CMAJ OPEN

Research

Maternal and newborn outcomes after a prior cesarean birth by planned mode of delivery and history of prior vaginal birth in British Columbia: a retrospective cohort study

Celeste D. Bickford BSc, Patricia A. Janssen PhD

Abstract

Background: As rates for cesarean births continue to rise, more women are faced with the choice to plan a vaginal or a repeat cesarean birth after a previous cesarean. The objective of this population-based retrospective cohort study was to compare the safety of planned vaginal birth with cesarean birth after 1–2 previous cesarean births.

Methods: We identified singleton term births in British Columbia from 2000 to 2008 using data from the British Columbia Perinatal Data Registry. Women carrying a singleton fetus in cephalic presentation at term (37–41 weeks of gestation completed) with 1–2 prior cesarean births were included. Those with gestational hypertension, pre-existing diabetes and cardiac disease were excluded. Maternal and neonatal outcomes were classified as either life-threatening or non–life threatening. We compared outcomes among women with none versus at least 1 previous vaginal birth, by planned method of delivery. We estimated relative risks (RR) and 95% confidence intervals (CI) for composite outcomes using Poisson regression.

Results: Of the 33 812 women in the sample, 5406 had a history of vaginal delivery and 28 406 did not. The composite risk for life-threatening maternal outcomes was elevated among women planning vaginal compared with cesarean birth both with and without a prior vaginal birth (RR 2.06, 95% CI 1.20–3.52) and (2.52, 95% CI 2.04–3.11). Absolute differences (attributable risk [AR]) were 1.01% and 1.31% respectively. Non–life threatening maternal outcomes were decreased among women planning a vaginal birth if they had had at least 1 prior vaginal delivery (RR 0.51, 95% CI 0.33–0.77; AR 1.17%). The composite risk of intrapartum stillbirth, neonatal death or life-threatening neonatal outcomes did not differ among women planning vaginal or cesarean birth with a prior vaginal delivery and non–life threatening neonatal outcomes were decreased, (RR 0.67, 95% CI 0.52–0.86; AR 1.92%).

Interpretation: After 1 or 2 previous cesarean births, risks for adverse outcomes between planned vaginal and cesarean birth are reduced among women with a prior vaginal birth. Our data offer women and their health care providers the opportunity to consider risk profiles separately for women who have and have not had a prior vaginal delivery.

As cesarean birth rates continue to rise,[1] increasingly more women are faced with the choice of planning a vaginal or cesarean birth after a previous cesarean birth. Current clinical practice guidelines in Canada recommend that planned vaginal birth be offered to women with 1 previous transverse low-segment cesarean and no contraindications, provided that discussions of maternal and perinatal risks and benefits have taken place.[2] Lack of adherence to these guidelines continues, partly because of fear of litigation among physicians.[3,4] In 2011, the cesarean birth rate in Canada reached 27.1%[5] and 30.7% in British Columbia.[6] Among women with a previous cesarean birth, the rate of repeat cesarean births was 81.7% in Canada.[7]

Recent comparisons of elective repeat cesarean births with planned vaginal birth have reported inconsistent findings.[8–11] A Canadian study of over 300 000 women reported a twofold elevated risk for uterine rupture, 0.65 v. 0.25 per 100 000 women (adjusted odds ratio [AOR] 2.38, 95% confidence interval [CI] 2.12–2.67) among women planning vaginal birth.[9] A systematic review of 12 cohort studies reported a threefold reduction in maternal mortality among women undergoing planned vaginal birth (relative risk [RR] 0.33, 95% CI 0.13–0.88) and higher perinatal mortality (RR 1.82, 95% CI 1.24–2.67).[12] A prospective multicentre study in the

Competing interests: None declared.

This article has been peer reviewed.

Correspondence to: Patricia Janssen, patti.janssen@ubc.ca

***CMAJ Open* 2015. DOI:10.9778/cmajo.20150055**

United States[13] reported that uterine dehiscence, blood transfusion and endometritis occurred more frequently in the planned vaginal birth group. A meta-analysis from Scotland involving 313 238 patients reported an excess risk of perinatal death associated with planned vaginal birth, 12.9 v. 1.1/10 000 women (OR 11.7, 95% CI 1.4–101.6).[14]

A few studies have evaluated the role of a history of prior vaginal birth in moderating adverse maternal outcomes of birth after a cesarean birth. A 1999–2002 study of 13 532 births in the US among women with at least 1 prior cesarean birth reported a significant decrease in the rate of uterine rupture for planned vaginal births after at least 1 prior vaginal birth.[15] Prior vaginal birth was associated with one fifth of the risk of uterine rupture in a US hospital-based study on 3783 births.[16] A third hospital-based study (n = 2204) reported no difference in the rates of uterine rupture.[17] We compared maternal and perinatal outcomes according to history of prior vaginal birth in a population of women planning a vaginal or cesarean birth after a previous cesarean birth.

Methods

Study setting and design

We conducted a retrospective cohort study using data from the British Columbia Perinatal Data Registry for 2000–2008. Women with 1 or 2 prior cesarean births carrying a singleton fetus in cephalic presentation at term (37–41 weeks of gestation completed) were included. In British Columbia, 17.9% of women have more than 2 children.[18] Women with gestational hypertension, pre-existing diabetes and cardiac disease were excluded.

Outcomes were designated as life-threatening or non–life threatening by a multidisciplinary group of obstetricians, pediatricians, anesthetists, nurses and midwives who were funded to apply methods in quality assurance for the evaluation of cesarean birth rates in BC.[19] Maternal outcomes categorized as life-threatening included deep vein thrombosis, pulmonary embolism, amniotic embolism, uterine rupture, hysterectomy, surgery to control intrapartum or postpartum bleeding, receipt of blood transfusion, septic embolism, and pulmonary, cardiac, or central nervous system complications from anesthesia. Non–life threatening adverse outcomes included uterine dehiscence, surgical wound infection, puerperal infection or sepsis, and non–life threatening anesthesia complications, including failed or difficult intubation.

Fetal and neonatal outcomes were similarly categorized. Death or life-threatening outcomes included intrapartum stillbirth, neonatal death, an Apgar score of 3 or less at 5 minutes, admission to a neonatal intensive care unit, need for ventilation, a diagnosis of hypoxic ischemic encephalopathy or intraventricular hemorrhage. Non–life threatening outcomes included an Apgar score of 4–6 at 5 minutes, requirement for oxygen lasting more than 24 hours, admission to an observation nursery or birth trauma, including Erb palsy or other facial nerve injury, ocular damage, liver hematoma, or fracture of the clavicle, long bones or skull. Infants with congenital anomalies were excluded from the analyses of neonatal outcomes.

Approval to conduct the study was obtained from The University of British Columbia Clinical Research Ethics Board.

Sources of data

The British Columbia Perinatal Data Registry contains the data for 99% of all births in BC, including home births attended by registered midwives. Data were extracted from standardized birth records by trained health-records staff using standardized protocols, then merged with additional diagnostic and procedural codes from the Canadian Institute for Health Information (CIHI) hospital discharge data and compared with data from the British Columbia Ministry of Health Vital Statistics Agency to ensure completeness and accuracy.[20]

Statistical analysis

Relative risks of planned vaginal versus planned cesarean birth were calculated using Poisson regression with robust error variance.[21] We assessed sociodemographic and pregnancy-related characteristics for their role as confounders. We planned to retain variables in the final multivariate models if their sequential removal from the full multivariable model changed the estimates of RRs between planned mode of delivery and outcomes of interest by at least 10%. We report absolute differences or attributable risk (AR) in outcomes according to planned mode of delivery. Our sample size provided us with greater than 80% power for the detection of an absolute difference of 1.0% in our composite outcomes (1.5% among non–life threatening maternal outcomes) from our baseline rates among the planned cesarean birth group, with a type I error of 0.05, 2-sided. We calculated number needed to treat (NNT) or harm (NNH) as the inverse of the AR. No adjustments were made for multiple comparisons. All analyses were carried out using SAS software version 9.3 (SAS Institute Inc., Cary, NC).

Results

We analyzed the data for 33 812 women with either 1 (n = 29 446) or 2 (n = 4366) prior cesarean births. Only 717 women (2% of all women who gave birth in BC during the study period) had more than 2 prior cesarean births. Among 28 406 women with no prior vaginal deliveries, 7614 (26.8%) planned a vaginal birth; 4766 (62.6%) subsequently delivered vaginally. There were 5406 women (16.0%) who had a prior vaginal birth and, of these, 3726 (68.9%) planned a vaginal birth; 3297 (88.5%) subsequently delivered vaginally. We excluded women with unknown planned modes of delivery (n = 41).

Women planning a vaginal birth were slightly younger and more likely to have normal or low body mass index (BMI) than those planning a cesarean birth with and without a prior vaginal delivery (Table 1). Single parent status, newborn birth weight and size of the hospital where the birth took place did not differ between comparison groups. In all multivariate models, exclusion of each of the covariates listed in Table 1 did not alter the relative risk by more than 10%; therefore, we present unadjusted relative risks.

Maternal outcomes

There were no maternal deaths. The composite risk of life-threatening outcomes was significantly elevated among women planning vaginal birth compared with cesarean birth among women without history of vaginal deliveries (RR 2.52, 95% CI 2.04–3.11) and those with 1 or more previous vaginal deliveries (RR 2.06, 95% CI 1.20–3.52) (Table 2). The ARs were 1.31% (NNH = 76) and 1.01% (NNH = 99, respectively, (i.e., the number of women who would have to have a vaginal birth before the expectation of a life-threatening outcome). The risk of uterine rupture was significantly elevated among women without a previous vaginal delivery planning a vaginal birth compared with cesarean birth (RR 6.93, 95% CI 3.65–13.16), but this risk was not significantly elevated among

Table 1: Patient characteristics, by number of prior vaginal deliveries and planned mode of birth

	No previous vaginal births		≥ 1 Previous vaginal births	
Characteristic	Planned vaginal, no. (%)* *n* = 7 614	Planned CS, no. (%)* *n* = 20 792	Planned vaginal, no. (%)* *n* = 3 726	Planned CS, no. (%)* *n* = 1 680
Maternal age, yr				
< 20	62 (0.8)	102 (0.5)	10 (0.3)	0 (0.0)
20–24	692 (9.1)	1 514 (7.3)	207 (5.5)	76 (4.5)
25–29	1 935 (25.4)	4 513 (21.7)	887 (23.8)	365 (21.7)
30–34	3 001 (39.4)	7 725 (37.1)	1 329 (35.7)	604 (36.0)
35–39	1 688 (22.2)	5 669 (27.3)	1 013 (27.2)	474 (28.2)
40–55	236 (3.1)	1 269 (6.1)	280 (7.5)	161 (9.6)
BMI				
Normal or underweight	3 703 (65.9)†	7 419 (57.5)‡	1 504 (60.8)§	514 (53.5)¶
Overweight	1 290 (22.9)†	3 162 (24.5)‡	568 (23.0)§	244 (25.4)¶
Obese	630 (11.2)†	2 327 (18.0)‡	401 (16.2)§	202 (21.0)¶
Unknown	1 991 (26.1)	7 884 (37.9)	1 253 (33.6)	720 (42.9)
Previous cesarean				
1	7 504 (98.6)	16 913 (81.3)	3 623 (97.2)	1 406 (83.7)
2	110 (1.4)	3 879 (18.7)	103 (2.8)	274 (16.3)
Augmentation of labour prostaglandins				
Oxytocin	1 171 (15.4)	0	368 (9.9)	0
Induction of labour				
Oxytocin	609 (8.0)	0	350 (9.4)	0
Prostaglandin	283 (3.7)	0	175 (4.7)	0
Both	54 (0.7)	0	19 (0.5)	0
Hospital size, births/yr				
1–49	23 (0.3)	108 (0.5)	18 (0.5)	11 (0.7)
50–249	480 (6.3)	1 289 (6.2)	303 (8.1)	125 (7.4)
250–999	1 293 (17.0)	3 069 (14.8)	784 (21.0)	322 (19.2)
1000–2499	2 199 (28.9)	6 827 (32.8)	1 097 (29.4)	514 (30.6)
> 2500	3 530 (46.4)	9 449 (45.4)	1 453 (39.0)	705 (42.0)
Home birth	33 (0.4)	0	28 (0.8)	0
Single parent	178 (2.3)	560 (2.7)	123 (3.3)	54 (3.2)
Birth weight, g; mean ± SD	3 552 ± 463	3 500 ± 450	3 584 ± 493	3 501 ± 487

Note: BMI = body mass index, CS = cesarean section, SD = standard deviation.
*Unless otherwise specified.
†Unknown BMI value not included in total for calculation of percentage (*n* = 5 623).
‡Unknown BMI value not included in total for calculation of percentage (*n* =12 908).
§Unknown BMI value not included in total for calculation of percentage (*n* = 2 473).
¶Unknown BMI value not included in total for calculation of percentage (*n* = 960).

those with a previous vaginal delivery (RR 3.16, 95% CI 0.39–25.63). The risk of blood transfusion (RR 1.44, 95% CI 1.01–1.72) was similarly elevated only among women planning vaginal birth without a previous vaginal delivery. The risk of surgical intervention to control bleeding was significantly elevated among women planning vaginal birth with (RR 7.67, 95% CI 2.40–24.52) or without a prior vaginal delivery (RR 5.40, 95% CI 3.78–7.72).

Non–life threatening maternal outcomes, compared in composite, did not differ significantly among women without a prior vaginal delivery planning vaginal birth compared with cesarean birth (RR 0.99, 95% CI 0.82–1.18) and were decreased among women planning vaginal birth with a prior vaginal delivery (RR 0.51, 95% CI 0.33–0.77). The AR was –1.17% (NNT = 85 with planned vaginal birth to prevent a non–life threatening outcome). Rates of uterine dehiscence were significantly increased among women planning vaginal birth without a previous vaginal delivery (RR 2.94, 95% CI 2.04–4.17) but not among women with a prior vaginal delivery (RR 1.16, 95% CI 0.49–2.77). Rates of obstetrical wound infection (RR 0.54, 95% CI 0.40–0.73 without prior vaginal birth; RR 0.26, 95% CI 0.15–0.48 with prior vaginal birth) and puerperal infection (RR 0.39, 95% CI 0.24–0.63 without prior vaginal birth; RR 0.24, 95% CI 0.10–0.57 with prior vaginal birth) were significantly decreased among women planning vaginal birth regardless of whether they had a prior vaginal delivery.

Fetal and neonatal outcomes

The composite risk of intrapartum stillbirth, neonatal death or life-threatening neonatal outcomes among neonates was significantly elevated among women planning vaginal birth compared with cesarean birth after no prior vaginal delivery (RR 1.65, 95% CI 1.20–2.26) but not after a prior vaginal delivery (Table 3). The AR was 0.32% (NNH = 312). The risk of an Apgar score of 3 or less at 5 minutes (RR 8.85, 95% CI 2.89–27.14) and admission to a neonatal intensive care unit (RR 1.54, 95% CI 1.04–2.26) were elevated among newborns of women planning a vaginal birth without a prior vaginal delivery but not among those whose mothers had a prior vaginal delivery.

The composite risk of 1 or more non–life threatening neonatal outcomes was not significantly different according to planned mode of birth among women with no previous vaginal deliveries and was significantly decreased among women planning a vaginal birth with a previous vaginal delivery (RR 0.67, 95% CI

Table 2: Maternal outcomes after 1–2 previous cesarean sections (CSs), by planned mode of delivery and number of previous births

	No previous vaginal deliveries			≥ 1 Previous vaginal deliveries		
Maternal outcome	Planned vaginal, no. (%) *n* = 7 614	Planned CS, no. (%) *n* = 20 792	RR (95% CI)	Planned vaginal, no. (%) *n* = 3 726	Planned CS, no. (%) *n* = 1 680	RR (95% CI)
Life-threatening or death						
Maternal death	0	0	–	0	0	–
Uterine rupture	33 (0.4)	13 (0.06)	6.93 (3.65–13.16)	7 (0.2)	1 (0.06)	3.16 (0.39–25.63)
Hemorrhage requiring blood transfusion	46 (0.6)	87 (0.4)	1.44 (1.01–2.06)	19 (0.5)	12 (0.7)	0.71 (0.35–1.47)
Surgical control of bleeding*	89 (1.2)	45 (0.2)	5.40 (3.78–7.72)	51 (1.4)	3 (0.2)	7.67 (2.40–24.52)
Hysterectomy	2 (0.03)	23 (0.1)	0.24 (0.06–1.01)	1 (0.03)	1 (0.06)	0.45 (0.03–7.20)
Complications of anesthesia†	3 (0.04)	11 (0.05)	0.74 (0.21–2.67)	1 (0.03)	0	–
Deep vein thrombosis	0	5 (0.02)	–	0	0	–
Pulmonary embolism	0	3 (0.01)	–	0	0	–
Obstetric septic embolism	0	1	–	0	0	–
Amniotic embolism	0	1	–	0	0	–
≥ 1 Life-threatening outcome	165 (2.2)	179 (0.9)	2.52 (2.04–3.11)	73 (2.0)	16 (0.9)	2.06 (1.20–3.52)
Non–life threatening						
Uterine dehiscence	62 (0.8)	58 (0.3)	2.94 (2.04–4.17)	18 (0.5)	7 (0.4)	1.16 (0.49–2.77)
Complications of anesthesia‡	43 (0.6)	115 (0.5)	1.02 (0.72–1.45)	9 (0.2)	1 (0.06)	4.06 (0.51–32.00)
Obstetric surgical wound infection	50 (0.7)	252 (1.2)	0.54 (0.40–(0.73)	17 (0.5)	29 (1.7)	0.26 (0.15–0.48)
Puerperal infection	19 (0.3)	133 (0.6)	0.39 (0.24–(0.63)	8 (0.2)	15 (0.9)	0.24 (0.10–0.57)
Puerperal sepsis	9 (0.1)	23 (0.1)	1.07 (0.49–2.31)	1 (0.03)	3 (0.2)	0.15 (0.02–1.44)
≥ 1 Non–life threatening outcome	159 (2.1)	439 (2.1)	0.99 (0.82–1.18)	45 (1.2)	40 (2.4)	0.51 (0.33–0.77)

Note: CI = confidence interval, RR = relative risk.
*Surgical control of bleeding uterus and surrounding structures, or dilation and curettage following delivery.
†Pulmonary, cardiac or central nervous system complications of anesthesia, including aspiration pneumonitis, toxic reaction to anesthesia and failed or difficult intubation.
‡Spinal and epidural induced headache, other and unspecified complications of anesthesia.

0.52–0.86). The AR was –1.92% (NNT = 52). Rates of admission to an observation or step-down nursery were significantly decreased among newborns of women who planned vaginal birth (RR 0.84, 95% CI 0.73–0.97 for women without a prior vaginal delivery; RR 0.52, 95% CI 0.39–0.69 for women with a prior vaginal delivery) as was the risk of requiring oxygen therapy for more than 24 hours (RR 0.63, 95% CI 0.43–0.94 for women with no prior vaginal deliveries; RR 0.35, 95% CI 0.15–0.79 for women with prior vaginal deliveries) regardless of history of vaginal delivery. The risk of an Apgar score of 4–6 at 5 minutes was increased for women planning a vaginal birth regardless of history of prior vaginal delivery (RR 4.90, 95% CI 3.41–7.05 for women with a prior vaginal delivery; RR 2.70, 95% CI 1.05–6.95 for women without a prior vaginal delivery). Birth trauma occurred more frequently among neonates born to women who planned vaginal birth with no prior vaginal delivery (RR 3.94, 95% CI 2.16–7.18) but not among women with a prior vaginal delivery (RR 2.71, 95% CI 0.80–9.17).

Given that 87.1% of women in our sample had only 1 previous cesarean birth, we analyzed outcomes for this subset (Table 4, Table 5). The direction and size of differences for each outcome group according to planned mode of delivery was similar to those for the entire sample.

Interpretation

Main findings

The association between planned mode of delivery and adverse outcomes after 1 or 2 previous cesarean births may be modified by history of prior vaginal birth. Life-threatening maternal outcomes overall were more common among women planning vaginal compared with cesarean birth regardless of history of prior vaginal delivery, but the risk of uterine rupture and requirement for blood transfusion were each elevated only among women without a previous vaginal delivery. Non–life threatening maternal outcomes, compared in composite, were decreased only among women with a prior vaginal delivery, as were rates of uterine dehiscence. The risk of death or life-threatening neonatal outcomes overall were significantly elevated only among women who had not had a prior vaginal delivery. The same was true for individual outcomes of an Apgar score of 3 or less at 5 minutes and admission to a neonatal intensive care unit. The risk of non–life threatening outcomes among neonates was significantly decreased only among women with a previous vaginal delivery. Differences in relative risks according to number of previous cesarean births (1 v. 2) were negligible.

Table 3: Neonatal outcomes after 1–2 previous cesarean sections (CSs), by planned mode of delivery and number of previous vaginal births*

	No previous vaginal deliveries			≥1 Previous vaginal deliveries		
Neonatal outcome	Planned vaginal, no. (%) *n* = 7 417	Planned CS, no. (%) *n* = 20 212	RR (95% CI)	Planned vaginal, no. (%) *n* = 3 634	Planned CS, no. (%) *n* = 1 639	RR (95% CI)
Life-threatening or death						
Intrapartum stillbirth	2 (0.03)	0	–	0	0	–
Death at ≤ 7 d	3 (0.04)	2 (0.01)	4.09 (0.68–24.46)	0	0	–
Death at 8–28 d	0 0	6 (0.03)	–	0	0	–
Admission to neonatal intensive care nursery†	40 (0.5)	71 (0.3)	1.54 (1.04–2.26)	8 (0.2)	8 (0.5)	0.45 (0.17–1.20)
Ventilation required	18 (0.2)	34 (0.2)	1.40 (0.79–2.47)	6 (0.2)	6 (0.2)	0.45 (0.15–1.40)
Apgar score of ≤ 3 at 5 min	13 (0.2)	3 (0.02)	8.85 (2.89–27.14)	1 (0.03)	0	–
Hypoxic ischemic encephalopathy	1 (0.01)	0	–	0	0	–
Intraventricular hemorrhage	0	0	–	0	0	–
≥ 1 Life-threatening outcome	61 (0.8)	100 (0.5)	1.65 (1.20–2.26)	14 (0.4)	11 (0.7)	0.57 (0.26–1.26)
Non–life threatening						
Admission to observation nursery‡	238 (3.2)	772 (3.8)	0.84 (0.73–0.97)	96 (2.6)	84 (5.1)	0.52 (0.39–0.69)
> 24 h of oxygen required	30 (0.4)	129 (0.6)	0.63 (0.43–0.94)	10 (0.3)	13 (0.8)	0.35 (0.15–0.79)
Apgar score of 4–6 at 5 min	81 (1.1)	45 (0.2)	4.9 (3.41–7.05)	30 (0.8)	5 (0.3)	2.7 (1.05–6.95)
Birth trauma	26 (0.3)	18 (0.09)	3.94 (2.16–7.18)	18 (0.5)	3 (0.2)	2.71 (0.80–9.17)
≥ 1 Non–life threatening outcome	333 (4.5)	887 (4.4)	1.02 (0.90–1.16)	143 (3.9)	96 (5.9)	0.67 (0.52–0.86)

Note: CI = confidence interval, RR = relative risk.
*Excludes infants with congenital anomalies.
†Baby had high acuity or was at risk of high acuity, and required multispecialty care.
‡Baby required increased observation and acute management.

Explanation and comparison with other studies

A prospective multicentre study that reported on singleton pregnancies after 1 or more previous cesarean births found comparable decreases in morbidity associated with planned vaginal birth with no prior vaginal deliveries compared with planned vaginal birth with 1 or more prior vaginal deliveries.[15] The rates of uterine rupture were 0.87% v. 0.45% compared with the results of our study (0.43% v. 0.19%). Corresponding rates of hypoxemic ischemic encephalopathy were 0.17% and 0.07%, higher than our rates. In this study, women were included if their prior vaginal birth took place after a previous cesarean and the birth took place in one of 19 participating academic medical centres. A 12-year, single-centre study reported a 1.1% rate of uterine rupture among planned vaginal births without prior vaginal delivery and a rate of 0.2% with prior vaginal delivery, midway between the multicentre study and our study.[16] Although it did not measure morbidity, a study in Quebec using a validated prediction model confirmed the significance of prior vaginal birth as a predictor of vaginal birth compared with cesarean birth.[22]

A study from an academic teaching hospital in Montréal involving women with previous cesarean births who were planning a vaginal birth (n = 2204) reported a rate of uterine rupture of 1.5% in women with no prior history of vaginal delivery and a rate of 0.5% in women with a prior vaginal delivery.[17] Rates of uterine dehiscence in these women were 5.35% and 2.8%, respectively, considerably higher than our rates of 0.81% and 0.48%, respectively.

Our results are comparable to those reported by a retrospective study among 17 medical centres.[23] Similar to our study, rates of a composite maternal outcome incorporating uterine rupture, uterine artery laceration and bladder and bowel injuries were twice as high (2.84% v. 1.07%) among women with no prior vaginal births compared with women with 1 or more prior vaginal births. The rates of uterine rupture in that study were 1.94% and 0.40%, respectively, compared with our corresponding rates of 0.43% and 0.19%, respectively.

Limitations

Our findings are limited by our retrospective design in which we rely on the coding protocols used by health-records staff,

Table 4: Maternal outcomes after 1 previous cesarean section (CS), by planned mode of delivery and number of previous vaginal births

	No previous vaginal deliveries			≥ 1 Previous vaginal deliveries		
Maternal outcome	Planned vaginal, no. (%) n = 7 504	Planned CI, no. (%) n = 16 913	RR (95% CI)	Planned vaginal, no. (%) n = 3 623	Planned CS, no. (%) n = 1 406	RR (95% CI)
Life-threatening or death						
Maternal death	0	0	–	0	0	–
Uterine rupture	32 (0.4)	11 (0.07)	6.56 (3.31–13.00)	6 (0.2)	1 (0.07)	2.33 (0.28–19.32)
Blood transfusion	46 (0.61)	73 (0.4)	1.42 (0.98–2.05)	17 (0.5)	10 (0.7)	0.66 (0.30–1.44)
Surgical control of bleeding*	88 (1.2)	34 (0.2)	5.83 (3.93–8.66)	51 (1.4)	2 (0.1)	9.9 (2.42–40.59)
Hysterectomy	2 (0.03)	19 (0.1)	0.24 (0.06–1.02)	1 (0.03)	1 (0.07)	0.39 (0.02–6.20)
Complications of anesthesia†	2 (0.03)	10 (0.06)	0.45 (0.10–2.06)	1 (0.03)	0	–
Deep vein thrombosis	0	2 (0.01)	–	0	0	–
Pulmonary embolism	0	2 (0.01)	–	0	0	–
Obstetric pyemic or septic embolism	0	1 (0.01)	–	0	0	–
Amniotic embolism	0	0	–	0	0	–
≥ 1 Life-threatening outcome	162 (2.2)	142 (0.8)	2.57 (2.06–3.22)	70 (1.9)	13 (0.9)	2.09 (1.16–3.76)
Non–life threatening						
Uterine dehiscence	61 (0.8)	38 (0.2)	3.62 (2.42–5.42)	16 (0.4)	2 (0.1)	2.07 (0.60–7.09)
Complications of anesthesia‡	43 (0.6)	86 (0.5)	1.13 (0.78–1.63)	9 (0.2)	1 (0.07)	3.49 (0.44–27.54)
Obstetric surgical wound infection	46 (0.6)	196 (1.2)	0.53 (0.38–0.73)	17 (0.5)	24 (1.7)	0.27 (0.15–0.51)
Puerperal infection	17 (0.2)	113 (0.7)	0.34 (0.20–0.56)	8 (0.2)	13 (0.9)	0.24 (0.10–0.57)
Puerperal sepsis	9 (0.1)	20 (0.1)	1.01 (0.46–2.23)	1 (0.03)	3 (0.2)	0.13 (0.01–1.24)
≥ 1 Non–life threatening outcome	154 (2.0)	332 (2.0)	1.05 (0.87–1.26)	43 (1.2)	31 (2.2)	0.54 (0.34–0.85)

Note: CI = confidence interval, RR = relative risk.
*Surgical control of bleeding uterus and surrounding structures, or dilation and curettage following delivery.
†Pulmonary, cardiac or central nervous system complications of anesthesia, including aspiration pneumonitis, toxic reaction to anesthesia, and failed or difficult intubation.
‡Spinal- and epidural-induced headache, other and unspecified complications of anesthesia.

Table 5: Neonatal outcomes after 1 previous cesarean section (CS), by planned mode of delivery and number of previous vaginal births*

	No previous vaginal deliveries			≥ 1 Previous vaginal deliveries		
Neonatal outcome	Planned vaginal, no. (%) *n* = 7 310	Planned CS, no. (%) *n* = 16 442	RR (95% CI)	Planned vaginal, no. (%) *n* = 3 533	Planned CS, no. (%) *n* = 1 374	RR (95% CI)
Life-threatening or death						
Intrapartum stillbirth	2 (0.03)	0	–	0	0	–
Death at ≤ 7 d	3 (0.04)	2 (0.01)	3.37 (0.56–20.19)	0	0	–
Death at 8–28 d	0	5 (0.03)	–	0	0	–
Admission to level III NICU†	40 (0.5)	59 (0.4)	1.52 (1.02–2.28)	7 (0.2)	8 (0.6)	0.34 (0.12–0.94)
Ventilation required	18 (0.2)	26 (0.2)	1.56 (0.85–2.84)	6 (0.2)	5 (0.4)	0.47 (0.14–1.53)
Apgar score of ≤ 3 at 5 min	13 (0.2)	4 (0.02)	7.31 (2.38–22.41)	1 (0.03)	0	–
Hypoxic Ischemic encephalopathy	1 (0.01)	0	–	0	0	–
Intraventricular hemorrhage	0	0	–	0	0	–
≥ 1 Life-threatening outcome	61 (0.8)	83 (0.5)	1.65 (1.19–2.30)	13 (0.4)	10 (0.7)	0.51 (0.22–1.15)
Non–life threatening						
Admission to level II NICU‡	234 (3.2)	624 (3.8)	0.84 (0.73–0.98)	93 (2.6)	71 (5.2)	0.51 (0.38–0.69)
> 24 h of oxygen required	29 (0.4)	93 (0.6)	0.7 (0.46–1.06)	9 (0.2)	13 (0.9)	0.27 (0.12–0.63)
Apgar score of 4–6 at 5 min	79 (1.1)	37 (0.2)	4.8 (3.25–7.09)	30 (0.8)	3 (0.2)	3.89 (1.19–12.72)
Birth trauma	26 (0.4)	14 (0.08)	4.18 (2.18–7.99)	18 (0.5)	1 (0.07)	7 (0.94–52.39)
≥ 1 Non–life threatening outcome	326 (4.5)	713 (4.3)	1.03 (0.90–1.17)	139 (3.9)	81 (5.9)	0.67 (0.51–0.87)

Note: CI = confidence interval, NICU = neonatal intensive care unit, RR = relative risk.
*Excludes infants with congenital anomalies.
†Baby had high acuity or was at risk of high acuity, and required multispecialty care.
‡Baby required increased observation and acute management.

which in turn rely on diagnoses charted by caregivers who may not use consistent standards for differentiating, for example, uterine rupture from dehiscence. However, we do not believe that documentation would differ by exposure groups. Furthermore, the use of composite measures limits comparison among studies, but we also included comparisons of individual outcomes. We anticipate that women would want to know the risk of any serious outcome versus a series of comparisons for individual outcomes. Our study is further restricted by our observational design that precludes our inability to control for preferences among primary caregivers and other potentially important but unmeasured confounders, including the indication for the initial cesarean birth. This is an inevitable consequence of the inability to study mode of birth in a randomized trial because women have not been willing to relinquish choice of planned mode of birth. The smaller sample size of women with a history of cesarean birth and vaginal delivery resulted in wide confidence intervals for this group. Finally, we did not have access to data for interpregnancy interval and ethnicity.

Conclusion

Decision-making regarding planned mode of delivery after a prior cesarean birth is complex. In consideration of safety, advantage may be attributed to planned vaginal or repeat cesarean birth depending on whether one is assessing maternal or neonatal outcomes, the level of morbidity involved and the nature of the outcomes. Overall, risks for adverse outcomes after 1 or 2 previous cesarean births are reduced among women with a prior vaginal birth compared with no prior vaginal birth. Absolute differences between planned vaginal birth compared with planned cesarean birth remain small.

Our data may encourage the development of decision aids that weigh women's values for safety for different categories of outcomes. Our data offer women and their caregivers the opportunity to consider risk profiles separately for women who have and have not had a prior vaginal delivery. A consistent finding across comparisons is that absolute risk differences remain small, at most 2%, whereas ratio measures show increases as high as ninefold. We encourage the inclusion of absolute measures of risk in patient counselling to provide more interpretable comparisons.[24]

References

1. Kelly S, Sprague A, Fell DB, et al. Examining caesarean section rates in Canada using the Robson classification system. *J Obstet Gynaecol Can* 2013;35:206-14.
2. Society of Obstetricians and Gynaecologists of Canada. Guidelines for vaginal birth after previous caesarean birth. *Int J Gynaecol Obstet* 2005;89:319-31.
3. Chaillet N, Dubé E, Dugas M, et al. Identifying barriers and facilitators towards implementing guidelines to reduce caesarean section rates in Quebec. *Bull World Health Organ* 2007;85:791-7.

4. Yang YT, Mello M, Subramanian S, et al. Relationship between malpractice litigation pressure and rates of cesarean section and vaginal birth after cesarean section. *Med Care* 2009;47:234-42.
5. *Health Indicators 2013*. Ottawa: Canadian Institute for Health Information; 2013.
6. *Perinatal annual indicators by place of delivery for British Columbia from 2003/04 to 2012/13*. Vancouver: Perinatal Services BC; 2014.
7. *Perinatal health indicators for Canada 2013: report of the Canadian Perinatal Surveillance System*. Ottawa: Public Health Agency of Canada; 2013.
8. McMahon MJ, Luther E, Bowes W, et al. Comparison of a trial of labor with an elective second cesarean section. *N Engl J Med* 1996;335:689-95.
9. Wen SW, Rusen I, Walker M, et al. Comparison of maternal mortality and morbidity between trial of labor and elective cesarean among women with previous cesarean delivery. *Am J Obstet Gynecol* 2004;191:1263-9.
10. Smith GC, Pell J, Cameron A, et al. Risk of perinatal death associated with labor after previous cesarean delivery in uncomplicated term pregnancies. *JAMA* 2002;287:2684-90.
11. Paré E, Quinones J, Macones G. Vaginal birth after caesarean section versus elective repeat caesarean section: assessment of maternal downstream health outcomes. *BJOG* 2006;113:75-85.
12. Guise JM, Denman M, Emeis C, et al. Vaginal birth after cesarean: new insights on maternal and neonatal outcomes. *Obstet Gynecol* 2010;115:1267-78.
13. Landon MB, Hauth J, Leveno K, et al. Maternal and perinatal outcomes associated with a trial of labor after prior cesarean delivery. *N Engl J Med* 2004; 351:2581-9.
14. Smith GC, Pell J, Dobbie R. Cesarean section and risk of unexplained stillbirth in subsequent pregnancy. *Lancet* 2003;362:1779-84.
15. Mercer BM, Gilbert S, Landon M, et al. Labor outcomes with increasing number of prior vaginal births after cesarean delivery. *Obstet Gynecol* 2008; 111:285-91.
16. Zelop CM, Shipp T, Repke J, et al. Effects of previous vaginal delivery on the risk of uterine rupture during a subsequent trial of labor. *Am J Obstet Gynecol* 2000;183:1184-6.
17. Hendler I, Bujold E. Effect of prior vaginal delivery or prior vaginal birth after cesarean delivery on obstetric outcomes in women undergoing trial of labor. *Obstet Gynecol* 2004;104:273-7.
18. *Selected vital statistics and health status indicators: 137th annual report*. Victoria: British Columbia Vital Statistics Agency; 2008. Available: https://vs.gov.bc.ca/stats/annual/2008/ (accessed 2015 Mar. 27).
19. Optimal Birth BC. Vancouver: 2009. Available: http://optimalbirthbc.ca/ (accessed 2015Apr.7).
20. British Columbia Perinatal Data Registry. Vancouver: Perinatal Services BC; 2013. Available: www.perinatalservicesbc.ca/DataAndSurveillance/DataRegistry/default.htm (accessed 2015 Mar. 20).
21. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702-6.
22. Chaillet N, Bujold E, Dube E, et al. Validation of a prediction model for vaginal birth after caesarean. *J Obstet Gynaecol Can* 2013;35:119-24.
23. Cahill AG, Stamilio DM, Adibo AO, et al. Is vaginal bith after cesarean (VBAC) or elective repeat cesarean safer in women with a prior vaginal delivery? *Am J Obstet Gynecol* 2006;195:1143-7.
24. Baker R, Camosso-Stefinvovic J, Gillies C, et al. Tailored interventions to overcome identified barriers to change: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2010;17:CD005470.

Affiliations: School of Population and Public Health (Bickford, Janssen), The University of British Columbia, Vancouver, BC; Child and Family Research Institute (Janssen), Vancouver, BC

Contributors: Celeste Bickford conceived the design of the study, analyzed the data and wrote the first draft of the article. Patricia Janssen acquired the data from Perinatal Services BC and contributed substantively to the design. Both of the authors revised the manuscript, gave final approval for the version to be published and agreed to act as guarantors of the work.

Acknowledgments: Celeste Bickford was supported by a Vanier Canada Graduate Scholarship. Patricia Janssen was supported by a salary award from the Child and Family Research Institute in Vancouver. All inferences, opinions and conclusions drawn in this publication are those of the authors, and do not necessarily reflect the opinions or policies of Perinatal Services BC.

Supplemental information: For reviewer comments and the original submission of this manuscript, please see www.cmajopen.ca/content/3/2/E158/suppl/DCI.