Vaginal Birth After Cesarean and Uterine Rupture Rates in California

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Objective: **To describe attempted and successful vaginal birth after cesarean (VBAC) rates and uterine rupture rates for women with and without prior cesareans, and compare delivery outcomes in hospitals with different attempted VBAC rates.**

Methods: **We used California hospital discharge summary data for 1995 to calculate attempted and successful VBAC rates and uterine rupture rates. We used multivariate logistic regression models to evaluate and adjust for age, ethnicity, and payment source. We report the relative risk (RR), attributable fraction, and 95% confidence intervals (CIs) for uterine rupture.**

Results: **There were 536,785 delivery discharges during 1995. The cesarean rate was 20.8%, and 12.5% of women had histories of cesareans. Of women with histories of cesareans, 61.4% attempted VBAC and 34.8% were successful. There were 392 uterine ruptures (0.07%). Women with prior cesareans were 16.98 (95% CI 13.51, 21.43) times more likely to experience uterine rupture, attributable fraction 66% (95% CI 60%, 73%). Among women with prior cesareans, those who attempted VBAC were 1.88 (95% CI 1.45, 2.44) times as likely to have uterine rupture, attributable fraction 34% (95% CI 21%, 46%). Women who delivered in hospitals with high attempted VBAC rates were less likely to have cesarean deliveries, more likely to have successful VBACs, and more likely to experience uterine ruptures.**

Conclusion: **Uterine rupture occurs at a low rate in women with and without prior cesarean delivery. Risk of rupture is increased among women with prior cesarean delivery and among those who attempt VBAC. (Obstet Gynecol 1999;94: 985–9. © 1999 by The American College of Obstetricians and Gynecologists.)**

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Since the National Institute of Health Consensus Conference on Cesarean Childbirth in 1980, there has been much interest in the cesarean rate in the United States.[1] Policymakers suggested changes in clinical practice that would bring the rate down to 15% by the year 2000.[2] In 1980, leading indications were repeat cesarean and dystocia, followed by "fetal distress," breech, and other.[1,3] Although multiple strategies for lowering the cesarean rate were suggested, widespread vaginal birth after cesarean (VBAC) was considered a primary goal because it would affect the largest number of women, those who would otherwise have repeat cesarean deliveries.[1,4] Aiming to lower the national cesarean rate, the Department of Health and Human Services targeted a VBAC rate of 35%.[2]

Although ACOG did not set specific numeric goals for VBAC, it stated recently that VBAC is the preferred method of delivery unless there are specific medical or obstetric contraindications to labor.[5] In a separate document, ACOG suggested that hospital experience with VBAC should be monitored by following the numbers of successful VBACs and women attempting VBACs.[6]

The relative safety of VBAC has been cited in the literature since the early 1900s,[7] and was well summarized in a recent review.[8] Despite early experience with VBAC, the practice was not popularized or endorsed in the United States until the early 1980s.[1,5,9] Maternal complications of VBAC include uterine rupture, hemorrhage requiring transfusion or hysterectomy, and infection. Neonatal complications include birth trauma, and those related to prolonged hypoxia (eg, birth asphyxia and death). Most of the early work on safety and morbidity of VBAC in the United States came from tertiary care academic hospitals,[10–12] although there are reports from private hospitals.[13,14] The results of those institutionally based studies might not be generalizable to other clinical settings. The purpose of this study was to describe attempted labor rates, successful VBAC rates, and uterine rupture rates for women with and

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without prior cesareans within a large, population-based sample.

Materials and Methods

We obtained 1995 discharge data from the California Office of Statewide Health Planning and Development. We extracted all cases related to childbirth (diagnosis-related group codes 370–375) to derive a study population that included all hospital deliveries in the state of California for 1995. We abstracted the demographic variables of age, race-ethnicity, and payment source and identified delivery hospitals. Latina assignment was made if ethnicity was specified as Hispanic, regardless of race. Otherwise, black, white, and other (Native American, Asian, Pacific Islander, unknown) categories were assigned. Payment sources were grouped as all government sources together (eg, Medicaid, Medicare, Champus), health maintenance organization, prepaid provider organization, Blue Cross/Blue Shield that were non–health maintenance organization non–prepaid provider organization, private insurance, and self-pay. A separate miscellaneous category was used for other types, including unknown sources.

Women were classified with histories of cesarean deliveries if the International Classification of Diseases, 9th Revision, clinical modification (ICD-9-CM) discharge diagnostic code 654.2 was present. We used a previously developed algorithm to classify women who had cesareans into elective cesarean (without labor) or cesarean after labor.[15] Women were identified as having labored if they had vaginal deliveries based on diagnosis-related group codes 372–375, or cesarean deliveries (diagnosis-related group codes 370, 371) plus any of the ICD-9-CM codes consistent with labor: 653 (disproportion), 660 (obstructed labor), 661 (abnormal uterine forces), 662 (long labor), 652.1 (successful version), 659 (failed induction), 656.3 (fetal distress), or 663 (cord complications).

Delivery outcomes for women with histories of cesareans were divided into three categories: VBAC, cesarean delivery after labor (repeat cesarean, failed VBAC), and cesarean delivery without labor (elective repeat cesarean). Women without histories of cesarean also were divided into three delivery categories: vaginal, primary cesarean with labor (primary cesarean, failed labor), and primary cesarean without labor (elective primary). These classifications allowed us to calculate cesarean rates, VBAC rates, and uterine rupture rates associated with and without labor. The ICD-9-CM codes 665.0 and 665.1 were used to identify women with diagnoses of uterine rupture.

We studied uterine rupture for three populations, first calculating the risk among all women with and without prior cesareans, then calculating the risk of uterine rupture with and without labor for all women with histories of cesareans, and finally, calculating the risk of rupture for all women delivering in hospitals with high attempted VBAC rates and low attempted VBAC rates. A high attempted VBAC rate hospital was defined as that in which at least 60% of women with prior cesareans had labor. The attempted VBAC rate was calculated as successful VBAC subjects plus repeat cesarean subjects who failed VBAC divided by total number of women with prior cesareans. For that part of the analyses, we excluded 38 hospitals with fewer than 200 deliveries or hospitals that did not have any cases of women with histories of cesarean delivery. We used logistic regression models when appropriate to evaluate and adjust simultaneously for age, ethnicity, and payment source. The SAS System for Windows, release 6.12 (SAS Institute, Cary, NC) was used to perform calculations; $P < .05$ was defined as statistically significant. Means are expressed $\pm$ the standard deviation (SD). Relative risks (RR) and 95% confidence intervals (CIs) were calculated and adjusted for confounding where appropriate.

The attributable fraction for the population was defined as the maximum proportion of potential uterine rupture cases that could be prevented hypothetically if the exposure to prior cesarean or attempted VBAC could be eliminated completely. Because uterine ruptures can occur among women with no prior cesareans,[16–19] we calculated the attributable fraction for the entire birth cohort when the exposure or risk factor was prior cesarean delivery. Uterine ruptures can occur with or without labor, so we also calculated the attributable fraction for women with prior cesareans when exposure or risk factor was labor (ie, VBACs and repeat cesareans, failed VBAC groups). For example, the attributable fraction was calculated as the risk of uterine rupture for all women with prior cesareans minus the risk of uterine rupture for women without prior cesareans divided by the risk of uterine rupture for women without prior cesareans.

Results

There were 536,785 delivery discharges in California for calendar year 1995. The population demographics are shown in Table 1. The overall cesarean rate was 20.8% (111,374 of 536,785), and it varied by age, ethnicity, and payer source. Table 2 lists methods of delivery and uterine rupture rates for women with and without previous cesareans. Women with histories of cesarean delivery represented 12.5% (66,856) of all deliveries. For women with histories of cesareans, 40.3% had elective repeat cesarean deliveries and the remainder attempted

Table 1. Population Study Characteristics and Cesarean Rates

Demographics	*n* (%)	Cesarean (%)
Ethnicity		
White	208,577 (38.9)	21.8
Hispanic	226,526 (42.2)	19.8
Black	36,522 (6.8)	23.6
Other	56,915 (10.6)	19.3
Unknown	8245 (1.5)	19.9
Age (y)		
Age ≥35	71,815 (13.4)	29.3
Age <35	464,970 (86.6)	19.4
Payment source		
Government*	261,297 (48.7)	20.0
HMO	160,130 (29.8)	20.5
PPO	64,669 (12.1)	23.9
Private	19,071 (3.6)	23.6
Self-pay	19,069 (3.6)	16.9
BC/BS	11,328 (2.1)	24.7
Miscellaneous	1221 (0.2)	19.2

HMO = health maintenance organization; PPO = preferred provider organization; BC/BS = Blue Cross/Blue Shield (non-HMO, non-PPO).

* Government includes Champus.

Table 3. Coefficient Estimates and Relative Risks of Models for Demographic Variables and Uterine Rupture

Variable	PE	SE	RR	95% CI	*P*
All women (*n* = 536,785)*					
Intercept	−9.89	0.27			<.001
Prior cesarean delivery	2.83	0.12	16.98	13.51, 21.34	<.001
Age (10-y intervals)	0.05	0.01	1.67	1.39, 2.00	<.001
Private insurance	0.04	0.11	1.04	0.84, 1.29	.72
White	0.07	0.11	1.07	0.86, 1.32	.55
Women with prior cesarean deliveries (*n* = 66,856)†					
Intercept	−7.09	0.35			<.001
Labor	0.63	0.13	1.88	1.45, 2.44	<.001
Age (10-y intervals)	0.04	0.01	1.44	1.16, 1.80	.001
Private insurance	0.08	0.13	1.09	0.84, 1.40	.53
White	0.16	0.13	1.19	0.92, 1.51	.19

PE = parameter estimate; SE = standard error; RR = relative risk; CI = confidence interval.

* Hosmer-Lemeshow goodness of fit = 2.36 (*P* = .97); Mean deviance = 0.01.

† Hosmer-Lemeshow goodness of fit = 4.05 (*P* = .26); Mean deviance = 0.05.

VBAC. Of the 39,096 women who attempted VBAC, 24,024 (61.4%) were successful. Those successful VBACs account for 35.9% of all deliveries among women with prior cesarean deliveries.

The uterine rupture rate was 0.07% (392 of 536,785) for all deliveries, and the uterine rupture rate was 0.43% (288 of 66,856) for women with prior cesareans. For women with histories of cesarean deliveries, the unadjusted RR for uterine rupture was 19.5 (95% CI 15.6, 24.4) compared with women with unscarred uteri (data not shown). Using logistic regression models, age, but not ethnicity or payer source, was associated with uterine rupture (Table 3). The RR for uterine rupture, when adjusted continuously for maternal age, was 16.98 (95% CI 13.51, 21.43), when calculated at the mean age of 27 years. The attributable fraction estimate (the proportion of all cases of uterine rupture attributable to having prior cesarean scars) was 66% (95% CI 60%, 73%).

Table 2. Delivery Method and Unadjusted Uterine Rupture Rates

	Deliveries (*n* = 536,785)		Ruptures (*n* = 392)	
	n	%	*n*	%
Women with prior cesareans (*n* = 66,856)				
No labor				
Elective repeat cesarean	27,760	5.17	79	0.28
Labor				
Repeat cesarean (failed VBAC)	15,072	2.81	174	1.15
VBAC	24,024	4.48	35	0.15
Total	66,856	12.45	288	0.43
Women without prior cesarean (*n* = 469,929)				
No labor				
Elective primary cesarean	17,209	3.21	13	0.08
Labor				
Primary cesarean (failed labor)	51,333	9.56	64	0.12
Vaginal delivery	401,387	74.78	27	0.01
Total	469,929	87.54	104	0.02

VBAC = vaginal birth after cesarean.

Considering only women with histories of cesareans, the unadjusted RR for uterine rupture among women who attempted VBAC was 1.88 (95% CI 1.45, 2.44) compared with women not undergoing labor. Maternal age contributed to the risk of uterine rupture, whereas payment source and ethnicity did not significantly affect the RR when examined using logistic regression models. The attributable fraction estimate (the proportion of all cases of uterine rupture among women with prior cesareans attributable to attempting VBAC) was 34% (95% CI 21%, 46%).

We calculated the attempted VBAC rate and uterine rupture rate for all hospitals, after excluding those with fewer than 200 deliveries or no women with histories of cesareans to examine whether hospitals that have VBAC attempt rates of at least 60% had increased uterine ruptures. There were 331 hospitals reporting delivery discharges; 38 were eliminated. This left 534,937 deliveries (99.6%) at 293 hospitals, of which 134 (46%) had attempted VBAC rates of at least 60%. The results of the analysis are presented in Table 4. Women who delivered at hospitals with high attempted VBAC

Table 4. Rates of Cesarean, Vaginal Birth After Cesarean, and Uterine Rupture by High and Low Attempt

Population	Cesarean rate	VBAC rate	Rupture rate
Women who delivered at high VBAC hospitals (n = 286,007)	18.5%	65.0%	0.088%
Women who delivered at low VBAC hospitals (n = 248,930)	23.3%	55.6%	0.056%
Relative risk (95% confidence intervals)	0.80 (0.79, 0.81)	1.17 (1.15, 1.19)	1.56 (1.27, 1.92)

VBAC = vaginal birth after cesarean.

rates were less likely than women delivering in hospitals with low attempted VBAC rates to have cesarean deliveries (RR 0.80; 95% CI 0.79, 0.81) and more likely to have successful VBACs (RR 1.17, 95% CI 1.15, 1.19), and uterine ruptures (RR 1.56, 95% CI 1.27, 1.92).

Discussion

Our denominator for women with prior cesareans and VBAC is the largest reported to date, and included a population that was ethnically diverse and represented all payment sources and all hospital types within California. The findings should reliably estimate the risk of uterine rupture by averaging variation across practice settings.

California has achieved the Healthy People 2000 goal for successful VBACs (35%), a rate higher than the national average of 25%.[20] The overall uterine rupture rate for all women (0.07%) and those with prior cesareans (0.43%) was similar to previous institutionally based estimates.[14,21,22] Using multivariate logistic regression to adjust for potential confounders in a large population, we were able to confirm that the predominant risk factor for uterine rupture was prior uterine scar; however, there appeared to be an independent age effect as well. Although ethnicity and payer source were independent risk factors for cesarean, they did not appear to be risk factors for uterine rupture. Among women with histories of cesareans, uterine rupture was 1.9 times more likely if a trial of labor was attempted; however, only 34% of uterine ruptures among women with histories of cesareans were attributable to labor.

We found that women who delivered at hospitals with higher trial of labor rates did have slightly higher absolute risks of uterine rupture. From the population perspective that occurred with the benefits of decreased overall cesarean rates (and associated decreased clinical morbidities) and increased VBAC success rates. A similar association between increased trial of labor and increased uterine rupture rates was observed in other settings in which efforts have been used to increase trial of labor.[22] Flamm et al reported increased trial of labor from 36% to 70% over an 8-year period, which was associated with an increased incidence of uterine rupture from 0.2% to 0.8% (average 0.5% for 8-year period).

Several limitations are inherent in this study. Secondary administrative data do not allow us the opportunity to objectively define uterine rupture. Thus, there is a risk for misclassification or ascertainment bias. For example, the increased incidence of uterine ruptures reported by Flamm et al could be attributed to a less rigorous interpretation of case definitions for uterine rupture at their institution.[22] They defined uterine rupture as defects involving the entire uterine wall or that were symptomatic and required operative intervention compared with the more rigorous definition of catastrophic rupture requiring extrusion of fetal parts, operative repair, or hysterectomy used by other investigators.[22–24]

We were not able to associate those findings with clinical data that might be useful, such as parity or specific number of prior cesareans. Our findings showed that age is a significant predictor for uterine rupture; however, the analysis cannot determine the significance of the age variable. Is it the chronological age that is important, or is age acting as a proxy for important clinical variables such as parity or number of prior cesareans? Previous studies demonstrated that risk of uterine rupture increases with subsequent cesareans.[24] Although we used an algorithm to assign women to labor and nonlabor categories, it is possible that some misclassification of labor status occurred due to coding errors, or lack of specificity of the algorithm. Simply stratifying women into labor or nonlabor categories might not be enough to elucidate risk of uterine rupture. Leung et al,[25] using detailed chart review, showed that there are certain labor characteristics associated with uterine rupture (eg, protraction or arrest disorders). The data set does not include neonatal outcome, which would allow us to estimate the risk of neonatal injury associated with uterine rupture.

Despite limitations, our findings support recommendations by the National Institute of Health and the Department of Health and Human Services that cesarean rates can be reduced by widespread VBAC. Using ACOG clinical indicators, we also showed that increased attempts at VBAC are associated with greater success at VBAC, which suggests that clinical practices at high-attempt VBAC hospitals might be different from those at low-attempt VBAC hospitals. Further exploration of the findings through patient-specific clinical data is warranted. Finally, in this ethnically diverse, population-based study, the uterine rupture rate for women

attempting a trial of labor was 0.43%. This corroborates the relative safety of VBAC, with respect to uterine rupture, that has been demonstrated in smaller, institutionally-based samples.

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