

Duration of a vaginal birth after cesarean section depending on the degree of cervical dilation in the prior cesarean delivery: A retrospective study

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Abstract

Objective: Labor and birth lead to significant immunological and regenerative changes in the uterus, such that multiparous women typically experience faster and more effective labor than primiparous women. In this retrospective study, we examined the influence of labor activity and childbirth progress in the previous pregnancy on the duration of vaginal delivery of a second child in women with a history of one cesarean section.

Methods: A total of 200 women bearing their second child with a trial of labor after cesarean who presented for delivery between January 2018 and December 2022 at the Clinic St. Hedwig (a tertiary maternity hospital of University of Regensburg, Germany) were included. Three subgroups were analyzed: women with a history of elective cesarean section, those with a history of cesarean section during the first stage of labor, and those with a history of cesarean section during the second stage of labor. The two stages were defined depending on the cervical dilation (first stage <10 cm, second stage: full dilatation). The duration of labor was defined as time between regular contractions or time of rupture of the membranes (whatever was first) to childbirth. A t-test and Pearson correlation analysis were conducted (using SigmaPlot 14.0).

Results: In 75.5% of cases (151/200), a vaginal birth (VBAC, vaginal birth after cesarean section) was achieved, and in 24.5% of cases (49/200), an unplanned repeat cesarean section was performed. The median duration of labor for VBAC in women with a history of elective cesarean was 12.2 h (interquartile range [IQR] 6.9–19.5), for those with a history of cesarean during the first stage of labor 10.0 h (IQR 6.0–16.2), and for those with a history of cesarean during the second stage of labor 8.0 h (IQR 3.9–12.0).

Conclusion: Women with a history of cesarean during the second stage of labor deliver 4 h faster than women with a history of elective cesarean. Even if labor must

Abbreviations: BMI, body mass index; CS, cesarean section; ERCS, elective repeat cesarean section; TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.

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be terminated during the first stage, an advanced degree of cervical dilation has a shortening effect on the duration of a subsequent VBAC.

KEYWORDS

cervical dilation, stage of labor, trial of labor after cesarean section, vaginal birth after cesarean section

1 | INTRODUCTION

Cesarean delivery rates have continued to increase over the past decade.¹ The main reason for this is elective repeat cesarean section (ERCS) due to prior cesarean section.² However, cesarean deliveries carry a higher risk of maternal mortality and morbidity compared to vaginal deliveries. Reports indicate an 8- to 10-fold increased risk of maternal mortality with cesarean sections compared to vaginal births.³

Providing detailed information to patients concerning the chances and likelihood of success of vaginal birth after cesarean (VBAC) remains difficult. The management and safety of a successful VBAC was analyzed in several studies. For patients with a history of one previous cesarean section, their chance of a successfully completed vaginal delivery is between 63.6% and 83% regardless of the indication of the previous cesarean section.^{4,5} Different studies have identified factors that increase the likelihood of a successful VBAC in women attempting trial of labor after cesarean (TOLAC). These factors include a pre-pregnancy body mass index (BMI) of $<24 \text{ kg/m}^2$, a Bishop score of the cervix of 5 or higher, a history of vaginal delivery,⁶ an interval of 9 years or more since the previous cesarean, and a newborn birth weight of less than 3300g.⁷ Demographic characteristics also play a crucial role, so women living in rural areas have a higher chance of successful VBAC.⁸

Those previous publications focused mostly on the variables predicting VBAC success appearing in the second delivery. Almost no studies focus on the question of whether even a minimum cervical opening in the previous cesarean section would influence the duration of VBAC. However, this is certainly a very interesting question for our patients. Contractions presumably lead to distinct immunologic and regenerative changes in uterine tissue.⁹ This is probably the reason for multiparae developing faster and more effective contractions than primiparae.¹⁰ Our hypothesis is that even a delivery planned vaginally ending as a cesarean section will have some positive impact on following TOLAC. In this retrospective study, we evaluated the influence of contractions and progress of labor in the previous pregnancy on duration of VBAC of the second child of women after having had a cesarean section. A better understanding of this could encourage women in their decision to give VBAC a try. Pre-treatment consultation is important to provide women enough information regarding expectations on the course and success rates of VBAC to ensure well-informed consent.

2 | METHODS

The present study is a single-center retrospective cohort study conducted at the tertiary university maternity hospital Clinic St. Hedwig, University of Regensburg, Germany, between January 2018 and December 2022. The hospital database was screened for all women with a second singleton pregnancy who underwent a TOLAC during the study period. Eligible cases were identified by applying predefined inclusion and exclusion criteria. No random sampling was performed. All women meeting the eligibility criteria and with complete documentation of both deliveries were included in the final analysis, resulting in a study population of 200 women.

Ethical approval was obtained from the Ethics Committee of the University of Regensburg (Reference No. 26-4732-104). The Committee raised no ethical or legal objections to the conduct of this retrospective study. All women gave written consent for data collection, storage, and analysis.

Inclusion criteria were a singleton second pregnancy, one previous low-transverse cesarean section, planned TOLAC, and documented cervical dilatation at the time of the previous cesarean section. Women with a previous longitudinal or T-shaped uterine incision, fetal anomalies, preterm deliveries or contraindications to vaginal delivery were excluded. For women whose previous cesarean section had been performed at our institution, uterine closure was routinely performed using a standardized double-layer technique. Information on the uterine closure technique was not consistently available for women whose previous cesarean section had been performed elsewhere. We did not analyze the influence of the interpregnancy interval for two reasons: (i) this study presents real-world-data and (ii) the aim of the study was not to determine the VBAC-rate and influencing factors but only the duration of an uncomplicated VBAC.

Women undergoing TOLAC were managed by an experienced obstetric team according to institutional protocols. Labor induction was performed, when clinically indicated, using a balloon catheter or prostaglandin E2 gel (both off-label-use). Labor augmentation with oxytocin was permitted when required. Continuous intrapartum fetal monitoring was routinely performed, and facilities for immediate emergency cesarean delivery were always available. Operative vaginal delivery was performed for standard obstetric indications, including prolonged second stage of labor or pathological cardiotocography (CTG) findings. Repeat cesarean section was performed for standard obstetric indications, such as arrest of labor,

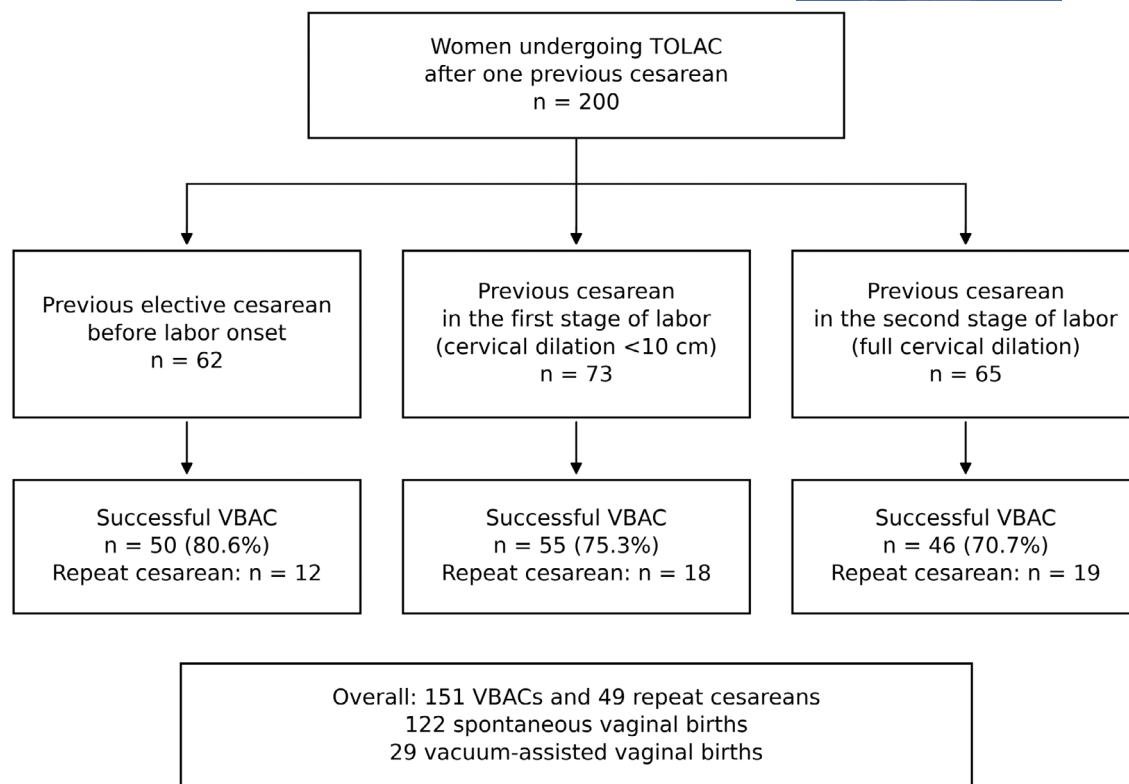


FIGURE 1 Flow chart of the collective of TOLAC and its subgroups according to cervical dilation in the previous CS with the mode of birth in second delivery. CS, cesarean section; TOLAC, trial of labor after cesarean; VBAC, vaginal delivery after cesarean.

pathological CTG findings, suspected uterine rupture, or other obstetric indications.

All parameters and measured values were drawn from a digital archive of our clinic system and had previously been collected during the inpatient treatment of the participants in our department. At our institution, labor and delivery records are routinely documented in detail by attending midwives and obstetricians as part of standard clinical care. In addition, the course of previous deliveries, including the timing of a previous cesarean section, is usually documented during obstetric history-taking. Therefore, only women with reliable documentation of the timing of the previous cesarean section were included in the study, ensuring accurate classification of the study groups.

Duration of delivery was defined as time between regular contractions or time of rupture of the membranes (whatever was first) to childbirth.

Women were classified into three predefined groups: elective cesarean section before the onset of labor, cesarean section during the first stage of labor (<10 cm cervical dilatation), and cesarean section during the second stage of labor (full cervical dilatation).

The primary outcome of this work was the duration of a successful vaginal birth of a second child.

The parameters collected in all subgroups included maternal age (years, at time of second delivery), BMI (kg/m^2) and, for each delivery, gestational age at delivery (days), maximal dilation of the cervix (in cm), fetal body length at birth (in cm), fetal head circumference (in cm), and fetal birth weight (in grams). For first delivery, timing of

cesarean section was recorded (i.e., elective cesarean section and cesarean section in first or second stage of labor). For second delivery, duration of birth was recorded (in hours).

The fetal parameters were documented using the ViewPoint program (ViewPoint ver. 5.6, GE Healthcare GmbH, 42655 Solingen). Only cases with complete datasets were included in the final analysis; therefore, no imputation of missing data was performed. Given the observational and exploratory design of the study, no multivariable analyses were conducted to adjust for potential confounding variables.

The t-test for paired samples was performed to calculate differences between groups. Correlation analysis was performed after Pearson analysis. The Kruskal-Wallis test was used to test continuous values for more than two groups. To test categorical values, the χ^2 -test was performed. A P-value of <0.05 was defined as statistically significant. SigmaPlot 14.0 (Inpixon GmbH, 40212 Düsseldorf) was used for statistical analysis. Graphs were drawn using "Graphpad Prism 10."

Ordinal and metric data were initially described using skewness, mean values, and measures of dispersion. In the case of asymmetric distribution (skewness >1.5) the median with interquartile range was considered in these cases.

3 | RESULTS

In total, 200 women undergoing TOLAC were included in the study; 62 of these had a history of primary cesarean section, 138

Characteristics					
Mean (±SD)	Group 1, elective CS n = 62		Group 2, CS with cervical dilation <10 cm n = 73	Group 3, CS with full cervical dilation, n = 65	P-value
Median (IQR)					
Maternal age in TOLAC (years)	32 (±3.87)		33 (±4.7)	33.6 (±3.5)	0.14
	32 (30–35)		33 (30–36)	33 (31–36.5)	
BMI pre-pregnancy (kg/m ²)	24.5 (±5.17)		24.0 (±5.976)	23.3 (±4.267)	0.94
	23.374 (21.2–26.25)		22.583 (20.5–27.64)	23.30 (21.18–25.78)	
Gestational age in first delivery (days)	262.9 (±19.57)		275.7 (±14.1)	277.8 (±13.04)	<0.001
	272 (94–275)		280 (268–284)	279 (276–286)	
Fetal birth weight in first delivery (g)	2896 (±830)		3252 (±648)	3373 (±552)	<0.001
	3010 (2460–3420)		3340 (2773–3722)	3395 (3040–3817)	
Fetal head circumference in first delivery (cm)	34 (±3.9)		34.4 (±2.1)	34.5 (±1.8)	0.42
	34.5 (29.5–35.5)		35 (33.3–36)	35 (34–36)	
Fetal length in first delivery (cm)	48.5 (±5.4)		49 (±6.4)	51.7 (±3.32)	0.003
	50 (4.5–52)		51 (48–53)	52 (50–54)	
Gestational age in second delivery (days)	278.9 (±7.96)		276 (±10.7)	276.7 (±10.3)	0.59
	279 (272–284)		278 (272–284)	279 (271–284)	
Fetal Birth weight in second delivery (g)	3406.45 (±328)		3385 (±520)	3425 (±417)	0.76
	3405 (3195–3628)		3370 (3067–3725)	3430 (3200–3725)	
Fetal head circumference in second delivery (cm)	35.1 (±1.3)		34.8 (±1.4)	34.8 (±1.5)	0.46
	35 (34–36)		35 (34–36)	35 (34–36)	
Fetal length in second delivery (cm)	51.3 (±2.6)		51.6 (±2.5)	51.7 (±2.7)	0.59
	52 (50–53)		52 (50–54)	52 (50–53.7)	

Abbreviations: BMI, body mass index; CS, cesarean section; IQR, interquartile range; SD, standard deviation; TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.

Duration between the first and third group differed significantly ($P=0.02$) (Figure 2).

Further, in the second group, a significant negative correlation between the duration of VBAC and the previous cervical dilation at the time of cesarean section was shown ($r = -0.28$, $P = 0.047$). This means that the more progressed the labor in the first pregnancy was, the faster the VBAC in subsequent vaginal delivery (Figure 3).

The success rate of TOLAC in this study varied depending on the stage of labor in which a cesarean section was performed in the first pregnancy. We observed the highest success rate of vaginal delivery at 80.6% (50/62) after a cesarean section performed without labor onset, at 75.3% (55/73) when the previous cesarean section was performed in the first stage of labor, and at the lowest at 70.7% (46/ 65) in women in the post-cesarean state in the second stage of labor. The success rates did not differ significantly between the groups ($P=0.22$).

This retrospective cohort study demonstrated an overall VBAC success rate of 75.5% among women with one previous cesarean section undergoing TOLAC. The success rate varied according to the stage of labor at which the prior cesarean section had been performed. Women with a history of elective cesarean section showed the highest VBAC rate (80.6%), followed by women with a previous cesarean section during the first stage of labor (75.3%) and those with a previous cesarean section during the second stage of labor (70.7%).

The results of similar studies are diverse. Our study aligns with Hoskins and Gomez, Kwon et al., and Ollendorf et al., showing that women who had a cesarean at full dilation have lower chances of

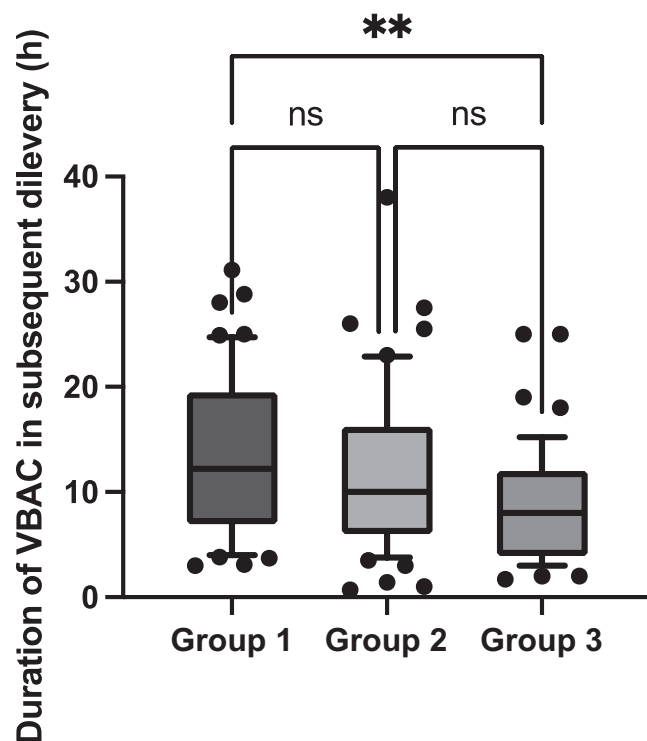


FIGURE 2 Duration of VBAC in subsequent delivery in three groups. Group 1=VBAC after elective cesarean section; group 2=VBAC after cesarean in the first stage of labor; group 3=VBAC after cesarean in the second stage of labor. ns, non-significant; VBAC, vaginal delivery after cesarean.

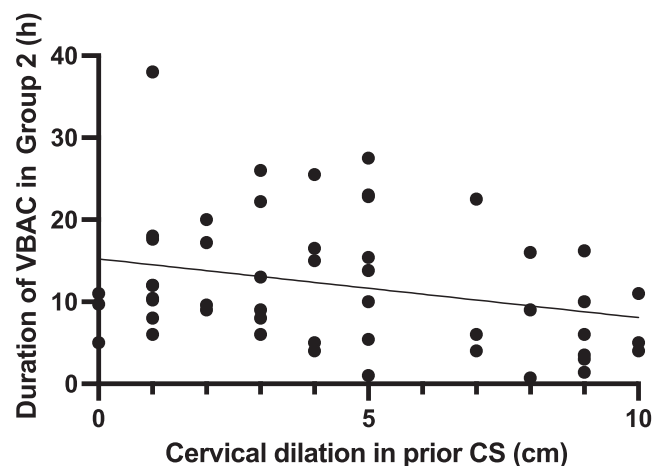


FIGURE 3 Correlation between the duration of a VBAC and the cervical dilation in previous CS during first stage of labor (group 2). Group 2=VBAC after cesarean in the first stage of labor. CS, cesarean section; VBAC, vaginal delivery after cesarean.

a successful VBAC compared to those who had a cesarean during the dilation phase.^{5,11,12} In contrast, some studies report higher success rates for women fully dilated at the time of their previous cesarean.^{13,14} These differences might be due to factors like local guidelines at the time of study participation, obstetrician experience, patient wishes and study cohort characteristics (e.g., excluding women with previous vaginal births in our study).

However, our study investigated mainly the duration of vaginal birth after a previous cesarean section (VBAC) in women who had previously undergone a single cesarean section. The main question was whether the progress of labor during the first cesarean section affected the duration of a subsequent vaginal birth. Women with a fully dilated cervix at first cesarean section delivered significantly faster compared to women with a previous elective cesarean section without labor.

Previous studies have explored various factors influencing labor duration, such as maternal age, weight, number of previous births, infant birth weight and fetal position.^{15–18} However, only a few have examined the relationship between the timing of a previous cesarean section and the duration of a subsequent VBAC.

Key findings from notable studies include Li et al., who found that women with VBAC had significantly shorter labor durations (430min) compared to primiparae (495 min), without considering the labor phase during the previous cesarean section.¹⁹ Harlass and Duff grouped second-time mothers based on the labor stage during their first cesarean section and discovered that their subsequent labor durations were similar to primiparae, although their study was limited by a small sample size ($n=29$).²⁰ Rottenstreich et al. found that cesarean sections during the second phase (expulsion) were associated with significantly shorter subsequent labor durations compared to elective cesarean sections and those during the first phase (cervical dilation), based on a larger sample of 751 VBAC cases.²¹

Our study aligns with Rottenstreich et al., showing that women with previous cesarean section during the second stage had significantly shorter subsequent labor durations (8.0h) compared to those with elective cesarean section (12.3h) and cesarean section during the dilation phase (10.0h).²¹

This phenomenon may be due to cellular “memory” in uterine cells, which undergo significant changes from early pregnancy to labor onset, including cellular hypertrophy, matrix expansion, and increased contractile activity influenced by hormones like estrogen and progesterone.^{22,23} This memory, similar to muscle memory in skeletal muscles, might lead to more efficient contractions and shorter labor durations in subsequent births.

5 | LIMITATIONS AND STRENGTHS

The study's limitations include the following:

1. Study duration and scope: The research covered only a 5-year period, and data were collected from a single tertiary maternity center, limiting the generalizability to other populations and lower-level clinics.
2. Lack of control groups: The study did not compare outcomes between women with a history of cesarean section and those with no uterine surgeries or between multiparous and nulliparous women. Unlike international studies, which included larger cohorts and control groups, this study's comparisons were more limited.

3. A further limitation of this study is that no multivariable analyses were performed to adjust for potential confounding factors, such as maternal age, body mass index, gestational age, fetal birth weight, or the indication for the previous cesarean section. Therefore, residual confounding cannot be excluded, and the findings should be interpreted accordingly.

The manual data collection, including detailed cervical findings and birth durations, enhances data quality and reliability and despite these limitations, the study provides new insights into how cervical findings during a previous cesarean affect the duration of subsequent TOLAC.

6 | CONCLUSION

This study analyzed the duration of vaginal births after a previous cesarean section in 200 women. It found that those with a prior cesarean section in the second stage of labor had shorter labor durations compared to those with an elective cesarean section or one performed during the dilation phase. Women with a cesarean section in the first stage of labor showed faster VBAC with every dilated centimeter of the cervix previously. The TOLAC success rate was high at 75.5%, aligning well with the findings of international studies.

The findings suggest that uterine activity and cervical dilation during a previous cesarean influence labor duration in subsequent vaginal deliveries. Women with prior cesareans in the second stage of labor had deliveries approximately 4 h shorter. This information is valuable for counseling pregnant women on delivery options following a cesarean. Future studies with larger samples could further enhance understanding and improve practices.

AUTHOR CONTRIBUTIONS

N.M. collected and analyzed data and wrote the article. A.K. analyzed the data and revised the work. M.R. revised the work. I.A.T. helped with data analysis and graphics. M.K. revised the analysis. A.S. analyzed the data and revised the work. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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