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Obstetric outcomes in women with two prior cesarean deliveries: Is vaginal birth after cesarean delivery a viable option?

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KEY WORDS
Vaginal birth after cesarean delivery
Cesarean delivery

Objective: This study was undertaken to compare clinical outcomes in women with 1 versus 2 prior cesarean deliveries who attempt vaginal birth after cesarean delivery (VBAC) and also to compare clinical outcomes of women with 2 prior cesarean deliveries who attempt VBAC or opt for a repeat cesarean delivery.

Study design: We performed a secondary analysis of a retrospective cohort study, in which the medical records of more than 25,000 women with a prior cesarean delivery from 16 community and tertiary care hospitals were reviewed by trained nurse abstractors. Information on demographics, obstetric history, medical and social history, and the outcomes of the index pregnancy was obtained. Comparisons of obstetric outcomes were made between women with 1 versus 2 prior cesarean deliveries, and also between women with 2 prior cesarean deliveries who opt for VBAC attempt versus elective repeat cesarean delivery. Both bivariate and multivariate techniques were used for these comparisons.

Results: The records of 20,175 women with one previous cesarean section and 3,970 with 2 prior cesarean sections were reviewed. The rate of VBAC success was similar in women with a single prior cesarean delivery (75.5%) compared with those with 2 prior cesarean deliveries (74.6%), though the odds of major morbidity were higher in those with 2 prior cesarean deliveries (adjusted odd ratio[OR] = 1.61 95% CI 1.11-2.33). Among women with 2 prior cesarean deliveries, those who opt for a VBAC attempt had higher odds of major complications compared with those who opt for elective repeat cesarean delivery (adjusted OR = 2.26, 95% CI 1.17-4.37).

Conclusion: The likelihood of major complications is higher with a VBAC attempt in women with 2 prior cesarean deliveries compared with those with a single prior cesarean delivery. In women with 2 prior cesarean deliveries, while major complications are increased in those who

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attempt VBAC relative to elective repeat cesarean delivery, the absolute risk of major complications remains low.

The rate of primary and repeat cesarean delivery continues to rise both in the United States and around the world.[1] Consequently, obstetricians are faced with counseling an increased number of patients with more than one previous cesarean section regarding the mode of delivery. Data describing clinical outcomes in this group of women are based mainly on small observational studies performed at tertiary care hospitals in the United States.[2-8] Currently, American College of Obstetricians and Gynecologists (ACOG) suggests that women with 2 prior low transverse segment cesarean sections can be offered a trial of labor.[9]

Given the relative paucity of data and the increasing number of women with multiple previous cesarean deliveries, we performed a study to assess the efficacy and safety of vaginal birth after cesarean delivery (VBAC) in women with 2 previous cesarean deliveries. We compared clinical outcomes in women with 1 versus 2 previous cesarean deliveries who attempt VBAC and also compared clinical outcomes of women with 2 previous cesarean deliveries who attempt VBAC or opt for a repeat cesarean delivery.

Methods

This is a secondary analysis of a record-based, multicenter, retrospective cohort study (1996-2000) to assess maternal outcomes in women with a previous cesarean delivery. There were 17 participating hospitals in this study, 16 of which were in a defined geographic area of the Delaware Valley (Southeastern Pennsylvania and Delaware). Given that a major goal of this study was to assess clinical outcomes in a group that is representative of the national population, we included both tertiary care hospitals and community hospitals (with and without obstetric/gynecology residency programs). All local Institutional Review Boards approved the conduct of this study.

Subjects with a previous cesarean delivery were identified by an International Classification of Diseases (ICD)-code based search at participating hospitals. The ICD-code used, "previous cesarean delivery, delivered," included both women who had an attempt at VBAC as well as those who underwent a repeat cesarean delivery. The accuracy of this ICD-code was validated in several pilot studies that predated the start of this investigation. Subjects with a fetal demise or known lethal fetal abnormality were excluded.

The medical records from the ICD-based search were requested from participating institutions. A team of trained nurse abstractors reviewed these medical records, using standardized, closed-ended data collection forms. At the start of the study and at several points during the study, the abstractors underwent training to further ensure data validity. In addition, approximately 3% of the medical records were reabstracted for quality assurance purposes. We excluded records of women with a prior classical cesarean delivery. All information was obtained from the inpatient delivery medical record, including information on demographics, obstetric history (including year/method of any deliveries), medical/surgical history, and social history. All information relevant to the index pregnancy was also collected, including any pregnancy complications and all delivery outcomes. We were primarily interested in clinically relevant outcomes, including VBAC success/failure and major maternal complications related to VBAC and elective cesarean delivery, including uterine rupture, major operative injuries, and bladder injuries. Information on lesser maternal morbidities, including postpartum fever (oral temperature $>100.5°F$) and blood transfusion was also collected. We did not attempt to define endometritis, as this can be a subjective diagnosis. We chose to use a more objective measure—postpartum fever—as a measure of postpartum febrile morbidity.

A majority of the clinical outcomes are unambiguous, such as transfusion and bladder injury. Uterine rupture, however, can be difficult to define, and is often confused with an asymptomatic dehiscence of the prior scar. For the purposes of this study, we had defined uterine rupture a priori as separation of the uterine scar (determined at laparotomy), immediately preceded by either a nonreassuring fetal heart rate pattern (determined by the treating obstetrician) or by signs/symptoms of acute maternal bleeding (systolic blood pressure <70 mm Hg, diastolic blood pressure <40 mm Hg, heart rate >20 beats/min) or by the presence of blood in the maternal abdomen at the time of laparotomy. All cases of uterine scar separation were reviewed by the principal investigator (G.M.) to be certain that the classification was accurate.

There were 2 comparisons that we believed were relevant to the care of patients with 2 prior cesarean deliveries. First, we sought to compare clinical outcomes (success/failure and major/minor complications) between women with a single prior low transverse segment (LTS) cesarean delivery and women with 2 previous cesarean deliveries who attempt VBAC. Second, we performed an analysis limited to women with 2 previous

cesarean deliveries, to compare complication rates in women with 2 previous cesarean deliveries who attempt VBAC versus those who elect for a repeat cesarean delivery. Both sets of these comparisons were approached in the same manner. First, descriptive statistics were applied to all risk factors and clinical outcomes of interest. Next, baseline characteristics of women were compared by using unpaired t tests for normally distributed continuous variables, Mann-Whitney U tests for non-normally distributed variables, and χ^2 or Fisher exact tests for categorical variables. Rates of major complications (uterine rupture, bladder injury, major operative injury) were compared initially with the use of bivariate statistics. Separate logistic regression models were fit for each clinical outcome of interest (rupture, bladder injury, major operative injury). Major operative injuries included bowel injury and uterine artery lacerations. We also assessed a "composite major morbidity outcome," which consisted of uterine rupture, bladder injury, or operative injury. We included variables in the regression models if the association with the outcome in the unadjusted analysis had a P value of .15 or less, or if a variable had previously been established to be biologically important.[10]

Results

The charts of 25,005 women with an ICD code for "previous cesarean delivery, delivered" were reviewed. Of these, 20,175 had already had 1 previous cesarean section, 3970 had already had 2 previous cesarean sections, and 863 had already had more than 2 previous cesarean deliveries. Of the 20,175 with 1 prior scar, 12,535 (62.1%) opted for a trial of labor, whereas 7640 (37.9%) underwent a repeat cesarean section. Of the study group with 2 prior scars, 1082 (27.2%) underwent a trial of labor, whereas 2888 (72.8%) had repeat cesarean sections.

Table I displays the characteristics of the women with either 1 or 2 previous cesarean deliveries. These groups were comparable with respect to birth weight, race, delivery at centers affiliated with a university and with a residency program, chronic hypertension, preeclampsia, lupus, and gestational diabetes. As expected, women in the group with 2 prior cesarean sections were older and had had more pregnancies. They were also more likely to have gestational hypertension, diabetes mellitus, and to be smokers (Table I).

Table II compares women with 1 versus 2 previous cesarean deliveries who attempt VBAC. Importantly, rates of induced or augmented labor did not differ appreciably between women with 1 versus 2 previous cesarean deliveries who attempt VBAC. The rate of VBAC success was also similar between these groups (75.5% in those with 1 previous cesarean delivery vs 74.6% in those with 2 previous cesarean deliveries, $P = .50$).

Table III compares major and minor morbidity rates in women who attempt VBAC in those with 1 versus 2 previous cesarean deliveries. Complication rates are

Table I Maternal demographics of the entire study population—women with 1 or 2 previous cesarean deliveries (n = 24,145)

Demographic	One previous cesarean delivery (n = 20, 175)	Two previous cesarean deliveries (n = 3970)	*P* value
Maternal age (y)	30.7	31.9	< .001
Gravidity (n)	3	4	< .001
Gestational age at delivery (wk)	38.4	38.1	< .001
Birth weight (g)	3349	3347	.87
Nonwhite race (%)	38.3	38.4	.85
Community hospital setting(%)	59.0	60.6	.07
Residency program (%)	72.8	72.1	.41
Chronic hypertension (%)	3.3	3.4	.71
Gestational hypertension (%)	3.9	5.2	< .001
Preeclampsia (%)	2.9	2.4	.09
Tobacco use (%)	17.2	19.9	< .001
Lupus (%)	0.3	0.3	.83
Gestational diabetes (%)	5.8	6.2	.28
Diabetes (%)	1.4	2.1	< .001

Table II Bivariate comparison of women who attempt VBAC in those with 1 vs 2 previous cesarean deliveries

Demographic	One previous cesarean delivery (n = 12535)	Two previous cesarean deliveries (n = 1082)	*P* value
Maternal age (y)	30.2	30.9	< .001
Gestational age at delivery (wk)	38.1	38.6	< .001
Birth weight (g)	3349	3347	.87
Nonwhite race (%)	42.4	50.5	< .001
Community hospital setting (%)	55.0	49.7	< .001
Residency program (%)	74.0	78.0	.005
Chronic hypertension (%)	2.8	3.1	.51
Preeclampsia (%)	3.6	3.0	.45
Tobacco use (%)	17.2	19.9	< .001
Cocaine (%)	3.6	6.3	< .001
Gestational diabetes (%)	4.5	4.1	.54
Diabetes (%)	1.1	1.2	.53
Prior vaginal delivery (%)	36.8	35.5	.39
Labor			
Spontaneous (%)	35.4	35.0	.93
Induced (%)	29.7	30.1	
Augmented (%)	34.9	34.9	

Table III Maternal outcomes for women who had a VBAC attempt after 1 or 2 previous cesarean deliveries (n = 13,617)

Outcome	One previous cesarean delivery (n = 12,535)	Two previous cesarean deliveries (n = 1082)	Unadjusted RR (95% CI)	Adjusted OR (95% CI)
Uterine rupture	0.9%	1.8%	2.0 (1.24-3.27)	2.30 (1.37-3.85)
Bladder injury	0.43%	0.55%	1.28 (0.56-2.98)	1.22 (0.52-2.84)
Transfusion	0.68%	0.92%	1.36 (0.70-2.62)	1.24 (0.64-2.41)
Fever	9.50%	8.90%	0.93 (0.77-1.14)	0.82 (0.65-1.04)
Other major operative injury	0.99%	1.02%	1.02 (0.56-1.90)	0.94 (0.49-1.81)
Composite major morbidity*	2.12%	3.23%	1.53 (1.08-2.16)	1.61 (1.11-2.33)

Models adjusted for age, gestational age, labor induction, race, hospital type, tobacco use, cocaine use, and prior vaginal delivery.

* Composite major morbidity defined as uterine rupture, bladder injury, or major operative injury.

Table IV Demographics of women with 2 previous cesarean deliveries and mode of delivery

	Elective repeat cesarean delivery (n = 2888)	VBAC attempt (n = 1082)	*P*
Maternal age (y)	32.1	30.9	< .001
Gestational age (wk)	38.1	38.1	.50
Birth weight (g)	3392	3227	< .001
Chronic hypertension (%)	3.5	3.1	.58
Gestational diabetes (%)	7.0	4.1	< .001
Diabetes (%)	2.3	1.2	.02
Asthma (%)	8.0	8.0	.99
Collagen vascular disease (%)	.65	.46	.47
Preeclampsia (%)	2.2	2.9	.20
Cocaine (%)	2.5	6.2	< .001
Tobacco (%)	18.0	25.0	< .001
Prior vaginal delivery (%)	8.0	35.0	< .001

generally higher in those with 2 previous cesarean deliveries. There were 113 uterine ruptures in the 1 previous cesarean delivery group (0.9%) and 20 ruptures in the 2 previous cesarean deliveries group (1.8%). Prostaglandins were used in approximately 20% of the cases of uterine rupture. Although there were no differences in rates of bladder injuries or major operative complications, composite major morbidity (rupture, bladder injury, major operative complications) were 60% more likely in those with 2 previous cesarean deliveries. Rates of minor morbidity (fever, transfusion) were similar between the 2 groups.

Among women with 2 previous cesarean deliveries, those who undergo an elective repeat cesarean section tend to have a greater frequency of medical problems such as diabetes and gestational diabetes, have slightly larger infants, and a lower frequency of cocaine and tobacco use (Table IV). Women who attempt VBAC more commonly have had a vaginal delivery in the past compared with those who have a repeat cesarean delivery. Table V shows the rates of major and minor complications in the population of women who had 2 previous cesarean deliveries, comparing women who attempted a VBAC with those who underwent a third cesarean delivery. Uterine rupture was more common in those who attempted VBAC, whereas rates of other major complications were similar to those who underwent elective cesarean delivery. Fever was more common in those who underwent elective cesarean delivery, whereas rates of transfusions were similar. Overall, there was a 2.2-fold increase in the risk of major complications in those who attempt VBAC compared with those who undergo repeat cesarean delivery. Two factors in particular were strongly associated with uterine rupture in those who attempted VBAC—induction/augmentation of labor and prior obstetric history. Among women who attempted VBAC, 16 of the 19 ruptures occurred in cases where labor was induced or augmented ($P = .06$). Having had a previous vaginal delivery appeared somewhat protective for uterine rupture, such that the incidence of rupture in those with a previous vaginal delivery was 0.5% compared with 2.4% in those without a previous delivery ($P = .02$). Delivery at a hospital with a residency program did not influence the risk of any major complications.

Comment

With the increasing rate of cesarean delivery, and the inevitability of subsequent pregnancies, the challenge of counseling women with uterine scars is a growing concern. The data presented herein are the result of careful analysis of a large number of women with uterine scars. Novel to this study is the inclusion of subjects from a variety of hospital types and populations, adding to the generalizability of the results. Previously, studies had shown a risk of uterine rupture in women with 1 previous cesarean delivery to be 0.2% to 1.5%.[9,11-15] Our study corroborates this finding (0.9%). When compared with women with 1 prior uterine scar, women with 2 prior uterine scars who underwent a trial of labor were twice as likely to have

Table V Comparison of outcomes in women with 2 previous cesarean deliveries

Outcome	Elective repeat cesarean section (n = 2888)	VBAC attempt (n = 1082)	Unadjusted RR (95% CI)	Adjusted OR (95% CI)
Uterine rupture	0.03%	1.76%	50.7 (6.8-378.4)	29.1 (3.4-246.3)
Bladder injury	0.45%	0.55%	1.23 (0.47-3.23)	1.16 (0.44-3.09)
Transfusion	1.18%	0.92%	0.78 (0.39-1.58)	0.54 (0.23-1.27)
Fever	12.7%	8.87%	0.70 (0.56-0.86)	0.36 (0.25-0.52)
Other major operative injury	0.69%	1.0%	1.47 (0.71-3.05)	1.34 (0.52-3.44)
Composite major morbidity*	1.18%	3.23%	2.74 (1.72-4.38)	2.26 (1.17-4.37)

Models adjusted for maternal age, birth weight, residency program, gestational diabetes, cocaine use, tobacco use, and prior vaginal delivery.
* Composite major morbidity defined as uterine rupture, bladder injury, or major operative injury.

a uterine rupture, with an absolute risk of 1.8%. However, the differences between the 1 and 2 scar groups, in the rates of all other major complications examined in this study, were similar. In addition, the success rates of VBAC attempts were similar (75.5% in the 1 scar group, and 74.6% in the 2 scar group), indicating that once the decision had been made to undergo a trial of labor, patients with 2 scars should be counseled that they are as likely as patients with 1 scar to successfully have a vaginal delivery.

For patients who have undergone 2 previous cesarean deliveries, the most clinically important comparison is the rate of morbidity in those who attempt VBAC compared with those who opt for repeat cesarean delivery. As is the case for women with 1 previous cesarean delivery, the risk of uterine rupture and major complications as a whole is higher with a VBAC attempt than with an elective repeat cesarean delivery.[12] Still, it is important to remember that although the *relative risk* of major complications is increased with a VBAC attempt, the *absolute risk* of such complications is quite small. Furthermore, a majority of the ruptures occurred in women whose labor was either induced or augmented, and in those who had not had a previous vaginal delivery. Thus, it would seem reasonable to target VBAC attempts in this lower risk subgroup (ie, those with a previous vaginal delivery) and to avoid interventions such as labor induction or augmentation.

Other studies have examined maternal outcomes in women who underwent a trial of labor, having had 1 or more prior cesarean sections. Miller et al[16] published 1 of the largest retrospective cohort studies, involving 17,322 patients with uterine scars. They found a 3-fold increased risk in uterine rupture in the group with at least 2 previous cesarean delivery compared with 1 previous cesarean delivery (which was statistically significant). They concluded that this is an acceptable risk difference to encourage a trial of labor. Other smaller studies have also looked at outcomes comparing the 1- and 2-scar groups having a trial of labor. Caughey et al[17] found a 4-fold adjusted increased risk of uterine rupture in the 1-scar group as compared with the 2-scar group. In comparison, Martin et al[5,18] and Novas et al[6] compared the same two groups, but they found no statistically significant difference in the rate of uterine rupture between women with one scar and those with two who underwent a trial of labor. All three of these studies were limited by size, making uterine rupture risk a difficult outcome to assess because the incidence of uterine rupture is low. Additionally, few prior studies compare outcomes of VBAC attempt vs. repeat cesarean in women with 2 previous cesarean deliveries.

The strengths of this study are not only in the large number of patients enrolled (the largest series to date), but also in the level of detail that was obtained for each patient. Specifically, the variables included were fairly comprehensive. Although an inherent weakness of retrospective studies is that they are dependent on the original data collection, this study design was optimized for data collection accuracy by having trained nurses abstract the data in a standardized, closed-end fashion and by employing quality assurance measures. Additionally, the data was categorized with narrow definitions, leaving little ambiguity to the clinical significance of outcomes. The use of a multi-center design, including data from both community and tertiary care hospitals, helps assure that the population studied is diverse and makes the results more generalizable. Despite these strengths, there are some weaknesses as well. There was inherent selection bias, due to the retrospective study design, as to how physicians/patients decide whether a VBAC trial or elective cesarean is selected. A second limitation relates to the fact that this study addresses only short term consequences of whether a subject with 2 prior cesareans opts for a VBAC attempt or elective repeat cesarean. As the number of prior cesareans increases, in subsequent pregnancies, surgical complications increase as do rates of placenta previa and accreta.[19] Thus, there may be long-terms implications to consider in strategies that include multiple repeat cesareans (especially for women planning large families).

In conclusion, this study confirms that the risk of uterine rupture with a trial of labor is higher in women with two prior cesarean deliveries than with one. Although the relative risk of uterine rupture and major

complications is increased in those who undergo a trial of labor compared to those who opt for a repeat cesarean, the absolute risk of major morbidity is small. Based on these data, A VBAC attempt still seems to be a reasonable option in appropriately counseled and managed women with 2 prior cesareans.

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Discussion

Dr Jay D. Iams, Columbus, Ohio. I would like to thank the Society for the opportunity to discuss Dr Macones's presentation, and to thank Dr Macones for providing me with his manuscript in a timely fashion. He and his colleagues have performed a secondary analysis of a retrospective, cohort study of data collected at 16 hospitals from the charts of almost 25,000 women who delivered after having had 1 or 2 prior cesarean births. The primary outcome of the study was to compare the rate of maternal complications according to the number of previous cesarean births, 1 versus 2. A secondary outcome was to compare the outcome in women with 2 prior cesarean births who chose a repeat cesarean section versus those who chose a trial of labor.

The study is distinguished first by its size: there were more than 20,000 women with 1, and almost 4000 women with 2 prior cesarean deliveries. This report is also notable for its "generalizability" to community practice. Because the women in this study were cared for at community as well as tertiary hospitals, the findings may be more widely applicable than similar studies from large urban teaching centers.

Dr Macones reported a 1.5- to 2-fold increase, from about 1% to 2%, in the rate of maternal complications in women who attempt a trial of labor after 2 cesarean births compared with a first attempt at VBAC. Among women with 2 previous cesarean births, a trial of labor carried a 2-fold increase risk of composite morbidity when compared with a repeat cesarean birth.

My questions for Dr Macones are these:

1. This is a secondary analysis of data collected for a study performed for another reason. Please describe the primary study and address any sources of bias in your data presented today that might have been created by the original study design.
2. In this retrospective analysis, specially trained nurses abstracted data for the study. What steps were taken to make sure that the data was accurately retrieved from the charts? The study nurses received training before the study—did they all receive repeated training? Was the data quality similar at all hospitals? For example, was there a difference in the quality of data from large versus small hospitals?
3. Women with a history of a classical uterine incision were intentionally excluded. How many had a classical incision? What about women with a "low vertical" incision, or with an extension of their transverse scar into the cervix or corpus? How many such women were there? Do the authors have data for the latter, group?
4. Landon et al found a modest but significantly increased rate of hypoxic ischemic encephalopathy in infants born to women who elected VBAC in the MFMU Network study presented at SMFM in February. Do you have any neonatal data?
5. You included uterine rupture, bladder injury and operative injury in your "composite morbidity."