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Uterine Rupture Risk After Periviable Cesarean Delivery

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Abstract

Objective—To compare risk of uterine rupture in women with prior periviable cesarean versus prior term cesarean, independent of initial incision type.

Methods—We conducted a retrospective longitudinal cohort study using Washington State birth certificate data and hospital discharge records, identifying primary cesareans performed at 20-26 weeks and 37-41 weeks of gestation with subsequent delivery between 1989-2008. We compared subsequent uterine rupture risk in the two groups considering both primary incision type and subsequent labor indication and augmentation.

Results—We identified 456 women with index periviable cesarean and 10,505 women with index term cesarean. Women with index periviable cesarean were younger, more frequently of non-white race, more likely to smoke, and more likely to have hypertension. Women in the periviable group had more index classical incisions (42% versus 1%, p<0.001) and fewer subsequent inductions and augmentations (8% vs. 16%, p<0.001). Uterine rupture in the subsequent pregnancy occurred more frequently among women in the index periviable group than those in the index term group (8/456 [1.8%] versus 38/10,505 [0.4%], OR 4.9, 95% CI 2.3-10.6). This relationship persisted among women with a low transverse incision (4/228 [1.8%] versus 36/9,558 [0.4%], OR 4.7, 95% CI1.7 – 13.4).

Conclusion—Cesarean at periviability compared to term is associated with an increased risk for uterine rupture in a subsequent pregnancy, even after low transverse incision. These data support judicious use of cesarean at periviable gestational ages and inform subsequent counseling.

Introduction

Over the last several decades, improved neonatal survival at extremely premature gestational ages has repositioned the demarcation of “periviability.” With this shift, the acceptable

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gestational age for neonatal resuscitation is moving earlier in pregnancy(1). As a result, the rate of cesarean delivery at periviability has increased dramatically over recent years(2-5). This is in part due to a higher incidence of traditional indications for cesarean, including malpresentation and other fetal indications, at periviability than at term(6).

Preterm cesarean deliveries are associated with higher risks both immediately and in the subsequent delivery than term cesarean deliveries(7, 8). Much of the increased risk in the subsequent delivery is attributed to the type of uterine incision(9). Classical uterine incisions occur in approximately 30% of cesarean deliveries prior to 28 weeks of gestation(7). The risk of uterine rupture in women varies by prior incision type, with the risk of uterine rupture after classical cesarean approximating 1-12%(10).

Prior studies comparing uterine rupture risk after term cesarean delivery versus preterm cesarean delivery have focused on late preterm gestational ages. Some studies suggest increased risk of subsequent rupture after preterm cesarean delivery, estimating between a 1.6 and 5 fold increase(11, 12), while other studies show no association(13-15). The specific risk for uterine rupture after cesarean delivery at periviability remains unknown.

We sought to compare the risk of uterine rupture and its comorbidities after a prior periviable cesarean delivery compared to prior term cesarean delivery.

Materials and Methods

We conducted a longitudinal retrospective cohort study of primary singleton cesarean deliveries linked to subsequent singleton births by the same mother. We identified women according to Washington state birth certificate and fetal death certificate files for the years 1989-2008, provided by the Washington State Department of Health through the University of Washington. Data were linked to maternal and neonatal hospital discharge diagnosis International Classification of Diseases, 9th Revision, Clinical Modification (1CD-9-CM) for both the index and subsequent births and provided as a de-identified dataset. The Human Subjects Division at the University of Washington determined this study exempt from review due to use of de-identified data.

For inclusion, women were required to have two singleton deliveries in the state of Washington between 1989 and 2008. We refer to the exposure pregnancy as “index” and outcome pregnancy as “subsequent.” Subsequent pregnancies were the next documented pregnancy in the Washington State birth certificate files through 2008. Subjects with cesarean section prior to the index pregnancy were excluded. We broadly defined periviability to include gestational ages between 20 0/7 and 26 6/7 weeks of gestation, choosing a lower gestational age limit consistent with the Periviable Birth: Executive Summary(1). All qualifying women identified with a periviable cesarean delivery during the study period were included in the exposure (periviable) group. The comparison (term) group included randomly selected women with an index term cesarean between 37 0/7 and 41 6/7 weeks of gestation. As an additional factor to validate gestational age in the dataset, index periviable deliveries were limited to birth weights of 250 grams to 1500 grams, and index

term delivery birth weights were limited to 2500-6500 grams. No limitations were placed on subsequent delivery gestational ages or birth weights.

Maternal and neonatal demographics and characteristics were evaluated for the index delivery as well as the subsequent delivery. The primary outcome was uterine rupture in the subsequent delivery (defined as birth certificate variable for uterine rupture or ICD-9-CM codes 665.0, 665.1). The cohort sample sizes of 456 periviable deliveries and 10,505 term deliveries were determined by including all qualifying deliveries during the time period. Secondary outcomes for the subsequent delivery included a composite measure of maternal morbidity and maternal length of stay. Composite morbidity included hemorrhage, infection, hysterectomy, obstetric injury and death (defined as birth certificate variable for transfusion, bleeding, coagulopathy, chorioamnionitis, sepsis, maternal infection, hysterectomy or maternal death or ICD-9-CM codes 641.3, 641.8, 641.9, 666.0, 666.1, 666.2, 666.3, 285.1, 286.6, 75.8, 99.0, 659.2, 659.3, 670, 672, 995.9, 68.3, 68.4, 68.8, 68.9, 665.3, 665.4, 665.5, 665.6, 665.8, 665.9, 998.2, 57.8, 69.29, 69.49, 75.5, 75.61, 761.6, or 798). Missing values for dichotomous outcome variables were assumed to represent negative values.

Differences in maternal demographics between groups according to gestational age at index cesarean delivery were assessed via t-tests and chi-squared tests. Binary outcomes were compared across groups via logistic regression models; continuous outcomes were analyzed via linear regression models. A logarithmic transformation was applied to length of hospital stay to accommodate modeling assumptions. Because our primary outcome is rare, we limited our covariates to two preset variables: index incision type and labor induction or augmentation. These two covariates were included one at a time in the primary outcome model to assess for confounding. A factor was defined as a confounder if there was a difference of 10% or more in the estimated coefficient of interest between the multivariable model including the factor and the model without it.

Index incision is determined by diagnosis code used for the index delivery and induction or augmentation is defined by ICD-9-CM codes for induction (73.1, 73.4, 73.99, 96.49) and birth certificate variables for induction and augmentation of labor in the subsequent pregnancy. For secondary outcomes with sufficient events we adjusted for confounding considering the *a priori* variables index incision type and labor induction or augmentation, as well as other potential confounders during the subsequent delivery including mother's race, mother's age, obesity, smoking status, diabetes, hypertension, birth weight, gestational age and delivery mode. Odds ratios (OR) are presented with 95% confidence intervals (CI). For all analyses, a two-sided significance level of <0.05 was considered statistically significant. Analyses were performed using SAS version 9 (SAS Institute, Inc., Cary, N.C.).

Results

We identified 456 index periviable primary cesarean deliveries and 10,505 index term primary cesarean deliveries. Index periviable deliveries occurred at 20 (N=5), 21 (N=10), 22 (N=9), 23 (N=27), 24 (N=94), 25 (N=144), 26 (N=167) weeks of gestation. Of women with an index periviable delivery, 163 (42%) underwent an index classical incision., Of women with an index term delivery, 61(1%) underwent an index classical incision.

Table 1 compares characteristics for the index and subsequent pregnancies among women in the periviable group and the term group. Women in the periviable group were younger at both pregnancies, more likely to be non-white, smokers, hypertensive, and more likely to have a lower income at the subsequent pregnancy than women in the term group. The distribution of number of prior live births (an approximation of parity) also varied significantly across groups.

Mean gestational age for the subsequent delivery was lower for the periviable group than the term group (36.0 weeks versus 38.8 weeks, respectively, p<0.001). Women in the periviable group were less likely to have had an induced or augmented subsequent delivery. The majority of women in this cohort delivered the subsequent pregnancy by repeat cesarean, over 70% in both exposure groups. There were fewer successful vaginal deliveries in the periviable group compared to the term group (20% versus 26%, respectively, p=0.01).

Our primary outcome, uterine rupture in the subsequent pregnancy, occurred more frequently among women in the periviable group than those in the term group (1.8% versus 0.4%, OR 4.9, 95%CI 2.3-10.6, p<0.001, Table 2). The relationship was not confounded by index incision type nor by subsequent induction or augmentation. Among the subset of women with a low transverse incision in the index pregnancy, uterine rupture remained more common in the periviable group compared to the term group (OR 4.7, 95% CI 1.7-13.4, p=0.004).

The incidence of our secondary maternal morbidity composite outcome was similar across groups (14.0% in the periviable group and 10.0% in the term group, p=0.68 in adjusted model). Analyses are presented in Table 3. The composite component maternal infection in the subsequent delivery occurred more often in the periviable group than the term group, although this difference was not statistically significant in an adjusted model (6.6% versus 3.8%, OR 1.1, 95% CI 0.6-1.9, p=0.74, Table 3). The composite components hemorrhage, hysterectomy, obstetric injury, and death were similar between the two groups (Table 3). The unadjusted mean maternal hospital stay was longer in the index periviable group than in the index term group (3.6 days, 95% CI 3.2 – 4.1 vs. 2.5 days, 95% CI 2.4 – 2.6, p<0.001).

Notably, uterine rupture cases in our cohort occurred with a substantial amount of morbidity. Of uterine ruptures occurring after index periviable cesarean, 7/8 (88%) had an associated morbidity or clinical sign such as hemorrhage, infection, obstetric injury (including bladder injury), abnormal fetal heart rate or fetal death. Among ruptures occurring after index term cesarean, 28/38 (74%) occurred with at least one of these associated clinical signs. Detailed clinical information on all uterine rupture cases is shown in Table 4 (included as supplementary digital content).

Discussion

Our data show an increased risk of uterine rupture after periviable cesarean delivery compared with term cesarean delivery. This risk was consistent across prior periviable classical and low transverse uterine incision types, reflected by a nearly fivefold increased risk after index periviable low-transverse cesarean delivery compared with index term low-

transverse cesarean delivery. Overall, uterine rupture occurred in approximately 2% of women with a prior periviable cesarean delivery.

Our findings add to an extensive literature describing uterine rupture risk after cesarean delivery(9, 11-15). Some studies have demonstrated a higher risk of uterine rupture after preterm cesarean delivery, and our data support this risk after periviable cesarean. Sciscione et al reported higher uterine rupture risk after prior birth <37 weeks of gestation with an adjusted OR of 1.6 among index “nonclassic” cesarean deliveries(11). In this study, first delivery birth weight was considered a surrogate for gestational age and was not associated with subsequent uterine rupture risk. Similarly, Rochelson et al demonstrated an association of uterine rupture with preterm low transverse cesarean <36 weeks of gestation compared with term cesarean (OR 5.39)(12). However, the majority (80%) of women with a prior preterm cesarean delivery were >31 weeks of gestation, leaving uncertainty about risk after cesarean at earlier gestational ages.

Several additional studies found no heightened uterine rupture risk after preterm cesarean(13-15), though some studies were limited by relatively small cohort sizes(13, 14). Harper et al compared uterine rupture risk after cesarean delivery before or after 34 weeks of gestation and found no difference in risk among women undergoing a subsequent trial of labor. However, a subset analysis of women with a prior cesarean delivery at <28 weeks of gestation (n=55) compared to prior term cesarean showed a non-significant increased risk, with frequencies of uterine rupture of 1.8% and 0.9%, respectively (RR 2.1, 95% CI 0.3-15.0), similar in magnitude to our current findings.

While our study population is large and carefully defined, the limitations of our study design should be considered in interpretation of its findings. With a rare but important outcome, a population-based study is the most feasible way to identify important risk factors. This study uses birth certificate data which carry inherent limitations including concerns for accuracy and inconsistencies in data collection(16, 17). We carefully selected variables for clarity, prior validation, and conservative estimation of risk; for example we did not assess spontaneous labor, because a reliable variable was not available. Not all variables used in the current study were specifically assessed in validation studies, nor were we able to directly validate our findings with a chart review in the current study. However, while misclassification bias remains a concern in both directions, the additional information gleaned from hospital discharge data minimizes this issue. Specifically, our database of WA state birth certificate variables is enhanced by linked ICD-9-CM codes, which has been shown to improve accuracy in validation studies(18, 19). Lydon-Rochelle et. al. demonstrated that the true positive rate of several variables improves without increasing the false-positive rate when combining birth certificate data with hospital discharge data compared to medical chart review(18, 19). In addition, the association of uterine rupture with maternal and neonatal morbidity demonstrates clinical relevance and appropriate classification (Table 4).

We conclude that the risk of subsequent uterine rupture after periviable cesarean delivery, including low transverse uterine incisions, may be greater than previously estimated. Prospective studies are needed to confirm these findings and direct clinical management.

However, in the absence of prospective studies, these data highlight the need for caution in the management of pregnancy after prior periviable cesarean delivery, regardless of incision type.

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Table 1

Demographic and pregnancy characteristics by gestational age group of index cesarean delivery

	Periviable (20 – 26 weeks) N=456	Term (37 – 41 weeks) N=10,505	p-value[1]
Index pregnancy			
Maternal age (years)			<0.001
Mean (SD)	23.7 (5.8)	25.7 (6.1)	
Missing: N (%)	0 (0)	12 (<1)	
Maternal race: N (%)[2]			<0.001
White	310 (68)	8022 (76)	
Non-white	125 (27)	1986 (19)	
Missing	21 (5)	497 (5)	
Gestational age (weeks)			
Median (IQR)	25 (24 – 26)	40 (39 – 40)	–
Missing N (%)	0 (0)	0 (0)	
Birth weight (grams)			
Mean (SD)	756 (202)	3589 (499)	–
Missing N (%)	0 (0)	0 (0)	
Incision type: N (%)			<0.001
Low transverse	228 (50)	9558 (91)	
Classical	163 (36)	61 (<1)	
Other	1 (<1)	11 (<1)	
Missing	64 (14)	875 (8)	
Subsequent pregnancy			
Maternal age (years)			<0.001
Mean (SD)	26.7 (6.0)	28.9 (6.0)	
Missing: N (%)	0 (0)	2 (<1)	
Maternal obesity: N (%)			0.08
No	253 (55)	6152 (58)	
Yes	63 (14)	1968 (19)	
Missing	140 (31)	2385 (23)	
Prior live births: N (%)			<0.001
0	71 (16)	198 (2)	
1	225 (49)	8552 (81)	
2	89 (20)	1031 (10)	
3 or more	51 (11)	508 (5)	
Missing	20 (4)	216 (2)	
Inter-delivery interval (months)			0.07
Median (IQR)	28 (18 – 45)	32 (23 – 47)	
Missing N (%)	0 (0)	0 (0)	
Maternal smoking: N (%)			<0.001

	Periviable (20 – 26 weeks) N=456	Term (37 – 41 weeks) N=10,505	p-value[1]
No	346 (76)	8903 (85)	
Yes	91 (20)	1316 (12)	
Missing	19 (4)	286 (3)	
Maternal income (× 10^3)			<0.001
Median (IQR)	37.9 (30.7 – 47.6)	42.5 (33.5 – 54.6)	
Missing: N (%)	18 (4)	215 (2)	
Hypertension: N (%)	75 (16)	670 (6)	<0.001
Diabetes: N (%)			0.64
No	423 (93)	9712 (92)	
Gestational	25 (5)	651 (6)	
Established	8 (2)	142 (1)	
Gestational age (weeks)			<0.001
Median (IQR)	37 (35 – 38)	39 (38 – 40)	
Missing: N (%)	7 (2)	150 (1)	
Birth weight (grams)			<0.001
Mean (SD)	2763 (841)	3509 (542)	
Missing: N (%)	5 (1)	53 (<1)	
Induction/augment: N (%)			<0.001
No	420 (92)	8824 (84)	
Yes	36 (8)	1681 (16)	
Delivery mode: N (%)			0.01
Vaginal	92 (20)	2681 (26)	
Cesarean	364 (80)	7822 (74)	
Missing	0 (0)	2 (<1)	

[1] Analyses exclude missing values

[2] SD = Standard deviation and IQR = Interquartile range.

[3] Race was categorized as white or non-white using data collected at both first and subsequent pregnancies. We assumed that a person's race did not vary over time, so that if race was missing for a subject's first pregnancy we could use a non-missing race value from the subsequent pregnancy, and vice versa.

[4] Data on maternal income at the subsequent pregnancy was missing and filled in with data from the first pregnancy for 273 patients, 259 (2.5%) in the term and 14 (3.6%) in the periviability delivery group (p=0.17).

Table 2

Risk of uterine rupture by gestational age group of index cesarean delivery

	Periviable	Term	Unadjusted	
	(20-26 weeks)	(37-41 weeks)	OR (95% CI)	p-value
All patients	8/456 (1.8%)	38/10,505 (0.4%)	4.9 (2.3 – 10.6)	<0.001
By incision type				
Classical	4/163 (2.5%)	0/61 (0%)	_[1]	–
Low transverse	4/228 (1.8%)	36/9,558 (0.4%)	4.7 (1.7 – 13.4)	0.004
Other[2]	0/1 (0%)	0/11 (0%)	_[1]	–
Missing	0/64 (0%)	2/875 (<0.1%)	_[1]	–
By induction or augmentation				
No	8/420 (1.9%)	23/8,824 (0.3%)	7.4 (3.3 – 16.7)	<0.001
Yes	0/36 (0%)	15/1,681 (0.9%)	_[1]	–

[1] OR could not be estimated for classical, other, and missing incision types or for womenwith induction/augmentation, due to lack of events.

[2] other incision types as determined by ICD-9-CM procedure code 74.4 or 74.9

Table 3

Results for secondary outcome: maternal composite morbidity by gestational age group of the index pregnancy

	Periviable	Term	Adjusted[2]	
	N=456	N=10,505	OR (95% CI)	p-value
Composite morbidity[1]	**64 (14.0%)**	**1047 (10.0%)**	**1.1 (0.7 – 1.6)**	**0.68**
Hemorrhage	24 (5.3%)	442 (4.2%)	1.0 (0.5 – 1.7)	0.89
Infection	30 (6.6%)	403 (3.8%)	1.1 (0.6 – 1.9)	0.74
Hysterectomy	2 (0.4%)	17 (0.2%)	2.7 (0.6 – 11.8)	0.18
Obstetric injury	15 (3.3%)	271 (2.6%)	1.3 (0.8 – 2.2)	0.37
Maternal death	0	0	–	–

[1] Maternal composite includes: death, hemorrhage, infection, obstetric injury, and hysterectomy.

[2] Composite morbidity, hemorrhage, and infection models adjusted for maternal race, incision type, gestational age, induction or augmentation and mode of delivery in the subsequent delivery and excludes missing values (N=9,395). Analyses of hysterectomy, obstetric injury, and maternal death were unadjusted due to insufficient events.

Table 4

Uterine rupture case descriptions.

Case	INDEX PREGNANCY					Inter-delivery Interval (month)	SUBSEQUENT PREGNANCY				
	Weeks of Gestation	Indication	Incision	Birth weight (gm[1])	Complications		Weeks Gestation	Intrapartum Risk Factors	Birth weight (gm[1])	Obese	Complications
INDEX PERIVIABLE CASES											
1	21	Preterm PROM[1], cord prolapse, malpresentation	Low transverse	312	Perinatal stillbirth	13	38[2]		1814	.[3]	Maternal hemorrhage, obstetric injury, respiratory complication, retained placenta Neonatal respiratory disease
2	22	Preterm labor, puerperal infection, cord prolapse	Classical	454	Neonatal death, low Apgar[4]	12	34		2098	Yes	Maternal placental abruption, obstetric injury, abnormal fetal heart rate Neonatal ventilation, umbilical vessel catheterization, respiratory disease, jaundice
3	24	Puerperal infection, previa with hemorrhage, cord prolapse, abnormal fetal heart rate	Low transverse	623	Maternal anemia, transfusion, retained foreign body Neonatal death, low Apgar[3], ventilation, umbilical vessel catheterization, cutaneous hemorrhage	20	.[3]		.	.[3]	Maternal anemia, transfusion Perinatal stillbirth
4	24	Puerperal infection, placental abruption, abnormal fetal heart rate	Classical	695	Neonatal death, low Apgar[3], ventilation	12	36		3385	Yes	Maternal anemia, hemorrhage, transfusion, puerperal infection, ileus, failed operative vaginal delivery Neonatal ventilation, hemolytic disease, jaundice, respiratory disease
5	25	Preterm PROM[1], malpresentation	Classical	822	Neonatal death, respiratory disease, ventilation, umbilical vessel catheterization	13	36		2665	No	Maternal obstetric injury Neonatal temperature dysregulation, hypoglycemia, jaundice observation for infection
6	25	Preterm labor, puerperal infection, oligohydramnios, malpresentation	Low transverse	790	Neonatal ventilation, retinopathy, anemia, jaundice	63	38		3075	No	Maternal obstetric injury
7	25	Puerperal infection, hypertensive disorder	Classical	595	Maternal pulmonary edema Neonatal death, ventilation, umbilical vessel catheterization, necrotizing enterocolitis, intraventricular hemorrhage, feeding problems, jaundice, electrolyte disturbance	22	38		3275	No	Maternal wound complication

Case	INDEX PREGNANCY					Inter-delivery Interval (month)	SUBSEQUENT PREGNANCY				
	Weeks of Gestation	Indication	Incision	Birth weight (gm[1])	Complications		Weeks Gestation	Intrapartum Risk Factors	Birth weight (gm[1])	Obese	Complications
8	26	Preterm labor, puerperal infection malpresentation	Low transverse	709	Neonatal low Apgar[3], ventilation	56	22[3]	Intraamniotic infection	1219	No	Maternal placental abruption, puerperal infection, obstetric injury Neonatal ventilation, respiratory disease, pneumonia, parenteral nutrition, metabolic acidosis, fluid overload, electrolyte disturbance, jaundice
INDEX TERM CASES											
9	37	Oligohydramnios malpresentation	Low transverse	2807		33	38		2892	No	
10	37	PROM[1], hypertensive disorder, malpresentation, abnormal fetal heart rate	Low transverse	3334		31	38		3502	No	Maternal wound complication, abnormal fetal heart rate
11	37	Abnormal fetal heart rate, failed operative vaginal delivery	Low transverse	4110	Neonatal ventilation	55	38	Induction	3666	No	
12	37	Previa with hemorrhage	Low transverse	3543		22	41	Induction	3968	No	Maternal obstetric injury, abnormal fetal heart rate Neonatal hypoglycemia, observation for infection
13	38	Labor dystocia, abnormal fetal heart rate	Low transverse	2775	Neonatal feeding problems, jaundice	30	36		3655	.[3]	Placenta previa with hemorrhage Neonatal respiratory disease, observation for infection
14	38	Labor dystocia	Low transverse	3713	Neonatal respiratory disease, observation for infection	15	37		3090	No	Maternal hemorrhage, transfusion, obstetric injury, hysterectomy, bladder injury, respiratory complication, abnormal fetal heart rate Neonatal ventilation
15	38	Hypertensive disorder, suspected macrosomia, labor dystocia	Low transverse	4054	Maternal hemorrhage Neonatal temperature dysregulation, observation for infection, spinal tap	21	38	Induction, labor dystocia	3883	.[3]	Maternal hypertensive disorder, complication of anesthesia, respiratory complication, vascular complication
16	38	PROM[1], puerperal infection, abnormal fetal heart rate	Low transverse	3742	Neonatal respiratory disease, hypoglycemia	25	39		3572	No	Neonatal temperature dysregulation
17	38	Labor dystocia	Low transverse	3798	Neonatal patent ductus arteriosus	44	40		3402	No	Maternal anemia, obstetric injury, abnormal fetal heart rate
18	39		Low transverse	3061		37	37	Labor dystocia	3231	.[3]	Maternal anemia, hemorrhage, obstetric injury, bladder injury, abnormal fetal heart rate
19	39	Hypertensive disorder, other abnormal labor, abnormal fetal heart rate	Low transverse	3144		33	40	Induction, labor dystocia	3423	.[3]	Maternal anemia, hemorrhage, obstetric injury, hypertensive disorder, abnormal fetal heart rate
20	39	Malpresentation	Low transverse	3619		34	40		3785	No	Maternal obstetric injury
21	39	Malpresentation	Low transverse	3883	Maternal anemia	37	40	Labor dystocia	4167	No	Maternal obstetric injury Neonatal metabolic acidosis
22	40	Labor dystocia	.[3]	3713		52	38		3118	Yes	Abnormal fetal heart rate Neonatal observation for infection

Case	INDEX PREGNANCY					Inter-delivery Interval (month)	SUBSEQUENT PREGNANCY				
	Weeks of Gestation	Indication	Incision	Birth weight (gm[1])	Complications		Weeks Gestation	Intrapartum Risk Factors	Birth weight (gm[1])	Obese	Complications
23	40	Hypertensive disorder, labor dystocia	Low transverse	3224		24	39		3314	.[3]	
24	40	Hypertensive disorder, labor dystocia	Low transverse	3459	Maternal hepatorenal syndrome Neonatal umbilical vessel catheterization, respiratory disease	19	39	Labor dystocia, augmentation	4706	.[3]	Neonatal hemorrhagic disease
25	40	Cord prolapse, abnormal fetal heart rate	Low transverse	3856		26	39	Augmentation	2750	No	
26	40	Hypertensive disorder, labor dystocia, abnormal fetal heart rate, failed operative vaginal delivery	Low transverse	3175	Neonatal hemolytic disease, jaundice	30	40	Labor dystocia, augmentation	3770	No	Maternal anemia, hemorrhage
27	40	Hypertensive disorder, malpresentation	Low transverse	2835		24	40	Labor dystocia, augmentation	3175	No	Abnormal fetal heart rate
28	40	Malpresentation	Low transverse	3997		30	40	Augmentation	3798	.[3]	Abnormal fetal heart rate Neonatal low Apgar[3], ventilation, respiratory disease, non-mechanical resuscitation, seizures, observation for infection
29	40	Puerperal infection, other abnormal labor	Low transverse	3521		30	40		3827	.[3]	Maternal bladder injury, abnormal fetal heart rate
30	40	Puerperal infection, hypertensive disorder, labor dystocia, abnormal fetal heart rate	Low transverse	3835		29	40	Labor dystocia	4110	Yes	Abnormal fetal heart rate Neonatal jaundice
31	40	PROM[1], labor dystocia	Low transverse	3402		28	41	Induction, prostaglandin use, labor dystocia, intraamniotic infection	3969	.[3]	Maternal bladder injury, puerperal infection, abnormal fetal heart rate Neonatal respiratory disease, acute tubular necrosis, observation for infection
32	40	Previa with hemorrhage	Low transverse	3373		19	41	Labor dystocia, augmentation	4167	No	Maternal obstetric injury, puerperal infection, wound complication, abnormal fetal heart rate Neonatal jaundice
33	40	Labor dystocia	Low transverse	3969	Maternal obstetric injury, puerperal infection	23	41	intraamniotic infection	3515	No	Maternal puerperal infection, abnormal fetal heart rate Neonatal tachycardia
34	40	Malpresentation, abnormal fetal heart rate	Low transverse	3374		18	.[3]	Labor dystocia	3374	.[3]	Neonatal respiratory disease, non-mechanical resuscitation, scalp injury
35	41	Puerperal infection, abnormal fetal heart rate	Low transverse	3941	Maternal 3rd degree laceration Neonatal ventilation, umbilical vessel catheterization	17	38		3714	.[3]	Maternal obstetric injury, bladder injury
36	41	Puerperal infection, labor dystocia	Low transverse	3799		22	38	Labor dystocia, augmentation, intraamniotic infection	3289	.[3]	Maternal anemia, hemorrhage, puerperal infection, Abnormal fetal heart rate Neonatal observation for infection, spinal tap

Case	INDEX PREGNANCY					Inter-delivery Interval (month)	SUBSEQUENT PREGNANCY				
	Weeks of Gestation	Indication	Incision	Birth weight (gm[1])	Complications		Weeks Gestation	Intrapartum Risk Factors	Birth weight (gm[1])	Obese	Complications
37	41	Labor dystocia	Low transverse	3968		15	38		2636	.[3]	Maternal hemorrhage, hysterectomy, abnormal fetal heart rate
38	41	Labor dystocia, abnormal fetal heart rate	Low transverse	3770		64	39	Augmentation	2485	No	Maternal anemia, hemorrhage, transfusion, postpartum exploratory laparotomy, obstetric injury, retained placenta, hypertensive disorder, precipitate labor Neonatal Temperature dysregulation, hypoglycemia, jaundice
39	41	Malpresentation	Low transverse	3374		57	39	Induction, prostaglandin use	3395	No	Abnormal fetal heart rate
40	41	Labor dystocia, abnormal fetal heart rate	Low transverse	3611	Maternal anemia	29	39		4140	No	Maternal anemia
41	41	Labor dystocia, abnormal fetal heart rate	Low transverse	3856		21	39	Induction, labor dystocia	3771	No	Maternal pelvic floor abnormality, abnormal fetal heart rate
42	41	Suspected macrosomia	Low transverse	4706		45	40	Augmentation	4195	Yes	Maternal obstetric injury, puerperal infection, abnormal fetal heart rate Neonatal low Apgar[3], ventilation, umbilical vessel catheterization
43	41	Herpes simplex virus	Low transverse	3799		23	41	Labor dystocia	3742	No	Maternal obstetric injury
44	41	Labor dystocia	Low transverse	3685		21	41	Augmentation	4309	No	Maternal anemia, hemorrhage
45	41	Labor dystocia, abnormal fetal heart rate	Low transverse	4479		15	41	Labor dystocia	3713	Yes	Maternal anemia, hemorrhage, obstetric injury, failed operative vaginal delivery, abnormal fetal heart rate Neonatal cutaneous hemorrhage, jaundice
46	41	.[3]	.[3]	3572		37	42	Induction	3455	No	Abnormal fetal heart rate

[1] gm = grams, PROM = premature rupture of membranes.

[2] Gestational age based on best clinical estimate. For this patient, we noted discordance with birth weight and concordance with alternative gestational age estimation by last menstrual period of 32 weeks.

[3] . = missing data

[4] Low Apgar defined as less than <5 at 5 or 10 minutes of life.