Outcomes of Trial of Labor after a Cesarean Section in Bomet County, Kenya

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ABSTRACT

Trial of labor after cesarean section (TOLAC) is recommended for women with one prior cesarean section. However, TOLAC positive outcomes depend on proper selection of candidates to achieve higher success rates. Most available TOLAC data to inform patient selection originates from developed countries, which limits a patient-centered TOLAC practice in low-resource settings. Thus, we used a prospective observational cross-sectional approach to assess the success rate of TOLAC and establish the maternal and fetal factors associated with successful TOLAC in 170 women with one previous scar at two referral hospitals in Bomet County, a low-resource setting in Kenya. The primary maternal and neonatal outcomes were compared between those who had a vaginal birth after a cesarean section (VBAC) and those who had an emergency repeat cesarean section (ERCS) following a failed TOLAC between October 2022 and June 2023. The TOLAC success rate was 48.2% with the most common indication for emergency repeat cesarean section being failure to progress (34.1%). Factors associated with successful TOLAC included inter-delivery interval >60 months (p-0.044), and parity 2-4 (p- <0.001). Breech presentation and non-reassuring fetal status (NRFS) as indications for previous cesarean section, were associated with a successful VBAC (p-< 0.001, 0.033), while a birth weight of >3500 g was associated with increased risk of ERCS. Moreover, a failed TOLAC was associated with a prolonged (>4 days) hospital stay (p-0.012). Altogether, our findings suggest that with proper patient selection, TOLAC remains a viable option with better outcomes if successful. However, TOLAC candidates should be evaluated based on the contextual factors of a given setting, hence careful patient selection is recommended to improve outcomes associated with TOLAC.

Keywords: ERCS, Outcomes, TOLAC, VBAC.

I. INTRODUCTION

The once-popular dogmatic mantra: "Once a cesarean section, always a cesarean section (CS)" (Cragin, 1916) had far-reaching consequences contributing to the increase in CS deliveries with associated morbidity and mortality. While the CS is a lifesaving surgical procedure when medically indicated, the CS rate in both developed and developing countries continues to steadily increase in recent times—raising concerns of whether primary or repeat cesarean sections are necessary, with previous cesarean section being the most common indication for most cesarean sections (Betrán *et al.,* 2016; Barber *et al.,* 2011). The rise has been occasioned by several changes in the practice environment such as continuous electronic fetal monitoring, decrease in operative vaginal deliveries, and a decrease in attempts to conduct breech vaginal deliveries (Goetzinger & Macones, 2008; Lee *et al.,* 2008). Nevertheless, optimizing CS is of clinical importance since both underuse and overuse often lead to higher maternal and perinatal mortality. Lower CS rates levels could indicate an unmet need for CS as an essential health care service which contributes to an increase in morbidity and mortality (Betran *et al.,* 2021; Makinde *et al.,* 2020). A higher rate of more than the 10% as recommended by World Health Organization (WHO) is not associated with improved maternal and neonatal outcomes and may be associated with negative outcomes such as infections, and hemorrhage that burden both human and financial resources (WHO, 2015).

To reduce the increasing rate of cesarean section, various organizations and expert panels have recommended that women who meet a set criterion can attempt Trial of Labor After Cesarean Section [TOLAC] (American College of Obstetricians and Gynecologists [ACOG], 2019; Dy *et al.,* 2019; WHO, 1985). Trial of Labor after Cesarean section delivery (TOLAC) is the attempt to deliver vaginally after a cesarean section regardless of the outcome (ACOG, 2019). This offers women who desire to deliver vaginally that possibility—a VBAC. The set criteria to be considered for TOLAC includes, one previous cesarean section, lower transverse uterine incision in the previous CS, cephalic presentation and no other uterine scar such as myomectomy (Lalonde, 2005). Additionally, the facility in which a woman with a previous scar can attempt TOLAC should have resources to perform emergency repeat cesarean section (ERCS) within an appropriate period of time, preferably, within ten minutes of the decision. Such resources should include; a qualified clinician who is able to monitor labor and perform an ERCS, a clinician capable of administering obstetric anesthesia, nursing personnel to assist in the ERCS and a clinician capable of performing neonatal resuscitation should there be a need (Miazga *et al.,* 2022; ACOG, 2019).

Among the benefits of TOLAC as highlighted by ACOG (2019) include, avoidance of major abdominal surgery, lowered rates of thromboembolic events, and shorter recovery periods. The decision to go through labor for women with a previous scar, however, depends on several factors ranging from medical and obstetric indications to maternal preferences and the delivery settings (ACOG, 2019). Therefore, good candidates for TOLAC should be able to balance the risk associated with TOLAC with high chances of success and low risk as possible in order to optimize the positive outcomes. As such, a critical challenge is the selection of suitable TOLAC candidates which relies on relevant data that is often unavailable in most Sub-Saharan (SSA) facilities. For example, due to the risks of uterine rupture, TOLAC may not be recommended when operative records with information such as the incision type of the previous CS is unknown. Further, ACOG guides that TOLAC may not be a reasonably safe option for patients with a prior transfundal uterine incision and a prior uterine rupture (ACOG, 2019). Such operative history can only be available where proper medical records keeping and maintenance systems are well established.

Apart from patient management, medical records have been useful in TOLAC studies, several of which have been retrospective. Various observational studies have assessed the success rate of TOLAC, with the rate reported at 60-80% worldwide (Dodd et al., 2013). Wanyonyi (2010) has estimated the rate of vaginal birth to be between 54 and 97% in Sub-Saharan-African. This success rate, however, varies with large margins in different setups. For instance, a retrospective study in Kiambu, Kenya, documented a TOLAC success rate of 50.7%, which is below that of developed countries (Musila *et al.*, 2015). A separate study done at Pumwani hospital, Nairobi, Kenya, documented a success rate of 45.5% (Kimotho, 2009). These differences across studies have been largely attributed to patient selection. With careful patient selection, the rate of patients undergoing TOLAC may decrease with a resultant increase with successful VBAC rate (Parveen *et al.*, 2022; Thapsamuthdechakorn *et al.*, 2018). Nevertheless, further research is needed to help understand the TOLAC success rate disparity in local resource-limited and demographic contexts, while considering both maternal and neonatal outcomes to guide TOLAC candidate selection.

To address the problem of limited data in low-resource setups, this study sought to assess the success rate of TOLAC and establish the maternal and fetal factors associated with successful TOLAC in women with one previous scar within the low-resource setting of Bomet, Kenya. We anticipate that the data obtained in this study will have important implications for TOLAC practice with respect to patient selection for favorable TOLAC outcomes in the region, and in other similar low-resource setups.

II. METHODOLOGY

Study Design and Population

This was a prospective observational cross-sectional study at Tenwek Hospital and Longisa County Referral Hospital in Bomet, Kenya from October 2022 to June 2023. To our knowledge, since there were no TOLAC studies in the region, an observational cross-sectional study would help establish baseline data on TOLAC success rate and the associated factors as well as complications. Further, the study design allowed us to exercise a greater control over the data collection process in strict adherence to our inclusion and exclusion criteria. The two facilities are both level 5 referral hospitals in the county; Tenwek Hospital is a faith-based referral institution, while Longisa County Referral Hospital is a government facility. Hospitals in Kenya are classified from levels 1 - 6 according to the complexity of medical services offered. Level 5 hospitals have the capacity to offer specialized services and support training and research within their respective counties. Nevertheless, there could be differences in the capacities of different hospitals at the same level with regard to practice of certain medical procedures depending several factors including resources. For example, Tenwek requires informed consent for attempting TOLAC and has a screening criterion for eligible candidates. On the other hand, Longisa practices TOLAC for all patients with one previous cesarean section.

During this study period, patients who presented at the two facilities at a more than 36 weeks' gestational age and had consented to attempt TOLAC were included in the study under the following inclusion criteria: having had one previous cesarean section, a single intrauterine pregnancy with cephalic presentation, and a gap of at least 18 months since their previous cesarean section.

We excluded patients with any of the following conditions: a classical uterine incision from a prior cesarean section, previous histories of uterine myomectomy, rupture, or fetal anomalies. This study was approved by the Tenwek hospital institutional research ethics committee, Kabarak university research ethics committee, as well as the National Council of Science, Technology & Innovation – Kenya (*Approval no. NACOSTI/22/21093*).

Data Collection

Data on demographics, previous pregnancies and antenatal clinic visits were recorded at admission, while the data on neonatal and maternal outcomes, including information regarding the outcomes of delivery and actual mode of delivery that were retrieved directly from the patient and neonate charts in the hospital database at the time of discharge. The maternal complications and/or outcomes that were assessed included: hemorrhage with need for blood transfusion, infection postpartum as described by temperature >38ºC, wound infection, uterine tenderness, purulent lochia, or extended antibiotic coverage and mortality. Delivery associated trauma included uterine rupture, operative visceral injury, perineal and cervical lacerations. Maternal death was assessed. Neonatal outcomes/ or complications included asphyxia, Oxygen requirement, APGAR score of < 7 at 5 minutes, Neonatal Intensive Care Unit (NICU) admission for whatever indication and neonatal death.

Data Analysis

Data analyses involved exploratory, descriptive and inferential approaches using Statistical Package for Social Sciences (SPSS) v24. Variable data was categorized into ordinal and continuous variables. Descriptive statistics included measures of central tendency and dispersion i.e., mean (standard deviation) or median (interquartile range) for parametric and non - parametric continuous variables respectively. Categorical data was described using frequencies and percentages. Moreover, categorical variables were analyzed by odds ratios and Pearson's chi-squared test. A *p*-value of 0.05 was applied for statistical significance.

III. RESULTS

Demographic Characteristics of Participants and TOLAC Outcome Association

A total of 170 women underwent trial of labor after a cesarean section (TOLAC) in the two study centers during the study period (October 2022 – June 2023). We determined the success rate of TOLAC based on the actual mode of delivery where VBAC was considered a success while an ERCS was considered a failed TOLAC. Of the 170 deliveries, 82 delivered by VBAC, which represents 48.2% of all the deliveries.

The mean age of the study participants was 28.1 (SD 4.8) with their ages ranging between 18 and 42 years old with most of the participants being married (92.4%). As for their occupation, 43.5% were casual laborers with 28.2%, 16.5% and 11.8% being unemployed, in formal employment and self-employed, respectively. A majority (71.8%) of the patients had at least a secondary school level of education. Women aged between 26 to 35, and 36 to 45 years had increased likelihood of having a successful TOLAC (OR 1.3) compared to the 18 to 25 years old age group. In contrast, the self-employed were less likely to have successful TOLAC when compared to those in formal employment (OR 0.5), while the casually employed and unemployed had an equal probability of having a successful TOLAC when compared to the formal (OR=1.0). The participants' demographic characteristics and associations to TOLAC outcomes is summarized in Table 1.

Table 1:

Descriptive Summary of the Study Participants' Demographic Characteristics and Association with TOLAC Outcomes

	Overall, n=170 (*%*)	VBAC *(n=82)*	ERCS*(n=88)*	OR (95% CI)	*p*-value
Age in years, *n (%)*					
18 – 25	59 (34.7)	26 (31.7)	33 (37.5)	Reference	
26 – 35	101(59.4)	51 (62.2)	50 (56.8)	1.3 (0.7 – 2.5)	0.433
36 – 45	10 (5.9)	5 (6.1)	5 (5.7)	1.3 (0.3 – 4.9)	0.728
Marital status, *n (%)*					
Married	157 (92.4)	75 (91.5)	82 (93.1)	Reference	
Single	10 (5.9)	6 (7.3)	4 (4.5)	1.64 (0.5-6.0)	0.633
Separated or divorced	3 (1.8)	1 (1.2)	2 (2.3)	0.55 (0.1-6.2)	0.620
Occupation, *n (%)*					
Formal	28 (16.5)	14 (17.1)	14 (15.9)	Reference	
Self	20 (11.8)	7 (8.5)	13 (14.8)	0.5 (0.2 – 1.8)	0.304
Casual	74 (43.5)	37 (45.1)	37 (42.0)	1.0 (0.4 – 2.4)	1.000
Unemployed	48 (28.2)	24 (29.3)	24 (27.3)	1.0 (0.4 – 2.5)	1.000
Education, *n (%)*					
Primary	21 (12.4)	13 (15.9)	8 (9.1)	1.85 (0.7-4.8)	0.199
Secondary	122 (71.8)	57 (69.5)	65 (73.9)	Reference	
Tertiary	27 (15.9)	12 (14.6)	15 (17.0)	0.9 (0.4-2.1)	0.830

n, OR, VBAC, ERCS represent sample population, Odds Ratio, Vaginal Birth after Cesarean Section (successful TOLAC), Emergency Repeat Cesarean Section (failed TOLAC) respectively.

Maternal Characteristics, Factors & Indications for Failed TOLAC

We noted various indications for failed TOLAC—with the most common indication being poor progress of labor (34.1%) followed by non-reassuring fetal status (NRFS) (31.8%). The least common indications for failed trial of labor were fetal macrosomia, failed induction and abruption placentae reported at 1.1% each. Maternal choice for repeat cesarean section after the onset of labor accounted for 13.6% of the repeat cesarean section as summarized in Table 2, with most of the repeat cesarean sections occurring during the active phase of labor at 60.2% (see Table 3).

Table 2:

Observed Indications for Cesarean Section During this Study

	Frequency (n=88)	Percent
Poor progress	30	34.1
NRFS	28	31.8
Maternal choice	12	13.6
Malposition	4	4.5
Arrest of 2nd stage	5	5.7
"Impending uterine rupture"	3	3.4
Cord presentation	2	2.3
Abruption	1	1.1
Failed induction	1	1.1
Macrosomia	1	1.1

Table 3:

Recorded Cervical Dilation at Time of Cesarean Section

Dilation at CS	Frequency (88)	Percent
< 6 cm	35	39.7
> 6 cm	53	60.3

Women with an inter-delivery interval period of 25-48 months had 1.3 times odds of having a successful VBAC while those between 49-60 had an equal chance as compared to those with inter-delivery interval of less than 24 months (Table 4). Further, those with inter-delivery interval of >60 months were 2.7 times more likely to have a successful trial of labor after a cesarean section as compared to those with an inter-delivery interval of less than 24 months (p-0.044). Analysis regarding parity at enrolment indicated that those who had a parity of between 2-4 had a 3.8 likelihood of having vaginal delivery as compared to those who were para one (p-<0.001), while those with parity of more than 5 having an odd of 4.6 (p-0.077). Notably, however, the probability of having a successful TOLAC increased with history of prior successful trial of labor with an odds ratio of 7.2 (p-<0.001). Women with 1-2 previous vaginal deliveries had a 3.2 likelihood of having a vaginal delivery (p-0.002) and those with more than three prior deliveries having a 4.5 likelihood of having successful TOLAC (p-0.008) compared to those with no prior vaginal delivery.

Table 4:

Association of Antenatal Visit and Inter-Delivery Interval as Stratified by Delivery Mode

ANC visit, *n (%)*	Overall, n=170 (*%)*	VBAC *(n=82)*	ERCS*(n=88)*	OR (95% CI)	*p*-value
<4	65 (38.3)	35 (42.7)	30 (34.1)	1.4 (0.8 – 2.7)	0.250
≥4	105 (61.7)	47 (57.3)	58 (65.9)	Reference	
Inter-delivery interval, *n (%)*					
≤24	30 (17.6)	12 (14.6)	18 (20.5)	Reference	
25 – 36	37 (21.8)	17 (20.7)	20 (21.7)	1.3 (0.5 – 3.4)	0.625
37 – 48	33 (19.4)	15 (18.3)	18 (20.5)	1.3 (0.5 – 3.4)	0.662
49 – 60	28 (16.5)	11 (13.4)	17 (19.3)	1.0 (0.3 – 2.8)	0.956
>60	42 (24.7)	27 (32.9)	15 (17.0)	2.7 (1.0 – 7.1)	0.044
Previous VD after first CS, *n (%)*					
Yes	30 (17.6)	25 (30.5)	5 (5.7)	7.2 (2.6 – 20.1)	<0.001
No	140 (82.4)	57 (69.5)	83 (94.3)	Reference	
Parity, *n (%)*					
1	102 (60)	36 (43.9)	66 (75.0)	Reference	
2 – 4	61 (35.9)	41 (50.0)	20 (22.7)	3.8 (1.9 – 7.4)	<0.001
≥5	7 (4.1)	5 (6.1)	2 (2.3)	4.6 (0.8 – 24.8)	0.077
Medical History, *n (%)*					
Yes	9 (5.3)	3 (3.7)	6 (6.8)	0.5 (0.1 – 2.1)	0.365
No	161 (94.7)	79 (96.3)	82 (93.2)	Reference	

n, OR, VBAC, ERCS, ANC, VD, CS represent sample population, Odds Ratio, Vaginal Birth after Cesarean Section (successful TOLAC), Emergency Repeat Cesarean Section (failed TOLAC), Antenatal Care Visits,Vaginal Deliveries and Cesarean Section respectively.

Further, birth weights of 2000-2500g, 3001-3499g and >3500g were associated with 1.0, 0.8 and 0.4 times the likelihood respectively of having successful trial of labor as compared to those with infants weighing between 2500 and 3000g. However, a statistically significant difference was noted in those weighing >3500g (p-0.020) as shown in Table 5.

Table 5:

Birth Weight Association with Final Birth Delivery Outcomes

Birth Weight (*g*), *n (%)*	VBAC *(n=82)*	ERCS*(n=88)*	OR (95% CI)	*p*-value
2000 – 2500	9 (11.0)	7 (8.0)	1.0 (0.3 – 3.1)	0.951
2501 – 3000	24 (29.3)	18 (20.5)	Reference	
3001 – 3500	33 (40.2)	30 (34.1)	0.8 (0.4 – 1.8)	0.631
>3500	16 (19.5)	33 (37.5)	0.4 (0.2 – 0.9)	0.020

n, OR, VBAC, ERCS represent sample population, Odds Ratio, Vaginal Birth after Cesarean Section (successful TOLAC) , Emergency Repeat Cesarean Section (failed TOLAC) respectively.

With regard to indication of the first CS, the women who had mal-presentation as the indication for the first cesarean section were 7.0 times more likely to have a successful VBAC as compared to those who had CPD (p-0.001), while those with NRFS as an indication for previous CS having a probability of 3.4 (p-0.033). Prolonged labor and CPD in the previous cesarean section delivery were associated with increased probability of failed TOLAC. There was no statistically significant difference in the other indications of the previous cesarean section in relation to the mode of delivery as summarized in Table 6.

Table 6:

First Cesarean Section Indication Association, Stratified by Delivery Outcomes

First CS indication, *n (%)*	VBAC *(n=82)*	ERCS*(n=88)*	OR (95% CI)	*p*-value
Cervical dystocia	1 (1.2)	0 (0.0)	-	-
	5 (6.1)	17 (19.3)	Reference	
Failed induction	1 (1.2)	0 (0.0)	-	-
Malpresentation/Malposition/Breech/Cord presentation	29 (35.4)	14 (15.9)	7.0 (2.2 – 23.0)	0.001
Multiple gestation	2 (2.4)	3 (3.4)	2.3 (0.3 – 17.6)	0.434
NRFS	28 (34.1)	28 (31.8)	3.4 (1.1 – 10.5)	0.033
Pre-eclampsia/Eclampsia/HTN	3 (3.7)	4 (4.5)	2.6 (0.4 – 15.4)	0.308
Prolonged labor	11 (13.4)	19 (21.6)	2.0 (0.6 – 6.8)	0.286
Shoulder dystocia	0 (0.0)	1 (1.1)	-	-
Unknown	2 (2.4)	2 (2.3)	3.4 (0.4 – 30.7)	0.275

n, OR, VBAC, ERCS, NRFS, HTN represent sample population, Odds Ratio, Vaginal Birth after Cesarean Section (successful TOLAC), Emergency Repeat Cesarean Section (failed TOLAC) Non Reassuring Fetal Status, and Hypertension respectively.

Maternal and Perinatal Complications Associated with TOLAC

Results on maternal complications indicated that 6.5% of the women received blood transfusion, 72.7% of whom had ERCS compared to 27.3% who had a VBAC. Though not statistically significant (p-0.164), successful trial of labor was associated with a decrease in the need for blood transfusion (OR 0.4) and a decreased risk of postpartum infection (p-0.706) (OR-0.8).

Moreover, up to 9.4% of women were treated for infection with one case of surgical site infection, and 11.8% of women incurred delivery associated trauma. However, there was no statistically significant difference between the two groups. The delivery trauma reported included perineal and cervical tears with one case of bladder injury at cesarean section while no uterine rupture was recorded in both Longisa and Tenwek hospitals. In general, VBAC was associated with a significantly increased risk of delivery trauma (OR 25 and p-0.002) discounting the “trauma” of cesarean section itself.

The most common delivery associated trauma reported in this study were cervical and vaginal lacerations with one case (0.59%) of bladder injury at cesarean section and no uterine rupture reported. The typical length of stay in the two study facilities for an uncomplicated vaginal delivery is 24 hours while that of a cesarean section is 2 days. Prolonged hospital stay was defined as a hospital stay of more than 4 days which could indicate a complication. As shown in Table 7, we recorded a statistically significant decreased probability of a prolonged hospital stay of more than 4 days with VBAC (OR 0.2; p- 0.012). Moreover, no maternal mortality was reported in the two facilities for the duration of the study.

Table 7:

Maternal Complications Associated with TOLAC in This Study

Blood transfusion, *n (%)*	Overall, n=170	VBAC	ERCS	Odds Ratio	*p value*
Yes	11 (6.5)	3 (3.7)	8 (9.1)	0.4 (0.1 – 1.5)	0.164
No	159 (93.5)	79 (96.3)	80 (90.9)	Reference	
Infection, *n (%)*					
Yes	16 (9.4)	7 (8.5)	9 (10.2)	0.8 (0.3 – 2.3)	0.706
No	154 (90.6)	75 (91.5)	79 (89.8)	Reference	
Delivery associated trauma, *n (%)*					
Yes	20 (11.8)	19 (23.2)	1 (1.1)	25.2 (3.4 – 201.2)	0.002
No	150 (88.2)	63 (76.8)	87 (98.9)	Reference	
Hospital stay, *n (%)*					
Not prolonged	150 (88.2)	78 (95.1)	72 (81.8)	Reference	
Prolonged	20 (11.8)	4 (4.9)	16 (18.2)	0.2 (0.1 – 0.7)	0.012

Among the Fetal complications assessed, newborns with an APGAR score at 5 minutes of <7 were at 6.5%. Up to 15.3% of the neonates were admitted to NICU—with the most common indication of admission being a low APGAR score at 5 minutes (30.7%) and risk of sepsis (19.2%) (Table 8). “Risk of sepsis” included findings of prolonged rupture of membranes or foul smelling amniotic fluid. Additional indications included oxygen requirement (15.4%), “risk of hypoglycemia” due to fetal macrosomia (11.5%), jaundice (7.7%), meconium aspiration (7.7%), seizures (3%) and for monitoring (3%). In total, there were five perinatal deaths (2.9%), four of which were delivered via ERCS for NRFS with 2 of them being fresh stillbirths. The only perinatal death delivered via VBAC had meconium aspiration (Table 9). Further, VBAC was associated with reduced incidence of neonatal death (OR- 0.3) but didn’t reach statistical significance (p-0.232) as recorded in table 8.

Table 8:

Fetal Complications Associated with TOLAC in this Study

APGAR score, *n (%)*	Overall, n = 170	VBAC	ERCS	Odds Ratio	*p value*
<7	11 (6.5)	4 (4.9)	7 (8.0)	0.6 (0.2 – 2.1)	0.420
≥7	159 (93.5)	78 (95.1)	81 (92.0)	Reference	
NICU admission, *n (%)*					
Yes	26 (15.3)	10 (12.2)	16 (18.2)	0.6 (0.3 – 1.5)	0.281
No	144 (84.7)	72 (87.8)	72 (81.8)	Reference	
Neonatal death, *n (%)*					
Yes	5 (2.9)	1 (1.2)	4 (4.5)	0.3 (0.03 – 2.4)	0.232
No	165 (197.1)	81 (98.8)	84 (95.5)	Reference	

n, OR, VBAC, ERCS, APGAR, NICU represent sample population, Odds Ratio, Vaginal Birth after Cesarean Section (successful TOLAC), Emergency Repeat Cesarean Section (failed TOLAC), Appearance, Pulse rate, Grimace Activity Respiratory rate and Neonatal Intensive Care Unit respectively.

Table 9:
Indications for Nursery admission

	Frequency (*n=26*)	Percent
Birth asphyxia	8	30.7
Risk of sepsis	5	19.2
Oxygen requirement/assisted ventilation	4	15.4
Risk of hypoglycemia	3	11.5
Jaundice	2	7.7
Meconium aspiration	2	7.7
Monitoring	1	3.8
Seizures	1	3.8

IV. DISCUSSION

In this study, we calculated a 48.23% TOLAC success rate in 170 women with subsequent pregnancy greater than or equal to 18 months from their primary CS. This study rate falls within the range calculated in two previous retrospective studies performed in Pumwani and Kiambu hospitals in Kenya which reported a success rate of 45.5% and 50.1% respectively (Kimotho, 2009; Musila *et al.*, 2015). However, the study rate is generally lower than the rate demonstrated in various studies in developed countries, most of which report a success rate of 60-80% (Birara & Gebrehiwot, 2013; Parveen *et al.*, 2022). The large disparities of TOLAC success rates and outcomes between developed and developing countries have been ascribed to various factors including delays in access to healthcare services, lack of constant availability of operating rooms in cases of emergency, poor record-keeping, unavailability of painless labor, and unknown details of indication and type of previous cesarean section (Thapsamuthdechakorn *et al.*, 2018). Even so, there is also a notable difference in the rate of TOLAC across studies ranging from 20 to 80% worldwide which have been largely attributed to patient selection. Arguably, a careful patient selection will eliminate high risk TOLAC candidates from attempting VBAC with a resultant increase in successful TOLAC rates (Parveen *et al.*, 2022; Thapsamuthdechakorn *et al.*, 2018).

According to ACOG, factors including inter-delivery interval, no contraindication to vaginal delivery, and non-recurring indication of the primary CS are important guides in proper patient selection for successful TOLAC. In our study, an inter-delivery interval of more than 60 months and malpresentation—in particular breech presentation, as the indications for primary cesarean section were associated with increased probability of successful TOLAC. The most common indication for emergency repeat cesarean section was poor progress of labor followed by non-reassuring fetal status. Previous studies have reported the most common indication for failed TOLAC to be fetal distress followed by failed induction (Mounika *et al.*, 2022; Gupta *et al.*, 2014). These studies have recommended continuous intrapartum fetal and maternal monitoring to help minimize the risk associated with ERCS.

Although intrapartum management of TOLAC patients is similar to that in patients with an unscarred uterus, patients with a previous scar are more at risk given the increased chances of uterine rupture. Therefore, continuous intrapartum fetal and maternal monitoring assists in understanding the response of fetal heart rate to the maternal uterine contractions as the labor progresses. Such monitoring may help reduce incidences of neonatal seizures due to hypoxia during labor and injuries to the mother as it informs the decision when to undertake ERCS (ACOG 2019).

However, the capacity to undertake continuous intrapartum fetal and maternal monitoring is limited in most rural hospitals in Kenya. In this study for example, the capacity for continuous fetal and maternal monitoring was only available at Tenwek hospital and not Longisa hospital despite the former being the government referral center in the county.

The current study demonstrated that maternal choice after onset of labor played a significant role in ERCS, accounting for 13.6% of failed TOLAC. This observation was also noted in a study conducted in Iraq, which suggested that lack of anesthesia, such as epidural anesthesia, during the labor period could be the underlying cause (Abdulrahman & Ismail, 2021). A systematic review by Jenabi et al. (2020) observed an increase in the number of cesarean sections being conducted for maternal request without medical or obstetric indication. Further, they noted that maternal request was associated with higher levels of education and formal employment. Jenabi et al. (2020) argue that maternal choice for cesarean section to be due to fear of childbirth, fear of labor pains, and avoidance of labor pains. While our study did not elucidate the reasons for maternal choice for repeat cesarean section, the observation that most ERCS were conducted at active phase of labor could be explained by similar reasons advanced by Abdulrahman, & Ismail (2021) and Jenabi et al. (2020).

Maternal choice and requests underscores the need for patients to be provided with evidence-based information to guide their decision-making when considering TOLAC. Where TOLAC is anticipated, women should be consented for TOLAC and ERCS. Informed consent for TOLAC should include an evidence-based discussion of the risks associated with TOLAC as well as the success rate of TOLAC (ACOG 2019). Even though this was not a comparative study between Longisa and Tenwek hospitals, it was however observed that only Tenwek hospital routinely administers a TOLAC consent form. In Tenwek Hospital, patients are required to sign a TOLAC consent form after being counseled on the mode of delivery. While in Longisa county referral hospital, it is presumed that the patients are counseled on the mode of delivery during the ANC visits and at admission. However, there was no evidence of consent taken. Of the patients that were offered counseling, 37.5% chose Planned Repeat Cesarean Section.

The maternal complications assessed in the current study included delivery trauma, receipt of blood transfusion, and postpartum infection. The birth trauma assessed in this study included uterine rupture, perineal and cervical lacerations and visceral injuries. There were no reported cases of uterine rupture in the current study, though, one case of bladder injury was reported in the ERCS group. Other delivery traumas that were reported included perineal and cervical tears in the VBAC group. Uterine rupture has been cited in several studies as the reason for decline in TOLAC rates worldwide with the incidence reported to increase with failed TOLAC (Habak & Kole, 2020; Bangal *et al.,* 2013; Dodd *et al.,* 2013). A study in India reported an incidence of uterine rupture of 0.5% while that of scar dehiscence was at 2.1% (Parveen *et al.,* 2022). As in the present study, no patient was reported to have had hysterectomy in the India study. Nevertheless, other studies have reported varied incidences of uterine rupture ranging from 0.5-4.2% (Balachandran *et al.,* 2014; Bangal *et al.,* 2013; Parveen *et al.,* 2022).

Delivery trauma such as uterine rupture during TOLAC may cause bleeding that may require blood transfusion. Notably, however, blood transfusion in this study was higher in the ERCS than in the TOLAC group—albeit not statistically significant, which contrasts other studies that have reported significant increased rate of blood transfusion in ERCS patients within sub-Saharan Africa (Oboro *et al.,* 2010). The lack of significance in our blood transfusion results could be an implication of the small population size. Nevertheless, the possibility for blood transfusion is among important considerations for facilities in which TOLAC is to be practiced given the increased risk of uterine rupture and ERCS complications including postpartum hemorrhage (PPH) that may require blood transfusion in such settings. Like most low middle income countries, Kenya has a high demand for blood transfusion services and suffers dire shortages. An estimated seven people require a blood transfusion every 10 minutes while only 16% of the blood needed in Kenya is being collected (WHO 2022; World Bank, 2022). Timely access to blood transfusion is a critical healthcare intervention for emergency situations such as the obstetric hemorrhage from both TOLAC and ERCS. The indication that ERCS is associated with a higher transfusion rate in this study underpins the need for facilities practicing TOLAC to be prepared for such emergencies.

Postpartum infection is any bacterial infection of the reproductive tract after delivery. Postpartum infection accounts for significant and often preventable maternal morbidity and mortality. It is among the top five causes of maternal mortality globally as it accounts for 10-15% of maternal mortality in the postpartum period (Prestinaci *et al.,* 2015). In this study, we described it by temperature >38ºC, wound infection-purulent discharge, uterine tenderness, purulent lochia, extended antibiotic use with elevated white blood cells and chorioamnionitis (Belfort *et al.,* 2010). The incidence of postpartum infection in this study was noted to be 9.4% with a higher rate in the ERCS compared to the TOLAC group. Generally, both TOLAC and ERCS are not without risks of infection, however, the infection rate is likely to increase when ERCS becomes necessary (Armstrong, 2011). A number of studies report the incidence of postpartum infection to be more in women who undergo cesarean section as opposed to vaginal delivery with the risk increasing in women who had undergone labor before the cesarean section (Axelsson *et al.,* 2018; Allen *et al.,* 2003; Leth *et al.,* 2009). In their study, Allen *et al.* (2003) noted that incidence of endometritis was five to ten times more following a cesarean section delivery as compared to vaginal delivery. Surgical site infection is reported to complicate about 2-7% of cesarean section deliveries with history of prior cesarean section increasing the risk. This has been thought to be due to poor vascularization of scar tissue from prior surgery (Axelsson *et al.,* 2018; Olsen *et al.,* 2008).

Neonatal complications assessed in this study included a five-minute APGAR score of less than 7, admission to NICU, and neonatal death. Although there was no statistically significant difference between ERCS and VBAC groups, other studies have indicated that neonatal morbidity is highest in cases of failed trial of labor compared to VBAC and PRCS (Oboro *et al.,* 2010; Thapsamuthdechakorn *et al.,* 2018). Arguably, a trend towards significance could also have become apparent with a larger population size in our study. A recent cohort study done in England APGAR score of less than 7 at 5 minutes in nulliparous low risk women was at 1.2% while that of multiparous women and previous scar which was considered as high risk pregnancy was at 2.9%. The APGAR score was reported in the current study at 6.8%, which is worse compared to the above mentioned study (Jardine *et al.,* 2020). As regards the perinatal death of 2.9% in this study, it comparably was higher than a 2.4% rate reported by Ayah *et al.* (2018) from a cross sectional study done in six primary referral hospitals in Kiambu and Nairobi. In the same study by Ayah et al. (2018), perinatal mortality in Kiambu and Nairobi was reported to be 2.6 times higher in public

hospitals than in private and faith based hospitals—and this was attributed to differences in the quality of care.

The study assessed various factors associated with the success/failure of TOLAC. Among the factors assessed included patients' demographics such as age and occupation, co-morbidities and past obstetric history such as parity, indication for first cesarean section, inter-delivery interval, and previous vaginal deliveries. Among important factors on the obstetric history, a parity of between 2-4 was associated with successful TOLAC. This finding confirms observations of other previous studies that patients with no previous vaginal deliveries undergoing TOLAC are at a higher risk of adverse TOLAC outcomes than multiparous (parity 2-4) and grand multiparous (>5 parity) women (Lopian *et al.,* 2023; Kalok *et al.,* 2018; Mekonnen & Asfaw, 2013; Wu *et al.,* 2019). Kalok et al. (2018) argue the reason why a previous vaginal delivery has a higher chance of successful VBAC is that multiparous women have a higher likelihood of developing effective uterine contractions in labor and have less challenges in subsequent pregnancies. However, this claim requires further study.

Inter-delivery period or inter-pregnancy interval—as also referred to by other authors, was an important determinant on VBAC success or failure in this study. In particular, a short inter-delivery interval of less than 24 months was associated with failure while a period of >60 months was associated with higher chances of VBAC success in this study. In general, most studies and guidelines support an association of short delivery-intervals with VBAC failure. For example, ACOG guidelines suggest that an inter-delivery period of <19 months reduced the success rate of VBAC (ACOG, 2019), while the Society of Obstetricians and Gynecologists of Canada associate an inter-delivery period of < 18 months with an increased risk of uterine rupture when attempting TOLAC. Further, a multicenter cohort study in China on the optimal inter-delivery period concluded that an inter-delivery period of <24 and >120 months increased the risk of major maternal and neonatal TOLAC outcomes.

Neonatal birth weights of more than 3500 g were associated with an increased risk of ERCS. This finding confirms previous studies that have shown fetal weight to be of high prognosis value on TOLAC success (Maroyi *et al.,* 2021; Thapsamuthdechakorn *et al.,* 2018; Parveen *et al.,* 2022). A consistent finding is that the greater the fetal weight, the lower the likelihood of a successful VBAC. A previous VBAC study in the West African setting calculated that the CS rate for women with a fetal weight of more than 3450 g increased by 3 times, and the probability of VBAC success was reduced by 50% for those with a neonatal weight of more than 3700 g (Adany and McCarthy, 2007). Mi *et al.* (2021) posit the possible reason why a larger fetal weight lowers VBAC success rates is that a heavy fetus may cause excessive traction of the lower uterine fibers, resulting in incomplete or complete rupture of the muscle layer of the lower uterus—eventually leading to VBAC failure.

Various studies have indicated that CPD/failure to progress as the indication for initial CS may be associated with 50-67% successful VBAC as compared to breech presentation whose success rate is 89% (Birara & Gebrehiwot, 2013; Maroyi *et al.,* 2021; Wu *et al.,* 2019). As such, the indication for the previous cesarean section is an important predictor of a successful VBAC (Trojano *et al.,* 2019). This study noted malpresentation including breech ($p < 0.001$) and NRFS (p-0.033) as the indications for previous CS were associated with a higher probability of successful VBAC, as compared to CPD.

Higher socioeconomic status has previously been associated with increased probability of failed trials of labor (Lehmann, *et al.*, 2018). Further, results from studies in rural Ethiopia and Turkey have shown higher VBAC success rates in women from rural residences compared to urban setups (Mekonnen & Asfaw 2023; Senturk *et al.*, 2015). Arguably, the reasons given for the observations range from preference of the women due fear of surgery, and affordability that may be due to socioeconomic status. This study, however, did not note a statistically significant difference in patient's occupation or education in relation to success/failure of TOLAC. With the two hospitals in the study serving a mostly rural population, it may also be argued that there could be limitations on the choice of education and employment as surrogate measures of socioeconomic status in this study's local context. For example, employment in this rural context may not necessarily mean an individual has a higher socioeconomic status.

Various international organizations have recommended at least eight visits including Kenya's National Guidelines for Quality Obstetrics and Perinatal Care, which are based on the WHO Recommendations on Focused Antenatal Care (ACOG, 2019; Tunçalp *et al.*, 2017: MOH, 2022). This is a change from the previous Kenyan guidelines which recommended four visits. In this study all the participants had attended at least two ANC visits with only one participant having attended eight visit as currently recommended. The majority of the participants had more than four visits. There was no statistically significant difference in the mode of delivery in those who had four or more visits as compared to those with less than four visits. The study did not seek to elucidate the effect and practicality of the current guidelines on the mode of delivery.

In summary, this study demonstrates risk factors associated with failed TOLAC in a low-resource setting including increased risk of blood transfusion, infections and increased hospital stay. The neonatal risk factors include increased risk of admission to NICU, five-minute APGAR < 7, and increased risk of perinatal and neonatal mortality. A number of factors which would potentially influence the outcomes of trial of labor and ultimately the actual mode of delivery was considered. Of the factors that were assessed, only previous vaginal delivery, longer inter-delivery intervals, neonatal birth weight, and parity had statistically significant associations with success of TOLAC. Moreover, neonatal weight of >3500 g was associated with an increased risk of TOLAC while a previous VBAC had a positive association with TOLAC.

Conclusion

Based on the results and discussion, we conclude that the success rate was lower compared to that of the developed countries but TOLAC still remains a viable option. Therefore, the practice of TOLAC in any facility should anticipate possible failures and ensure the facility is equipped to handle the complications that may arise before attempting the procedure. Close to half of the patients who attempted TOLAC in this study had a successful VBAC. With the two study facilities being in a resource limiting setting, a careful TOLAC patient selection with due consideration to the available resources and personnel could improve VBAC success rates. TOLAC candidates should therefore be evaluated based on the contextual factors of a given setting. Further, both TOLAC and ERCS are risky, but TOLAC complications are worse in case of failure. Thus, selecting TOLAC candidates with low risks for failure is likely to reduce the need for ERCS. Furthermore, based on this study's analysis, evaluation of the CS rate should not center entirely on whether it is too high or too low. Rather, it should focus on the appropriateness of the CS performed, taking into account all the relevant information, including TOLAC risks and outcomes. While there is an unmet burden of CS as essential health care service in Sub- Saharan Africa, this

study suggests that clinicians should consider TOLAC as a mode of delivery by stratifying risk using the identified characteristics, which might allow the already limited obstetrical resources in SSA to be distributed to the neediest. However, since there is still a significant risk of negative outcomes with TOLAC, stratifying risks and attempting to prevent the need for TOLAC by using primary cesarean section only when necessary is prudent.

Recommendations

The findings of this study have important implications for TOLAC practice in low-resource settings with a bearing on policy and areas for further research. On TOLAC practice, contextual factors should be taken into account, including the individual risk factors, and the readiness of a facility to handle any eventuality that may hamper the likelihood of VBAC success. With regard to policy, we recommend a comprehensive policy framework and national guidelines on the rate of primary cesarean section and on practice of TOLAC in Kenya. Among the key considerations to be addressed should include; a set criterion of who should attempt TOLAC, facility resources e.g. for continuous fetal heart monitoring during TOLAC, and capabilities of performing an emergency CS should the need arise, as well as non-obstetric reasons such as maternal choice. For further research, we recommend studies to compare between planned repeat cesarean section and trial of labor after cesarean section in women with one previous scar in resource poor setups. The factors found to be associated with success and failed TOLAC may be utilized to develop machine learning predictive models that help in accurate patient selection of patients. However, more studies and data will be required to test such predictive models.

Conflict of Interest

The authors declare no conflict of interest.

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