelvic operative vaginal delivery were also increased, although these associations varied by indication and instrument used. Encouraging higher rates of operative vaginal delivery as a strategy to reduce the rate of cesarean delivery could result in increases in severe perinatal and maternal morbidity and mortality, especially birth trauma, severe postpartum hemorrhage and obstetric trauma.

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