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MATERNAL AND PERINATAL OUTCOMES OF TRIAL OF LABOUR AFTER PREVIOUS CESAREAN DELIVERY: THE IMPACT OF LABOUR INDUCTION, OXYTOCIN AUGMENTATION, AND INTRAPARTUM PHARMACOTHERAPY - A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Trial of labor after cesarean delivery (TOLAC) provides an opportunity for vaginal birth but requires careful intrapartum management because labor induction, oxytocin augmentation, and pharmacological interventions may influence maternal and perinatal outcomes. This study evaluated these associations among women undergoing TOLAC.

Methods: This retrospective cohort study included 600 women undergoing TOLAC at the Department of Gynaecology & Obstetrics, Liaquat University of Medical & Health Sciences, Hyderabad/Jamshoro. Participants were categorized according to spontaneous or induced labor and according to exposure to oxytocin and intrapartum pharmacotherapy. The primary outcome was successful vaginal birth after cesarean (VBAC). We also assessed maternal and perinatal outcomes. Multivariable logistic regression was performed to identify independent predictors of successful VBAC.

Results: A total of 438 (73.0%) women had a successful VBAC. VBAC occurred more frequently following spontaneous than induced labor (80.2% vs. 56.1%, P<0.001). The presence of oxytocin was correlated with decreased VBAC success (63.5% vs. 81.0%, P<0.001), increased labor duration and increased rates of uterine rupture and postpartum bleeding. The use of intrapartum pharmacotherapy was not independently associated with VBAC success after adjustment, but was associated with increased operative vaginal delivery. Induced labor was associated with higher rates of NICU admission (13.9% vs. 6.2%, P=0.003) and low 5-minute Apgar scores (7.8% vs. 3.1%, P=0.02). Previous vaginal delivery and previous VBAC were both predictive of successful VBAC independently.

Conclusion: Labor induction and oxytocin exposure were associated with reduced VBAC success and selected adverse outcomes. Individualized TOLAC selection and vigilant intrapartum management remain essential.

KEYWORDS: Trial of labor after cesarean; Vaginal birth after cesarean; Labor induction; Oxytocin; Intrapartum pharmacotherapy; Uterine rupture; Maternal outcomes; Perinatal outcomes.

INTRODUCTION

Women with a prior cesarean birth can be offered trial of labor after cesarean delivery (TOLAC) which is an established strategy in this population that has the potential benefit of vaginal delivery and the avoidance of maternal morbidity associated with recurrent surgical procedures. However, TOLAC is not without risk; maternal and neonatal morbidity from uterine rupture, failed labor, or emergency cesarean delivery requires considerable intrapartum vigilance. Modern recommendations thus underline suitable patient selection, ongoing fetal surveillance, and the presence of facilities able to perform emergency cesarean delivery when necessitated (1, 2).

Several maternal and obstetric characteristics influence the likelihood of successful vaginal birth after cesarean (VBAC), but management of labor itself may also modify outcomes. Induction of labor is frequently required when spontaneous labor does not occur or when delivery is indicated for maternal or fetal reasons. However, induction among women with a previous cesarean has been associated with lower VBAC rates and a higher frequency of uterine rupture than spontaneous labor (3). A meta-analysis including 48,457 women undergoing TOLAC reported pooled VBAC rates of 74.3% with spontaneous labor compared with 60.7% following induction, while uterine rupture occurred in 0.7% and 2.2%, respectively (4).

Oxytocin augmentation presents a related clinical challenge. Although oxytocin remains an important component of labor management, observational evidence suggests that its use during TOLAC may be associated with increased uterine rupture risk, with emerging evidence also indicating a possible dose-response relationship

(4). Consequently, the clinical context, timing, and intensity of oxytocin administration are important considerations when evaluating TOLAC safety.

Intrapartum pharmacotherapy, particularly epidural analgesia, represents another potentially important but incompletely characterized component of TOLAC management. Available studies have reported differing associations between epidural analgesia, VBAC success, labor duration, operative delivery, and maternal or neonatal outcomes (5). Recent evidence further suggests that epidural analgesia itself may not independently reduce TOLAC success after adjustment for relevant clinical factors (6).

However, relatively few studies have evaluated labor induction, oxytocin augmentation, and intrapartum pharmacotherapy together within a single TOLAC cohort while simultaneously examining maternal and perinatal outcomes. Therefore, this study aimed to evaluate the associations of these intrapartum management strategies with VBAC success and maternal and perinatal outcomes among women undergoing TOLAC after previous cesarean delivery.

METHODS

Study Design and Setting

This is a retrospective cohort study performed at the Department of Gynaecology & Obstetrics, Liaquat University of Medical & Health Sciences, Hyderabad/Jamshoro one of the tertiary-care sectors providing obstetric and neonatal health services. This study included all women with a history of cesarean delivery who underwent TOLAC between February 2024 and November 2025. Clinical, obstetric, intrapartum and neonatal data pertinent to the outcome were extracted from institutional medical records and registers of delivery retrospectively. The study was conducted in accordance with the Declaration of Helsinki and reported according to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) recommendations.

Study Population

Eligible women had to be documented as having undergone at least 1 prior cesarean delivery and a trial of labor with attempted vaginal birth after cesarean delivery. Eligibility was determined from the medical record based on recorded obstetric history and an individualized clinical decision to attempt a TOLAC.

We excluded records that did not contain all of the information necessary to assign a mode of labor or delivery, where delivery occurred prior to initiation of a trial of labor, or when available medical documentation would not have permitted determination of the principal maternal and neonatal outcomes. Other exclusions were applied as appropriate based on site-specific institutional TOLAC criteria.

Exposure and Intrapartum Management

The main exposures of interest were labour induction, oxytocin augmentation and intrapartum pharmacotherapy. Labour was classified as either spontaneous (not induced) or initiated using an induction method. Induction methods were captured according to the documented clinical management including pharmacological or mechanical cervical-ripening (where applicable) and labor-induction method.

Separate classifications were made for oxytocin exposure because of its utility in labor induction or augmentation, clinically distinct from spontaneous labor that was not exposed to oxytocin. Data were collected, when available from the medical record, on oxytocin indication, timing and documented use.

Intrapartum pharmacotherapy was operationalized as medications that only requested during labor and delivery and were administered per documented administration records. Pharmacological exposures were more appropriately treated as specific interventions rather than a broad exposure. The use of available epidural or other pharmacological analgesia was similarly noted from the records and analyzed according to pre-defined variables used in our study.

Maternal Outcomes

Women undergoing VBAC were identified, and the main maternal outcome was successful vaginal birth after cesarean (VBAC). Failed TOLAC (Intrapartum Cesarean Delivery) was defined as an unsuccessful trial of labor. Secondary maternal outcomes included uterine rupture, postpartum hemorrhage, blood transfusion, operative vaginal delivery (OVD), maternal infection and other clinically significant maternal complications recorded during the index hospitalization. Additionally, we recorded whether an emergency cesarean delivery occurred and the documented indication for this.

Perinatal Outcomes

Where available in the medical records, data obtained included Apgar scores, neonatal resuscitation, admission to the NICU; neonatal complications and perinatal mortality. Neonatal outcomes were examined when recorded uniformly across the cohort.

Covariates

We chose potential confounding variables a priori on the basis of clinical relevance and presence in our dataset. Variables associated with VBACs were maternal age, parity, gravidity, gestational age at cesarean delivery and maternal body mass index previous vaginasl delivery or pVaginal birth after cesarean (VBAC), indication for the previous cesarean delivery, and obstetric variables including cervical/labor characteristics and relevant maternal comorbidities. There are additional obstetric characteristics which were included when they were reliably documented.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 27). Continuous variables were assessed for distribution and summarized as mean ± standard deviation for normally distributed data or median with interquartile range for non-normally distributed data. Categorical variables were presented as frequencies and percentages.

Maternal and perinatal outcomes were compared according to the principal exposure groups, including spontaneous versus induced labor and oxytocin exposure versus no oxytocin exposure. The chi-square test or Fisher's exact test was used for categorical variables, as appropriate, while continuous variables were compared using the independent-samples *t*-test or Mann–Whitney *U* test according to data distribution.

To account for potential confounding, multivariable logistic regression analysis was performed for clinically relevant binary outcomes where the number of outcome events permitted reliable modelling. Adjusted odds ratios (aORs) with corresponding 95% confidence intervals (CIs) were reported. Covariates were selected based on clinical relevance and prespecified potential confounding rather than solely on univariable statistical significance. Interaction analyses between major intrapartum exposures were considered where sample size permitted.

Missing data were assessed for the extent and pattern of missingness. The primary analysis was based on available data, with the approach to missing observations specified according to the proportion and nature of missing data. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

Study Population and Baseline Characteristics

The analysis included 600 women most qualified for TOLAC. One hundred eighty (30.0%) women were started on labor induction, while in 420 (70.0%) spontaneous labor occurred. Maternal characteristics were generally similar, although women entering spontaneous labor more frequently had had a previous vaginal delivery and previous VBAC. The induction group had a slightly higher gestational age as well **(Table 1)**

Table 1. Baseline maternal and obstetric characteristics according to onset of labor

Variable	Overall (N=600)	Spontaneous labor (n=420)	Induced labor (n=180)	P value
Age, years	29.8 ± 4.6	29.6 ± 4.5	30.2 ± 4.8	0.14
BMI, kg/m²	27.1 ± 3.8	26.9 ± 3.7	27.5 ± 4.0	0.09
Gestational age, weeks	38.9 ± 1.1	38.8 ± 1.0	39.1 ± 1.2	0.003
Multiparity	412 (68.7%)	294 (70.0%)	118 (65.6%)	0.30
Previous vaginal delivery	198 (33.0%)	158 (37.6%)	40 (22.2%)	<0.001
Previous VBAC	126 (21.0%)	105 (25.0%)	21 (11.7%)	<0.001
Hypertension	78 (13.0%)	50 (11.9%)	28 (15.6%)	0.25
Diabetes mellitus	72 (12.0%)	43 (10.2%)	29 (16.1%)	0.06
One previous cesarean	566 (94.3%)	400 (95.2%)	166 (92.2%)	0.16
≥2 previous cesareans	34 (5.7%)	20 (4.8%)	14 (7.8%)	0.16

Values are presented as mean ± SD or n (%), as appropriate. BMI, body mass index; VBAC, vaginal birth after cesarean

Labor Pathway and Mode of Delivery

VBAC was the most common labor outcome among 600 women, with a successful VBAC occurring in 337 (93%) of patients after spontaneous or induced labor. Intrapartum cesarean delivery occurred in 83 women following spontaneous labor and 79 women following induction, illustrating a significantly different distribution of delivery outcome according to type of labor pathway. **(Figure 1)**

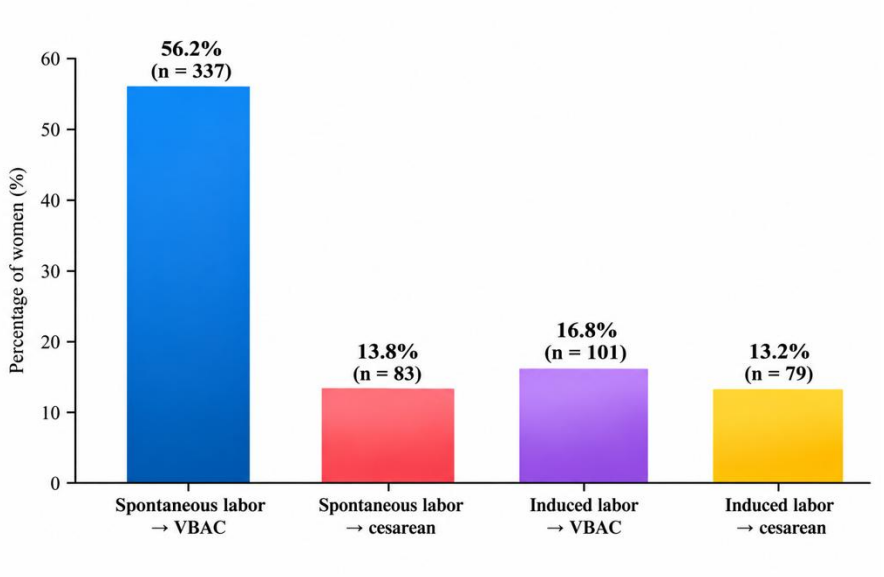


Figure 1. Distribution of spontaneous and induced labor and mode of delivery among women undergoing TOLAC

Oxytocin Exposure and Intrapartum Outcomes

Oxytocin was administered to 274 women (45.7%). Its use was associated with a greater frequency of operative vaginal delivery, uterine rupture, and postpartum hemorrhage, whereas blood transfusion and NICU admission did not differ significantly between exposure groups. Labor duration was also longer among women receiving oxytocin. **(Table 2)**

Table 2. Oxytocin exposure and intrapartum outcomes

Outcome	Oxytocin (n=274)	No oxytocin (n=326)	P value
Operative vaginal delivery	35 (12.8%)	24 (7.4%)	0.03
Labor duration, h	8.4 ± 2.9	6.9 ± 2.5	<0.001
Uterine rupture	8 (2.9%)	2 (0.6%)	0.04
Postpartum hemorrhage	31 (11.3%)	20 (6.1%)	0.03
Blood transfusion	8 (2.9%)	4 (1.2%)	0.12
NICU admission	29 (10.6%)	22 (6.7%)	0.10

Values are presented as mean ± SD or n (%). NICU, neonatal intensive care unit; VBAC, vaginal birth after cesarean.

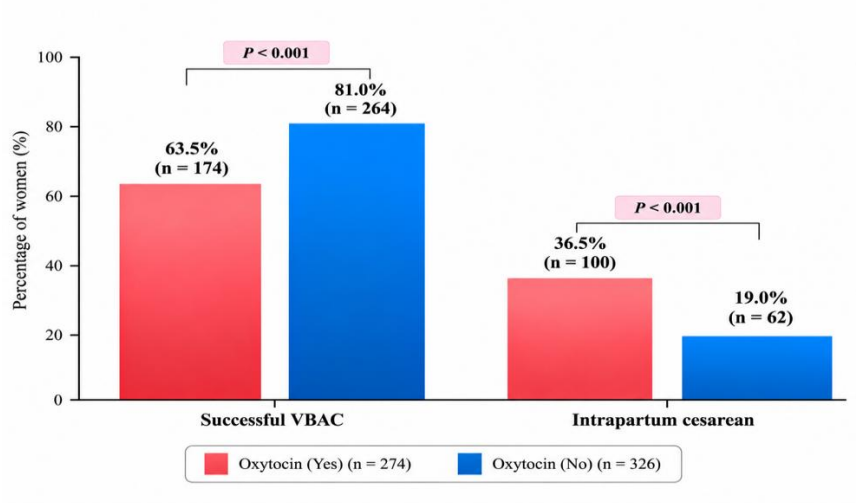


Figure 2. Successful VBAC and intrapartum cesarean delivery according to oxytocin exposure

Intrapartum Pharmacotherapy

Intrapartum pharmacotherapy was documented in 312 women (52.0%). Operative vaginal delivery occurred more frequently among women receiving pharmacotherapy, whereas differences in uterine rupture, postpartum hemorrhage, blood transfusion, maternal infection, and intensive care admission were not statistically significant. **(Table 3)**

Table 3. Maternal outcomes according to intrapartum pharmacotherapy

Outcome	Pharmacotherapy (n=312)	No pharmacotherapy (n=288)	P value
Operative vaginal delivery	42 (13.5%)	17 (5.9%)	0.003
Uterine rupture	6 (1.9%)	4 (1.4%)	0.75
Postpartum hemorrhage	32 (10.3%)	19 (6.6%)	0.12
Blood transfusion	8 (2.6%)	4 (1.4%)	0.37
Maternal infection	17 (5.4%)	10 (3.5%)	0.27
ICU admission	5 (1.6%)	2 (0.7%)	0.45

Values are presented as n (%). NICU, neonatal intensive care unit; VBAC, vaginal birth after cesarean.

Perinatal Outcomes

Perinatal outcomes differed primarily with respect to neonatal intensive care utilization and early neonatal condition. NICU admission and a 5-minute Apgar score below 7 were more frequent among neonates born following induced labor, whereas birth weight, neonatal resuscitation, respiratory morbidity, neonatal seizures, and perinatal mortality showed no statistically significant between-group differences. **(Table 4)**

Table 4. Perinatal outcomes according to onset of labor

Outcome	Spontaneous labor (n=420)	Induced labor (n=180)	P value
Birth weight, g	3025 ± 410	2988 ± 435	0.32
5-min Apgar <7	13 (3.1%)	14 (7.8%)	0.02
Neonatal resuscitation	24 (5.7%)	18 (10.0%)	0.07
NICU admission	26 (6.2%)	25 (13.9%)	0.003
Respiratory morbidity	18 (4.3%)	13 (7.2%)	0.15
Neonatal seizures	2 (0.5%)	1 (0.6%)	>0.99
Perinatal mortality	1 (0.2%)	2 (1.1%)	0.25

Values are presented as mean ± SD or n (%). NICU, neonatal intensive care unit; VBAC, vaginal birth after cesarean

Independent Predictors of Successful VBAC

In the adjusted analysis, previous vaginal delivery and previous VBAC were independently associated with higher odds of successful VBAC. Labor induction and oxytocin exposure remained independently associated with reduced odds of VBAC success, while intrapartum pharmacotherapy did not demonstrate an independent association after adjustment for maternal and obstetric characteristics. **(Table 5)**

Table 5. Multivariable logistic regression analysis of factors associated with successful VBAC

Predictor	Adjusted OR	95% CI	P value
Maternal age, per year	0.97	0.94–1.00	0.07
BMI, per kg/m²	0.95	0.92–0.99	0.01
Multiparity	1.31	0.89–1.93	0.17
Previous vaginal delivery	2.41	1.58–3.68	<0.001
Previous VBAC	3.18	1.89–5.35	<0.001
Labor induction	0.42	0.28–0.63	<0.001

Oxytocin exposure	0.58	0.40–0.84	0.004
Intrapartum pharmacotherapy	0.86	0.60–1.24	0.42
Diabetes mellitus	0.74	0.45–1.23	0.25
Hypertension	0.81	0.51–1.30	0.39

Adjusted odds ratios (ORs) are presented with 95% confidence intervals (CIs). The model was adjusted for clinically relevant maternal and obstetric covariates. BMI, body mass index; VBAC, vaginal birth after cesarean

DISCUSSION

In this retrospective cohort, the principal finding was that the mode of labor initiation was strongly associated with TOLAC outcome. Women entering spontaneous labor had a substantially higher proportion of successful VBAC than those undergoing induction. This finding is consistent with a large meta-analysis showing lower VBAC rates and higher uterine rupture rates among induced TOLAC compared with spontaneous labor (4). A population-based study likewise identified labor induction as an important predictor of failed TOLAC, while a Chinese cohort reported an adjusted odds ratio of 2.84 for TOLAC failure following induction (7). These observations support the interpretation that induction represents an important marker of reduced VBAC probability, although the indication for induction and cervical favorability may partly explain the observed association.

Previous vaginal delivery and previous VBAC were independently associated with successful VBAC in the present analysis. This finding is biologically and clinically plausible and is strongly supported by previous evidence. A meta-analysis of 94 observational studies involving more than 239,000 pregnancies found previous vaginal birth and previous VBAC among the strongest predictors of successful VBAC (8). Similar associations have been demonstrated in more recent systematic reviews, emphasizing the importance of previous vaginal birth, cervical status, and other obstetric characteristics when estimating the probability of TOLAC success (9). Importantly, these characteristics should be considered alongside, rather than replaced by, intrapartum management variables.

Oxytocin exposure was associated with lower VBAC success and a higher frequency of several intrapartum complications in this cohort. The association with uterine rupture is particularly relevant because rupture is uncommon but potentially severe. A meta-analysis of 14 observational studies involving 48,457 TOLACs found uterine rupture rates of 1.4% with oxytocin exposure versus 0.5% without exposure (4). More recent evidence strengthens this concern: a 2026 systematic review of 21 observational studies involving 51,511 TOLACs found higher odds of rupture with oxytocin use and suggested that escalation intervals and cumulative exposure may be clinically relevant (10). A contemporary cohort similarly reported increasing odds of rupture with greater maximum oxytocin exposure and longer exposure duration (11). Nevertheless, these findings should not be interpreted as evidence that oxytocin itself causes failed TOLAC, because women requiring augmentation frequently have prolonged or dysfunctional labor, which independently increases the likelihood of operative delivery.

The observed association between intrapartum pharmacotherapy and operative vaginal delivery, without a significant independent association with VBAC success after adjustment, is also consistent with the heterogeneous evidence surrounding analgesia during TOLAC. Earlier large observational data suggested that epidural analgesia could coexist with high VBAC rates without an appreciable increase in uterine rupture or adverse maternal-neonatal outcomes (5). Conversely, epidural exposure has been associated with increased operative intervention in some cohorts, making confounding by labor duration and dystocia an important consideration. The present findings therefore support viewing pharmacotherapy primarily as a component of intrapartum management rather than as an isolated determinant of delivery mode.

The perinatal findings provide an additional clinically relevant dimension. Induced labor was associated with higher frequencies of low 5-minute Apgar scores and NICU admission, although several other neonatal outcomes did not differ significantly. Similar findings have been reported in retrospective studies of induced TOLAC, including a French cohort in which induction was associated with a higher composite adverse perinatal outcome after adjustment (12). Population-based evidence also suggests that neonatal morbidity during TOLAC is generally uncommon but becomes substantially greater when uterine rupture occurs (13). Importantly, the present associations should not be interpreted as evidence that induction directly produces neonatal morbidity, because maternal indication for induction, gestational age, labor complications, and emergency cesarean delivery may contribute to these outcomes.

The clinical implications of these results are that there should be a more personalized approach to intrapartum risk assessment instead of avoidance of TOLAC or induction. There has been recent evidence to suggest that induction following previous cesarean may be considered in an appropriate selected population and that outcome is dependent on cervical status, prior vaginal delivery, fetal characteristics and the indication for induction (14). In addition, modern research has stressed the importance of patient selection, and the ability to provide prompt obstetric and neonatal medical intervention in the safety profile of TOLAC (15). Thus, the results argue for judicious use of oxytocin, ongoing intrapartum monitoring and careful selection, rather than induction or pharmacologic analgesia as absolute deterrents to TOLAC.

CONCLUSION

Women who had spontaneous labor were more likely to have a successful VBAC, while women who were induced or exposed to oxytocin were less likely to have a successful VBAC and were more likely to experience selected adverse maternal and/or perinatal outcomes, among women who underwent TOLAC. Previous vaginal delivery and previous VBAC were still significant independent predictors of a successful TOLAC. The results of this research agree with individualized patient selection, carefully planned induction and the judicious use of oxytocin in intrapartum care with close monitoring of the patient.

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