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Is Early Amniotomy Associated with Higher Likelihood of Vaginal Birth after Cesarean?

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Abstract

Objective The study aims to reduce cesarean rates, eligible women are being offered an option of vaginal birth after cesarean (VBAC). However, little data exist regarding efficacy of amniotomy as a tool in this population. We sought to evaluate the impact of early amniotomy on VBAC success.

Study Design This is a secondary analysis case-control study using the MFMU (Maternal-Fetal Medicine Units Network) Cesarean Registry. Women were included if they had a singleton pregnancy, were attempting VBAC, and underwent induction with artificial rupture of membranes. Cases were defined as subjects with successful VBAC; controls were defined as subjects with failed trial of labor after cesarean (TOLAC). Early amniotomy was defined as amniotomy at <4 cm. Demographic and obstetric characteristics were compared and multivariate logistic regression was performed.

Results A total of 1,490 women were included. Early amniotomy occurred in 59.5% with VBAC versus 63.2% with failed TOLAC ($p = 0.24$). After controlling for body mass index, prior vaginal delivery, African–American race, labor length, gestational age, birthweight, epidural use, Foley catheter balloon ripening, induction method and oxytocin use, early amniotomy was associated with a 34% decrease in VBAC success ($p < 0.01$). Women who had early amniotomy did not have higher rates of chorioamnionitis (2.8 vs. 2.9%, $p > 0.99$).

Conclusion Unlike data from nulliparous women, our data suggest that induction with early amniotomy does not increase the likelihood of VBAC.

Keywords

- induction
- amniotomy
- TOLAC
- vaginal birth after cesarean

In 2016, the overall cesarean delivery rate was 32%.[1] In the last few years, there has been a small decrease in the cesarean rate, but this is still a drastic increase from the historical rate of 5% in 1970. The vaginal birth after cesarean (VBAC) rate was 10% in 2012 despite estimated success rates of 70 to 80%.[2,3] This is a significant decline from a peak of 23% in 1996.[4,5] Vaginal delivery affords decreased blood loss, decreased infection risk, and other maternal and neonatal benefits over cesarean delivery and thus should be preferred in the appropriate clinical setting. Improving rates of VBAC can help drive down the overall rate of cesarean section and decrease delivery-related morbidity and mortality.

For women who have medical indications for delivery, induction is often recommended. Multiple studies have been conducted to evaluate possible improvements on induction of labor.[6–8] Clinical trials have been performed assessing the effectiveness of artificial rupture of membranes in both spontaneously laboring patients and during the induction of nulliparous patients.[9] Both studies showed a reduction in the time to delivery without a significant impact on the cesarean delivery rate.[6,10]

The evidence suggests that women undergoing induction are less likely to achieve a successful trial of labor after cesarean (TOLAC).[11] In the United States, women undergoing

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induction of labor after cesarean are typically restricted to mechanical dilation via Foley balloon catheter, oxytocin administration and/or artificial rupture of membranes. Factors that impact the odds of a successful TOLAC include maternal body mass index (BMI), history of prior vaginal delivery, and the indication for prior cesarean section.[9,11] The primary aim of this study is to determine whether early amniotomy (at less than 4 cm) affects the success rate of TOLAC. By understanding factors that improve the chance of VBAC, we can optimize our chances of successfully reducing the morbidity and mortality associated with the high cesarean delivery rate.

Materials and Methods

We performed a secondary analysis of the Maternal-Fetal Medicine Units Network (MFMU) Cesarean Registry dataset.[11] The original MFMU Cesarean Registry was created with the primary purpose of evaluating factors that influence the likelihood of a successful VBAC after one prior cesarean section. Inclusion criteria for this large multicenter prospective observational study included women with one prior cesarean with term singleton pregnancies (known low transverse scar or unknown scar) undergoing trial of labor. Demographic information was collected including maternal characteristics and obstetrical characteristics such as prior incision type, previous cesarean delivery, and prior successful VBAC.

Inclusion criteria for this secondary analysis include women with a vertex, singleton pregnancy with an estimated gestational age of equal to or greater than 37 weeks, and a history of at least one prior cesarean delivery who underwent induction that included amniotomy. Exclusion criteria include preterm gestational ages, multiple gestations, fetuses with known congenital anomalies, stillbirths, and patients with missing amniotomy or delivery data. The MFMU Cesarean Registry dataset was built by trained study nurses who reviewed all available medical records. Data regarding demographics, obstetric and medical history, and intrapartum events were obtained. Receipt of prenatal care was defined by the original study as having two or more prenatal visits, not including visits to the emergency room. Labor length was defined as time of first step of induction to delivery. Nonreassuring fetal status was defined as a failed nonstress test. While additional obstetrical data were collected in the original study, indication for prior cesarean section was not released in the MFMU dataset available for this study. Timing of oxytocin administration versus artificial rupture of membranes (AROM) was not captured in the parent dataset. This study was considered exempt from the Institutional Review Board (Pro00057547).

Statistical Analysis

Early amniotomy was defined as amniotomy at less than 4-cm cervical dilation, and was defined as the exposure of interest. A secondary exposure of interest was amniotomy at less than 6-cm cervical dilation. Women with successful VBAC are classified as cases. Controls were defined as women who had failed TOLAC. The two study groups (successful VBAC vs. failed TOLAC) were compared using bivariate statistics as appropriate. Multivariate logistic regression was performed to adjust for potential confounding factors using backward stepwise regression with variables with $p < 0.2$ remaining in the final model to predict factors associated with successful VBAC. Confounding variables in this model included BMI, prior vaginal delivery, African–American race, Medicaid insurance, labor length, gestational age at delivery, birthweight, epidural use, Foley catheter balloon ripening, and oxytocin use.

A second model was run to assess the impact of amniotomy performed at less than 6-cm cervical dilation. All variables that were statistically significant in the bivariate analysis at $p < 0.2$ were included. Similar to the first model, multivariate logistic regression was performed to adjust for potential confounding factors using backward stepwise regression with variables with $p < 0.2$ remaining in the second model to predict factors associated with successful VBAC. In the second model, confounding variables included BMI, prior vaginal delivery, Medicaid insurance, African–American race, labor length, gestational age at delivery, birthweight, epidural use, Foley catheter balloon ripening, and oxytocin use.

Nominal two-sided *p*-values and adjusted odds ratios are reported. Analyses were performed using Stata software (Version 14.0; Stata Corporation LLC, College Station, TX).

Results

Of the 14,529 women included in the original MFMU Cesarean Registry Study, 1,490 women met inclusion criteria for our secondary analysis. In the study cohort, 1,134 (76.1%) women had a successful VBAC and 356 (23.9%) had a failed TOLAC.

Controls tended to be older, to have a higher BMI, to be of African–American race, to have Medicaid, and to be undergoing a postdates induction (all $p < 0.05$, ►**Table 1**). Several obstetric and delivery characteristics were notably different between cases and controls including gestational age at delivery, cervical dilation at admission, and epidural use (►**Table 2**). No significant differences were noted in delivering provider (via midwife 3.7 vs. 3.0%, $p = 0.60$) or percentage of those with labor shorter than 24 hours (99.2 vs. 99.8%, $p = 0.09$) for failed TOLAC versus successful VBAC, respectively (►**Table 2**). Methods for induction also differed among the two groups. Foley balloons were more common in the failed TOLAC group (14.9 vs. 6.7%, $p \leq 0.01$), while oxytocin use, though common in both groups, was used less in this group (88.8 vs. 94.3%, $p \leq 0.01$). A total of 59.5% of women with successful VBAC versus 63.2% with failed TOLAC underwent early amniotomy prior to 4-cm dilation ($p = 0.24$). Additionally, 89.3% of women with VBAC versus 91.2% of women with failed TOLAC underwent amniotomy at fewer than 6 cm ($p = 0.30$).

When controlling for confounders, early amniotomy at fewer than 4 cm was associated with a 34% reduction in successful VBAC (adjusted odds ratio [aOR] 0.66; 95% confidence interval [CI] 0.48–0.90; ►**Table 3**). Amniotomy at fewer than 6 cm was not associated with failed TOLAC (aOR 0.93; 95% CI 0.57–1.53). Of note, the rate of chorioamnionitis did not differ between women who had early amniotomy (<4 cm) and those who did not (2.8 vs. 2.9%, $p > 0.99$).

Table 1 Baseline characteristics

Variable	Failed TOLAC $n = 356$ (%)	Successful VBAC $n = 1134$ (%)	*p*-Value
Median age, y, (IQR)	30 (25, 33)	31 (26, 35)	<0.01
Median BMI at delivery, (IQR)	32.5 (29.0, 37.2)	30.4 (27.0, 35.0)	<0.01
Prior vaginal delivery	113 (31.8)	727 (64.3)	<0.01
African–American	96 (27.0)	134 (11.8)	<0.01
Diabetes	27 (7.6)	91 (8.0)	0.91
Receiving prenatal care	350 (98.3)	1131 (99.7)	0.01
Medicaid	119 (33.4)	258 (22.8)	<0.01
Chronic hypertension (on medication)	5 (1.4)	18 (1.59)	>0.99
Group B *Streptococcus* (Rectovaginal culture/PCR positive)	65 (52.0)	225 (62.2)	0.06
Postdates induction[a]	126 (35.4)	238 (21.0)	<0.01
Nonreassuring fetal status induction	36 (5.9)	21 (3.2)	0.026
Elective induction	100 (28.1)	494 (43.6)	0.01
Hypertensive disorder of pregnancy induction	30 (8.4)	68 (6.0)	0.11

Abbreviations: BMI, body mass index; IQR, interquartile range; TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.
[a]Defined as EGA at or greater to 41 weeks.

Table 2 Obstetric and delivery outcomes

Variable	Failed TOLAC $n = 356$ (%)	Successful VBAC $n = 1134$ (%)	*p*-Value
Gestational age at delivery, wk, (IQR)	40.1 (39.0, 41.1)	39.4 (38.7, 40.4)	<0.01
Admission cervical dilation, cm (IQR)[a]	2 (1, 3)	2 (1, 3)	<0.01
Foley catheter cervical ripening	53 (14.9)	76 (6.70)	<0.01
Oxytocin use	316 (88.8)	1069 (94.3)	<0.01
AROM <4 cm	225 (63.2)	675 (59.5)	0.24
AROM <6 cm	318 (89.3)	1034 (91.2)	0.30
Dilation at rupture, cm, (IQR)[a]	3 (2, 4)	3 (2, 4)	0.02
Time from AROM to delivery time, h, (IQR)	8.82 (5.55,11.8)	5.57 (3.57, 8.17)	<0.01
Epidural	298 (83.7)	1032 (96.0)	<0.01
Labor length, h (IQR)	12.8 (9.26, 17.3)	8.14 (5.76,11.8)	<0.01
Chorioamnionitis	21 (5.9)	21 (1.85)	<0.01
Delivery <24 h	353 (99.2)	1132 (99.8)	0.09
Midwife delivery	13 (3.7)	34 (3.0)	0.60
Birthweight, g (IQR)	3585 (3220, 3894)	3446 (3185, 3761)	<0.01

Abbreviations: AROM, artificial rupture of membranes; cm, centimeters; IQR, interquartile range; TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.
[a]Cervical dilation was rounded to the nearest full numerical value for clinical significance.

Table 3 OR and aOR for risk factors associated with successful VBAC

Variable	OR (95% Confidence interval)	aOR (95% Confidence interval)
AROM < 4 cm[a]	0.86 (0.67–1.09)	0.65 (0.48–0.89)
AROM < 6 cm[b]	1.23 (0.83–1.83)	0.92 (0.56–1.52)

Abbreviations: aOR, adjusted odds ratio; AROM, artificial rupture of membranes; OR, odds ratio; VBAC, vaginal birth after cesarean.
[a]Controls for body mass index, prior vaginal delivery, African–American, Medicaid insurance, labor length, gestational age at delivery, birthweight, epidural use, Foley catheter balloon ripening, induction reason: postdates, elective, and nonreassuring fetal status and oxytocin use.
[b]Controls for body mass index, prior vaginal delivery, Medicaid insurance, African–American, labor length, gestational age at delivery, birthweight, epidural use, Foley catheter balloon ripening, induction reason: postdates, elective, and nonreassuring fetal status and oxytocin use.

Comment

In this study, early amniotomy at fewer than 4 cm, but not at fewer than 6 cm, was associated with a lower likelihood of VBAC. Women with successful VBAC were not only more likely to have amniotomy performed at greater than 4 cm but also to have lower BMI, prior vaginal delivery, epidural use, and oxytocin use. These findings are consistent with conclusion by prior studies on VBAC success being influenced by maternal BMI and history of prior vaginal delivery.[5,11–14] Failed TOLAC, on the other hand, was associated with Foley catheter use for cervical ripening, black race, and advanced gestational age. Of note, chorioamnionitis was not increased with early amniotomy (<4 cm) in our study.

Our study has notable strengths. The original MFMU study included over 14,000 women; this large size allows us to perform a secondary analysis with a high number of eligible subjects and to detect the impact of our primary exposure of interest on the rate of successful VBAC.[11] The MFMU Cesarean Registry was a large multicenter prospective cohort dataset with a diverse patient population which affords generalizability to our conclusions.[11] Another strength is that because of the additional clinical data that are included in this set, we are able to appropriately control for factors known to impact VBAC success such as maternal BMI and prior vaginal delivery.

Despite these strengths, our study has several limitations. Important clinical variables such as indication for prior cesarean(s), Bishop score at initiation of induction, and timing of amniotomy compared with oxytocin administration were not available in the dataset. We know that indication for prior cesarean impacts the chance of VBAC success and therefore is a significant limitation of our study.[9] Additionally, timing of amniotomy has been defined as fewer than 4 cm or fewer than 6 cm. These were selected because previously 4 cm, and now 6 cm, are felt to represent the onset of active labor.[9,15] However, clinically, other components of the cervical exam also play a role in consideration of the onset of active labor. Ideally, using the entire Bishop score would create a more complete picture of the active phase of labor, but these components were not available in the dataset. Finally, the clinical scenario around AROM is not available, which is associated with successful TOLAC. For example, a woman with regular contractions who has amniotomy is different than a patient who has a category two tracing and has amniotomy to facilitate fetal scalp electrode placement or a woman who has had a long induction, and amniotomy is performed as a last effort to avoid cesarean. However, in each of these cases, it remains an augmentation technique, trying to achieve the same end goal and study outcome of vaginal delivery. These limitations represent important directions for future research.

The cesarean delivery rate in the United States has increased to approximately 32%, and the induction rate is approximately 22%.[1] As the reproductive-aged population is becoming older, larger, and more medically complex than its prior cohort, we anticipate that the need for medically indicated deliveries will increase. Therefore, a larger proportion of women will be undergoing induction of labor in the setting of TOLAC. Successful VBAC represents a critical strategy to reduction of mortality and morbidity for pregnant women and their neonates. For women electing to undergo induction of labor after cesarean, our study identifies a potential clinical intervention that actually decreases chance of VBAC success. Interestingly, prior studies have shown increased vaginal delivery rates with early amniotomy in nulliparous patients[10]; however, our data run contrary to this finding after controlling for prior vaginal delivery. Original indication for cesarean may explain this different finding. Additionally, this may be explained by differences in management among women undergoing TOLAC as compared with nulliparous women, as well as the fact that in our population, over 40% of women had a prior vaginal delivery—thus represent a very different baseline population. Further studies are needed to better understand why this population differs from nulliparous women and to ensure reproducibility. In conclusion, clinicians should consider delay of amniotomy until beyond 4-cm dilation when inducing women undergoing TOLAC.

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Conflict of Interest
The authors report no conflict of interest.

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