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Effect of gestational age at the prior cesarean delivery on maternal morbidity in subsequent VBAC attempt

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Abstract

OBJECTIVE—The purpose of this study was to estimate the effect of gestational age at the time of prior cesarean on maternal morbidity in women attempting vaginal birth after cesarean delivery (VBAC).

STUDY DESIGN—A retrospective cohort study of women attempting VBAC, comparing women with a prior cesarean delivery ≤ 34 completed weeks to women with a prior cesarean delivery > 34 weeks. The primary outcome was maternal morbidity, including uterine rupture. Univariable, stratified, and multivariable analyses were used to estimate the effect of a prior cesarean performed at ≤ 34 weeks on maternal morbidities.

RESULTS—Of 19,474 women with 1 prior cesarean, 12,535 attempted VBAC and 508 of those had a previous cesarean ≤ 34 weeks. Study groups had similar risks of uterine rupture (adjusted OR [AOR], 1.5; 95% CI, 0.7–3.5; $P = .32$) and composite morbidity (AOR, 0.9; 95% CI, 0.5–1.8; $P = .81$).

CONCLUSION—Prior cesarean delivery at ≤ 34 weeks' gestation does not appear to increase the risk of maternal morbidity in a subsequent VBAC attempt.

Keywords

maternal morbidity; prior preterm cesarean; uterine rupture; VBAC

The rate of cesarean delivery in the United States has reached a new high, likely due to the increasing number of repeat cesareans and the corresponding decrease in vaginal birth after cesarean (VBAC) attempts with each passing year.¹ Despite the recent publication of 2 large studies supporting their safety,^{2,3} VBAC attempts have continued to decline due to concerns over the risks and complications, particularly uterine rupture. In both of the above studies, the uterine rupture rate was less than 1%. However, these studies are based on patients with prior transverse incisions in the lower uterine segment, the majority of which were made in term or near-term patients.

Some have proposed that VBAC data gathered from patient populations largely composed of subjects with a prior full-term low transverse cesarean delivery cannot be applied to patients whose prior cesarean was preterm.^{4–6} Implicit in these concerns is the question at what gestational age the lower uterine segment is truly developed. If the lower uterine segment develops later in gestation, a transverse incision made in the lower aspect of the

uterus in preterm gestations may confer a higher risk of uterine rupture and maternal morbidity than incisions made near term.

In order to test the hypothesis that a former low transverse cesarean delivery performed at an early gestational age confers a higher risk of maternal morbidity in subsequent VBAC attempts, we performed a cohort study comparing women with one prior cesarean delivery attempting VBAC whose prior cesarean was either at or before 34 completed weeks or beyond 34 completed weeks gestation.

Materials and Methods

This study was a secondary analysis of a retrospective, multicenter cohort study of women with a prior cesarean delivery.² From 1995–2000, 17 community and tertiary centers in the northeastern United States, all with institutional review board approval, participated in a study conducted to evaluate the rate of and risk factors associated with uterine rupture in VBAC attempts. Methods of the retrospective cohort study have been published in detail previously, but a brief description follows.

International Classification of Disease, 9th Revision (ICD-9) codes for “previous cesarean delivery, delivered,” were used to identify subjects at each of the 17 sites and data were extracted from medical charts by trained research nurses using standardized, closed-end data collection forms. Three percent of charts were re-extracted for quality control. Data collected included maternal demographics, medical and obstetric history, and social and family history. Other data collected included details of the index pregnancy, antepartum course, labor and delivery events, complications, and maternal outcomes.

In this analysis, patients with 1 prior cesarean undergoing a VBAC trial were identified and divided into 2 groups: women with a prior cesarean delivery at or before 34 completed weeks gestational age (range, 20–34 weeks) and women whose former cesarean delivery was later than 34 completed weeks’ gestational age. Women were excluded if they had a prior hysterotomy that was not documented as low transverse or more than 1 prior cesarean. Gestational age was defined by the number of completed weeks of gestation. The primary outcomes for this study were major maternal morbidity, including symptomatic uterine rupture and composite maternal VBAC-related morbidity (defined as at least 1 of the following: bladder injury, bowel injury, uterine artery laceration, or uterine rupture), and minor maternal morbidity, including postpartum fever and transfusion requirement. A priori, uterine rupture was defined as a full-thickness separation of the uterine scar as determined at the time of surgery, immediately preceded by nonreassuring fetal monitoring or maternal hemodynamic instability (systolic blood pressure < 70, diastolic blood pressure < 30, or pulse > 120 beats/minute) or by hemoperitoneum at the time of laparotomy. This definition excluded “uterine windows” and incidental scar separations noted at the time of laparotomy. Fever was defined as a postpartum temperature greater than 100.5°F. Need for transfusion, as determined by the physician, was used as a surrogate marker for clinically significant hemorrhage.

A subgroup analysis was performed examining maternal morbidity when the prior cesarean was earlier than 37, 32, or 28 weeks’ gestation. Each subgroup was compared to women whose prior cesarean was performed at ≥ 37 weeks.

We also performed an analysis defining the exposure as the difference in gestational age at delivery between the subsequent pregnancy and the index pregnancy. This definition of the exposure allowed us to consider the possibility that defining the exposure as delivery before or after 34 weeks may have dampened our estimate of the risk association by comparing groups that were heterogeneous. For this subanalysis, the exposure group was defined as

women whose gestational age at their subsequent VBAC was greater than or equal to 6 weeks of gestation later than their gestational age at the time of their prior cesarean. They were compared to women whose gestational age at the time of their VBAC attempt was less than 6 weeks of gestation greater than the gestational age at the time of their prior cesarean. A difference of 6 weeks of gestation was chosen as this difference places patients who were preterm at the time of their cesarean in the exposure group and patients who were term at their prior cesarean in the comparison group.

The exposure and comparison groups were compared with descriptive and bivariate statistics using unpaired *t* tests for continuous variables and chi-square or Fishers' exact tests for categorical variables. Potentially confounding variables of the exposure-outcome association were identified in the stratified analyses. Multivariable logistic regression models for each outcome were then developed to estimate the effect of previous cesarean delivery at 34 weeks on maternal morbidity in subsequent VBAC attempts. Covariates for initial inclusion in multivariable statistical models were selected using results of the bivariate and stratified analyses, and factors were removed in a backward step-wise fashion, based on significant changes in the exposure adjusted odds ratio or significant differences between hierarchical models using likelihood ratio tests. The statistical analysis was performed using STATA, version 8 Special Edition (College Station, TX).

Results

Of the 19,474 women who had undergone one prior cesarean, 12,535 attempted VBAC; 508 of these patients had undergone a previous cesarean at or prior to 34 weeks' gestation (Figure). Compared to women whose previous cesarean was beyond 34 weeks' gestation, women with a former cesarean at or earlier than 34 weeks' gestation were more likely to attempt VBAC (72% vs 62%; RR, 1.2; 95% confidence interval [CI], 1.1–1.2). The 2 groups undergoing a trial of labor were similar with respect to labor type (spontaneous, augmented, or induced) and oxytocin use. Compared to women whose prior hysterotomy was after 34 weeks, women with a prior pre-term cesarean were slightly older and delivered at a slightly later gestational age in the subsequent pregnancy. The preterm cesarean group was also more likely to be of black race, to have had a prior vaginal delivery, and to have a hypertensive disorder. They were less likely to deliver at a university hospital or to have had a prior cesarean delivery for cephalopelvic disproportion (Table 1). The rate of uterine rupture did not vary by hospital. All incidences of uterine rupture occurred in patients at 35 weeks completed gestation or later; the gestational age at uterine rupture did not differ significantly between the 2 groups.

In women with a cesarean delivery at or prior to 34 weeks, 6 (1.2%) experienced a uterine rupture in their subsequent trial of labor, versus 103 (0.9%) in the control group (RR, 1.3; 95% CI, 0.6–3.1). After adjusting for labor type (spontaneous, induced, or augmented) and prior vaginal delivery, this difference remained statistically nonsignificant (adjusted OR [AOR], 1.5; 95% CI, 0.7–3.5; *P* = .32). The risk of major composite complications (uterine rupture, uterine artery laceration, bladder injury, or bowel injury) was not significantly different in women with a cesarean delivery at or prior to 34 weeks (AOR, 0.9; 95% CI, 0.5–1.8; *P* = .81). Rates of minor complications such as blood transfusion (0.4% vs 0.7%; AOR, 0.6; 95% CI, 0.2–2.5; *P* = .49) and postpartum fever (7.4% vs 9.5%; AOR, 0.8; 95% CI, 0.6–1.1; *P* = .18) were similar in the 2 groups (Table 2).

A subgroup analysis was performed dividing women into categories based on a prior cesarean before 37 weeks, before 32 weeks, or before 28 weeks. When compared to women whose previous cesarean was at 37 weeks or later, no difference in the rates of uterine

rupture, composite complications, postpartum fever, and blood transfusion was noted (Table 3).

As a surrogate marker for maternal complications, the rate of failed VBAC attempt was examined. Of women whose prior hysterotomy was performed at ≤ 34 weeks, 91 (18%) had a failed VBAC attempt, compared to 25% of women whose cesarean was at or beyond 34 weeks (RR, 0.7; 95% CI, 0.6–0.9; $P < .01$). After adjusting for confounding variables (African American race, prior vaginal delivery, labor type, diabetes, pregnancy associated hypertension, and prior cesarean indication of cephalopelvic disproportion), the difference in the rate of VBAC failure remained significant (AOR, 0.7; 95% CI, 0.6–0.9; $P < .01$). In subgroup analysis, as the prior cesarean was increasingly at an earlier gestational age, the risk of a failed trial of labor progressively fell from 20% in the less than 37 week group to 10.9% in the less than 28 week group (RR, 0.4; 95% CI, 0.2–0.9).

We initially defined the primary exposure dichotomously based on the actual gestational age in weeks at the time of the cesarean in the index pregnancy (prior cesarean less than 34 weeks' gestation or not). To interrogate the possibility that such a definition may have combined heterogeneous groups (eg, since the subsequent delivery gestational age can vary) we also considered the primary exposure as a difference in gestational age at delivery between the current pregnancy and the index pregnancy. For example, a woman with a prior cesarean at 24 weeks and subsequent VBAC at term would be classified the same as a woman with a prior cesarean at 33 weeks and a subsequent VBAC at 35 weeks. Dividing women into 2 groups, those who delivered 6 weeks or more of gestation later than their gestational age at the time of their prior cesarean delivery and those delivered within 6 weeks of gestation of their gestational age at the time of their previous cesarean delivery, no difference in the rate of uterine rupture was found (1.7% vs 0.9%; AOR, 2.2; 95% CI, 0.8–6.1). No differences in the rate of composite complications, postpartum fever, or blood transfusions were found (Table 4).

Comment

In this large retrospective cohort of women attempting VBAC, women whose prior cesarean was performed at 34 weeks completed gestation or less had a similar rate of major (uterine rupture, bladder injury, bowel injury, uterine artery laceration) and minor (postpartum fever, blood transfusion) morbidity when compared to women whose prior cesarean was performed later than 34 weeks' gestation. Likewise, the difference in gestational age between the index pregnancy and the subsequent pregnancy does not change the rate of major or minor maternal complications.

Others have examined the effect of the gestational age at the time of cesarean delivery and its effect on VBAC complications. Rochelson et al performed a case control study in which 25 cases of uterine rupture were identified, and found that 40% of patients experiencing uterine rupture had had a cesarean delivery prior to 37 weeks, compared to only 10% in the control group.⁴ This study did not assess many confounding variables that could potentially affect the observed associations. A retrospective cohort study by Kwee et al found a uterine rupture rate of 1.1% in women with a prior cesarean delivery that occurred between 26 and 34 weeks gestation.⁵ The findings of this study are concordant with ours; however, the restricted sample size (246 women) limited the investigators' ability to assess rare VBAC-related morbidities.

Sciscione et al recently published a secondary analysis of the MFMU Network Cesarean study, a large prospective cohort study of approximately 40,000 women.^{3,6} They noted a 60% increased risk of uterine rupture in women with 1 prior nonclassical cesarean delivery

before 37 weeks who attempted VBAC in the subsequent pregnancy. While 2 great strengths of that study were the large size and prospective design, some differences exist between the study by Sciscione et al⁶ and our study, which could explain the differing results. First, women with “nonclassic” cesarean deliveries were included in their analysis, which may be a more heterogeneous population than ours since this exposure definition includes nontransverse uterine incisions. Although low vertical incisions do not appear to carry a higher risk of maternal morbidity,^{9–11} inverse T incisions extend into the fundus of the uterus and carry maternal risks similar to that of a classical cesarean.¹² Second, while Sciscione et al⁶ defined the exposure as a prior cesarean before 37 weeks, we chose to define the exposure as a prior cesarean at or before 34 weeks, as the lower uterine segment is likely developed or developing at 34 weeks.

Finally, Sciscione et al⁶ also examined the effect of the gestational age of the subsequent VBAC attempt on uterine rupture. They noted that patients whose cesarean was preterm followed by a term VBAC were more likely to have a uterine rupture than those who delivered pre-term in both pregnancies. We investigated this similarly when we defined the exposure as a VBAC attempt at greater than or equal to 6 weeks gestational age than the gestational age at the time of the prior cesarean. In contrast to the previously published study, we found no difference in the rate of uterine rupture or other maternal complications when patients advanced to 6 weeks or more past the gestational age at the time of their cesarean.

Knowing that failed VBAC attempts are strongly correlated to maternal VBAC morbidity, we examined the rate of VBAC failure based on the timing of the prior cesarean delivery.^{7,8} Women whose prior cesarean was preterm had fewer failed trials of labor. This endorses the finding that maternal morbidity in a VBAC attempt is not increased by the gestational age at the time of the prior cesarean delivery.

Our study has several strengths. First, this is a large cohort that was originally created to identify the rate of and risk factors for uterine rupture. The size of the cohort allows us to report on fairly rare outcomes, and the comprehensive clinical data available for the cohort enables us to assess for potentially confounding factors. Furthermore, uterine rupture was strictly defined, excluding clinically less relevant scar dehiscence and minimizing information bias. To our knowledge, this is the first study to examine the incidence of maternal complications other than uterine rupture as it relates to gestational timing of the initial cesarean.

By design, retrospective cohort studies have potential for selection bias. Specifically, we noted that patients with a prior preterm cesarean were less likely to have a failed VBAC attempt. The decreased failure rate could indicate that these patients were considered “good” VBAC candidates and encouraged to VBAC in antepartum counseling. However, this group was also more likely to attempt VBAC, suggesting that the decreased VBAC failure rate may not be explained by selection bias alone. Another limitation of this study is that neonatal outcomes are not available as this cohort was designed to investigate maternal VBAC-associated risks. Finally, it is important to note that despite our large sample size, the primary outcomes of this study are rare, and thus some measures of effect had limited precision. However, a post hoc power analysis assuming an α error of 0.05, and given the incidence of the outcomes in each of the study groups, indicated that our study has 80% power to detect a relative risk of 2.3 for uterine rupture and of 2.0 for composite maternal morbidity for patients exposed to an initial preterm cesarean. Thus, we would offer that our study was of sufficient size to detect clinically relevant differences in the rates of uterine rupture and composite morbidity between the groups.

Despite these potential study limitations, we feel clinically important conclusions can be drawn. Our study shows that a cesarean delivery at or prior to 34 weeks' gestation does not increase maternal morbidity in the subsequent VBAC attempt, thereby supporting the safety of VBAC in patients whose prior cesarean was preterm. This patient population exposed to a prior preterm cesarean may be counseled regarding subsequent VBAC attempt in a manner similar to patients whose prior cesarean was term.

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FIGURE.
Subjects included in study

TABLE 1

Characteristics of study groups

Variables	Prior C/S 34 weeks (n = 508)	Prior C/S > 34 weeks (n = 12,027)	P value
Maternal age (y)	30.3 ± 5.5	28.5 ± 6.1	< .01
Gravidity	3.4 ± 1.7	3.9 ± 2.0	< .01
Gestational age at delivery this pregnancy (wk)	38.7 ± 2.5	37.4 ± 3.6	< .01
University hospital	234 (46%)	6656 (55%)	< .01
Prior vaginal delivery	246 (48%)	4378 (36%)	< .01
African American race	233 (46%)	3409 (28%)	< .01
Labor type			
Spontaneous	181 (36%)	4168 (35%)	.65
Augmented	159 (31%)	4151 (35%)	.14
Induced	162 (32%)	3482 (29%)	.15
Oxytocin use	190 (37%)	4856 (40%)	.18
Medical problems			
Diabetes	26 (5.1%)	645 (5.3%)	.81
Any PIH (cHTN, gestational hypertension, preeclampsia)	63 (12%)	549 (4.5%)	< .01
Indication for prior cesarean			
Cephalopelvic disproportion	24 (4.7%)	1066 (8.8%)	< .01
Malpresentation	4 (0.8%)	91 (0.8%)	.94
Nonreassuring fetal status	36 (7.1%)	840 (6.9%)	.93
Other	11 (2.2%)	203 (1.7%)	.42

cHTN, chronic hypertension; PIH, pregnancy induced hypertension.

TABLE 2

Complications by gestational age at prior cesarean

Variables	Prior C/S	34 weeks (n = 508)	Prior C/S > 34 weeks (n = 12,027)	RR (95% CI)	Adjusted OR (95% CI)	P value
Uterine rupture	6 (1.2%)	103 (0.9%)	1.3 (0.6–3.1)	1.5 (0.7–3.5) ^a	.32	
Blood transfusion	2 (0.4%)	83 (0.7%)	0.6 (0.1–2.3)	0.6 (0.2–2.5) ^b	.49	
Postpartum fever	38 (7.4%)	1150 (9.5%)	0.8 (0.6–1.1)	0.8 (0.6–1.1) ^c	.18	
Composite complications ^d	9 (1.8%)	256 (2.1%)	0.8 (0.4–1.6)	0.9 (0.5–1.8) ^e	.81	
Failed VBAC	91 (18%)	2982 (25%)	0.7 (0.6–0.9)	0.7 (0.6–0.9) ^f	<.01	

^a Adjusted for labor type and prior vaginal delivery;

^b Adjusted for prior vaginal delivery;

^c Adjusted for labor type, university hospital, and prior vaginal delivery;

^d Includes uterine rupture, bladder injury, uterine artery laceration, and bowel injury;

^e Adjusted for labor type (spontaneous, augmented, induced) and prior vaginal delivery;

^f Adjusted for African American race, prior vaginal delivery, labor type, presence of any diabetes, presence of any pregnancy induced hypertension, history of cesarean for cephalopelvic disproportion.

TABLE 3

Complications by past cesarean subgroups

Variables		Uterine rupture			Composite complications ^a			Blood transfusion			Postpartum fever			Failed VBAC		
		N (%)	Unadjusted RR (95% CI)		N (%)	Unadjusted RR (95% CI)		N (%)	Unadjusted RR (95% CI)		N (%)	Unadjusted RR (95% CI)		N (%)	Unadjusted RR (95% CI)	
Prior C/S	37 wks (n = 11,683)	100 (0.9%)	Ref		250 (2.1%)	Ref		80 (0.7%)	Ref		1118 (9.5%)	Ref		2902 (24.8%)	Ref	
Prior C/S < 37 wks	(n = 852)	9 (1.1%)	1.2 (0.6–2.4)		15 (1.8%)	0.8 (0.5–1.4)		5 (0.6%)	0.9 (0.4–2.1)		70 (8.2%)	0.9 (0.7–1.1)		171 (20.0%)	0.8 (0.7–0.9)	
Prior C/S < 32 wks	(n = 229)	4 (1.7%)	2.0 (0.8–5.5)		5 (2.2%)	1.0 (0.4–2.4)		1 (0.4%)	0.6 (0.1–4.6)		13 (5.7%)	0.6 (0.4–1.0)		32 (14.0%)	0.6 (0.4–0.8)	
Prior C/S < 28 wks	(n = 55)	1 (1.8%)	2.1 (0.3–15.0)		1 (1.8%)	0.9 (0.1–5.9)		1 (1.8%)	2.7 (0.4–18.7)		3 (5.5%)	0.6 (0.2–1.7)		6 (10.9%)	0.4 (0.2–0.9)	

^aIncludes uterine rupture, bladder injury, uterine artery laceration, and bowel injury.

TABLE 4

Complications by delivery timing relative to prior cesarean

Variables	Prior C/S	6 weeks earlier than current gestational age (n = 232)	Prior C/S < 6 weeks earlier than current gestational age (n = 12,303)	RR (95% CI)	Adjusted OR (95% CI)	P value
Uterine rupture		5 (1.7%)	104 (0.9%)	2.0 (0.8–4.9)	2.2 (0.8–6.1) ^a	.12
Blood transfusion		2 (0.9%)	83 (0.7%)	1.3 (0.3–5.2)	1.4 (0.3–5.7) ^b	.65
Postpartum fever		17 (7.3%)	1171 (9.5%)	0.8 (0.5–1.2)	0.7 (0.4–1.1) ^c	.12
Composite complications ^d		5 (2.2%)	260 (2.1%)	1.0 (0.4–2.4)	1.1 (0.5–2.8) ^e	.78
Failed VBAC		40 (17%)	3033 (25%)	0.7 (0.5–0.9)	0.6 (0.5–1.0) ^f	.02

VBAC, vaginal birth after cesarean.

^a Adjusted for labor type and prior vaginal delivery;

^b Adjusted for prior vaginal delivery;

^c Adjusted for labor type, prior vaginal delivery, university hospital, and African American race;

^d Includes uterine rupture, bladder injury, uterine artery laceration, and bowel injury;

^e Adjusted for labor type (spontaneous, augmented, induced) and prior vaginal delivery;

^f Adjusted for African American race, prior vaginal delivery, labor type, presence of any diabetes, presence of any pregnancy induced hypertension, and prior cesarean for cephalopelvic disproportion.