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Predictors of successful vaginal birth after a caesarean in women with a previous single caesarean delivery

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Abstract. – OBJECTIVE: The aim of our study was to present our case series of the trial of labor after a caesarean (TOLAC) and determine significant predictors for a successful vaginal birth after a caesarean (VBAC).

PATIENTS AND METHODS: Women with previous single caesarean deliveries who underwent TOLAC between January 2016-December 2019 were included in the study (n = 474). All files were analyzed in terms of demographic characteristics, obstetric history, history of index pregnancy and medical characteristics of previous caesarean delivery. For each current pregnancy, we recorded time from the previous delivery, the BISHOP and TOLAC scores at admission, induction of labor, gestational age at delivery, estimated fetal weight, intrapartum characteristics, mode of delivery and intra-operative findings.

RESULTS: Among 474 women who had a previous caesarean delivery and gave consent for TOLAC, 216 resulted in a successful vaginal delivery, whereas 258 underwent repeat caesarean delivery. One hundred and seventy-nine women gave up trial of vaginal delivery during labor. The success rate of VBAC after exclusion of caesarean cases due to maternal requests was 73.2%. The induction rate was significantly higher in cases with successful VBAC (40% *vs.* 29.1%). The risk of uterine rupture was 0.42% in cases with labor induction. ROC analysis showed significant predictive values of the TOLAC score, body mass index (BMI), the number of previous VBACs and the number of previous vaginal deliveries, birth weight and the BISHOP score at admission.

CONCLUSIONS: Our data showed us that major determinants for successful VBAC following labor are the BISHOP score at admission, number of previous vaginal deliveries, body mass index, birth weight and the TOLAC score calculated at admission.

Key Words:
Vaginal birth after caesarean, TOLAC, Labor induction, Bishop score, BMI, Previous vaginal birth.

Introduction

Women who had a caesarean delivery have options to try labor after a caesarean (TOLAC) or a planned caesarean delivery scheduled for the index pregnancy. A planned TOLAC can result in a vaginal delivery (VBAC) or an unplanned intrapartum caesarean delivery. When deciding on the type of delivery, the patient's personal preferences, obstetric history and data on the risks and benefits of TOLAC against planned recurrent caesarean delivery should be considered. Two important concerns in making this decision are the chance of successful VBAC and maternal injury rates. A previous systematic review presented two small, randomized trials involving a total of 320 women with minimal data on maternal and infant clinical outcomes[1]. This review showed that overall maternal injury rates were low in both VBAC and elective repeat caesarean delivery. Although it is rare for both elective recurrent caesarean delivery and TOLAC studies, maternal mortality rate was increased for elective caesarean delivery (0.013%) in comparison to TOLAC (0.004%). Maternal hysterectomy, bleeding and transfusion rates did not differ significantly between the two groups. The risk of uterine rupture was significantly increased with TOLAC compared to elective repeat caesarean delivery (0.47% *vs.* 0.03%). Perinatal mortality was also found to be increased with TOLAC (0.13% *vs.* 0.05%). The review indicated that VBAC is a reasonable choice for the majority of women. Negative results were rare for both elective recurrent caesarean delivery and TOLAC[2]. For a better outcome, TOLAC should be offered for selected cases. For this purpose, predictive models have been developed to predict successful VBAC to ensure the success rate[3-6].

In this study, we aimed to present our case series of the trial of labor after caesarean delivery

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based on the TOLAC score and to determine significant predictors for a successful vaginal birth after a caesarean.

Patients and Methods

This is a retrospective cohort study of deliveries at our tertiary referral hospital. Women with a previous single caesarean delivery who underwent TOLAC between January 2016-December 2019 were included in the study (n = 474). The study protocol was approved by the Local Institutional Ethics Committee and was carried out in accordance with the principles set forth in the Helsinki Declaration 2008. The inclusion criteria were as follows: a history of caesarean section and a low transverse incision of the uterus; ≥ 37 weeks of gestation; and a normal-sized pelvis. Exclusion criteria were pregnancies with no prenatal care, fetal malformation, pregnancies with cephalopelvic disproportions, multiple gestations, non-low transverse caesarean delivery (CD) incision, additional previous uterine surgery, fetal malpresentation, placenta previa, an estimated fetal weight > 4,000 g and prenatal intervals less than 12 months (from the previous CD). In our clinic, we have a policy of encouraging TOLAC for vertex presentations with a maximum fetal weight estimate of 4,000 g in singleton pregnancies with a previous low transverse caesarean scar. All patients were under prenatal follow-up, where they received a consultation about the risks and complications of TOLAC and their chances of success. Women who preferred TOLAC signed an informed consent form.

All files were analyzed in terms of demographic characteristics, obstetric history, history of index pregnancy and medical characteristics of previous caesarean delivery. For each current pregnancy, we recorded the time from the previous delivery, prior vaginal deliveries, gestational age at delivery, estimated fetal weight, induction of labor, intrapartum characteristics, such as the mode of delivery and indication for operative or caesarean delivery, intra-operative findings (as evidence for uterine rupture or dehiscence), the BISHOP score at admission and the TOLAC score (https://mfmunetwork.bsc.gwu.edu/web/mfmunetwork/vaginal-birth-after-cesarean-calculator).

For pregnant women who had more than two contractions during 10-minute monitoring using tocodynamics, an extra amniotic balloon was preferred to oxytocin for labor induction. Detailed information about the extra amniotic balloon application procedure in our institution is summarized in our previous publication[7]. Oxytocin application was indicated in cases with fewer than three contractions within 10 minutes for labor augmentation. Five units of oxytocin in a liter of normal saline was applied to patients for labor induction. The initial dose was 2.5 mU/minute, and the dose was gradually increased in increments of 2.5 mU/minute until obtaining the desired intensity and amplitude of the contractions. After obtaining the desired contraction frequency with cervical dilation > 6 cm, the amniotic membrane was ruptured (spontaneously or artificially). According to the National Child Health and Human Development Institute workshop report, the non-reassuring fetal heart rate was defined as the fetal heartbeat pattern in Category II or III[8]. Vaginal prostaglandin E2 (PGE2), (Propess ovul, Ferring) was used for cervical ripening. Uterine rupture was defined as clinical rupture, including full-thickness myometrial tears requiring surgical repair.

Statistical Analysis

Data analysis was done with SPSS version 15.0 package (Chicago, IL, USA). Student *t*-tests and Mann-Whitney U tests were used to compare continuous variables where appropriate. Chi-square and Fisher exact tests were used for categorical variables. Multivariate logistic regression analysis was used to show adjusted associations. A p-value < 0.05 is accepted to be statistically significant.

Results

Among 474 women who had a single previous caesarean delivery, 216 (45.6%) of the cases resulted in a successful vaginal delivery, whereas 258 (54.4%) underwent repeat caesarean delivery. One hundred and seventy-nine women gave up trial of vaginal delivery during labor. The overall success rate of VBAC after exclusion of caesarean cases due to maternal requests was 73.2%. Of 474 patients, 347 (73.2%) had a previous caesarean delivery and no vaginal delivery, 98 (20.6%) had a vaginal delivery before the caesarean delivery, and 29 (6.2%) had a prior VBAC. The rates of successful trial of labor were 36%, 69.3% and 79.3%, respectively ($p < .001$).

Methods of labour inductions were as follows: balloon (n = 41), oxytocin (n = 84), balloon followed by oxytocin (n = 28), vaginal PGE2 (n = 1), balloon followed by vaginal PGE2 (n = 7), bal-

loon followed by vaginal PGE2 followed by oxytocin (n = 2) and spontaneous management (n = 311). The induction rate was significantly higher in cases with successful VBAC (40% *vs.* 29.1%, $p < 0.001$). Higher rates of VBAC were obtained by some specific induction methods, such as PGE2 (100%) and oxytocin (71.1%). The success rate of oxytocin induction reached 79.5% following the exclusion of caesarean deliveries with an indication of a maternal request for repeat caesarean as the trial progressed. Only seven out of 41 in the balloon group had achieved successful vaginal delivery. There were two cases (0.42%) with a uterine rupture; in one of these cases, labour induction was achieved by balloon application, and in the other case, oxytocin was used for labour augmentation.

Indications of caesarean delivery in index pregnancy were as follows: CPD (n = 12, 2.5%), placental abruption (n = 4, 0.8%), foetal distress (n = 28, 6%), labour arrest (n = 16, 3.3%), cord prolapsus (n = 1, 0.2%), suspected foetal macrosomia (n = 4, 0.8%), meconium passage (n = 1, 0.2%), pre-eclampsia (n = 5, 1.1%), suspected uterine rupture (n = 5, 1.1%), chorioamnionitis (n = 3, 0.6%) and maternal request for repeat caesarean as trial progressed (n = 179, 37.7%). Among the 474 cases, five needed blood transfusions following delivery.

Complications

Three patients experienced bleeding, two during caesarean section and one following vaginal delivery. To control bleeding, bilateral hypogastric artery ligation with Bakri balloon application was performed on one patient, whereas bilateral hypogastric and uterine artery ligations were conducted on the other. Uterine compression sutures were applied to stop bleeding in the third patient. Rates of complications were uterine atony (n = 2), failed vacuum extraction, emergent caesarean section followed by relaparotomy due to intrapelvic hematoma (n = 1), dehiscence (n = 10), deep vaginal laceration (n = 1), bladder injury (n = 1), postpartum haemorrhage (n = 1) and uterine rupture (n = 2).

Group Comparisons

Comparisons of some demographic characteristics of groups with and without VBAC are shown in Table I, indicating a significant difference between groups in terms of BMI, gravidity and parity ($p < 0.05$). Comparisons of the TOLAC scores, numbers of previous vaginal deliveries, numbers of previous VBACs and time intervals from previous caesarean deliveries between groups are summarized in Table II. There were significant differences between groups in terms of the TOLAC score, number of previous vaginal deliveries and number of previous VBACs ($p < 0.05$). The time interval from the previous caesarean delivery was similar between the two groups ($p > 0.05$). Gestational age of index pregnancy, estimated fetal weight, birth weight and the BISHOP score at admission were compared between the two groups and revealed significant differences between groups in terms of all of the above-mentioned variables ($p < 0.05$, Table III).

Outcome Predictions

ROC analysis showed significant predictive values of BMI, the TOLAC score, previous vaginal deliveries, birth weight and the BISHOP score at admission (Table IV, Figures 1 and 2).

Regression Analysis

Multivariate regression analysis showed significant associations between the TOLAC and BISHOP scores at admission and successful VBAC. In women with at least one previous VBAC or vaginal delivery, there was a significantly higher rate of successful VBAC following TOLAC (79.3% *vs.*

Table I. Comparisons of some demographic characteristics of groups with and without VBAC.

	VBAC Group (n=216)		Repeat Cesarean Group (n=258)		
	Mean	SD	Mean	SD	*p*-value
Maternal Age (years)	30	4.6	29.6	4.3	0.3
BMI (g/m^2)	28.9	3.9	30.1	4.2	0.001
Gravidity	2.6	0.9	2.4	0.7	0.01
Parity	1.3	0.6	1.2	0.7	0.02
Alive	1.3	0.6	1.1	0.5	<0.001

VBAC: Vaginal birth after cesarean, BMI: Body mass index.

Table II. Comparisons of the TOLAC score, number of previous vaginal deliveries, number of previous VBACs and time from previous caesarean delivery between groups.

	VBAC Group (n=216)		Repeat Cesarean Group (n=258)		
	Mean	SD	Mean	SD	*p*-value
TOLAC Score	74.2	11.05	67.3	10.3	<0.001
Number of Previous vaginal deliveries	0.3	0.6	0.2	0.4	<0.001
Previous VBAC	0.1	0.3	0.03	0.2	0.001
Duration since previous CD (months)	53.1	29.1	52.6	30.3	0.9

VBAC: Vaginal birth after cesarean. TOLAC: Trial of labor after cesarean.

69.3%, $p < 0.001$). Previous vaginal delivery was associated with a lower risk for failed TOLAC (RR = 0.4, 95% CI: 0.2-0.6, $p < 0.001$). Women with a BMI of less than 29 had a two times greater chance of giving vaginal birth after a caesarean (OR: 1.92, 95% CI: 1.33-2.78, $p < 0.001$).

Discussion

The current study aimed to present our case series of trial of labour after caesarean delivery based on the TOLAC score and to determine significant predictors for VBAC. Data analysis showed us that the BISHOP score at admission, the TOLAC score, BMI, number of previous vaginal deliveries and birth weight were significant predictors for successful vaginal delivery in women who underwent TOLAC.

In our series, the BISHOP score at admission was found to be the most powerful predictor for successful vaginal delivery (AUC = 0.799, $p < 0.001$). The second most powerful predictor was the TOLAC score (AUC = 0.666, $p < 0.001$). The overall success rate of TOLAC in our series was 45.6%. Following the exclusion of caesarean cases due to maternal requests for repeat caesarean sections, the success rate of vaginal birth after a caesarean was 73.2%. In our study, obesity was found to be a risk factor for failure of VBAC. Women with BMIs of less than 29 were two times likelier to have a vaginal delivery in comparison to obese women (OR: 1.92, 95% CI: 1.33-2.78, $p < 0.001$). Similarly, Juhasz et al[9] found that obese patients were almost 50% less likely to have a successful VBAC when compared to underweight patients. In accordance with our findings, another study[10] demonstrated that maternal BMI was an independent factor associated with a lower rate of successful vaginal birth after a caesarean delivery.

The number of previous vaginal deliveries was also a significant predictor for successful vaginal delivery in this study (AUC: 0.582, $p < 0.001$). Previous vaginal delivery was found to be associated with a lower risk for failed TOLAC. In particular,

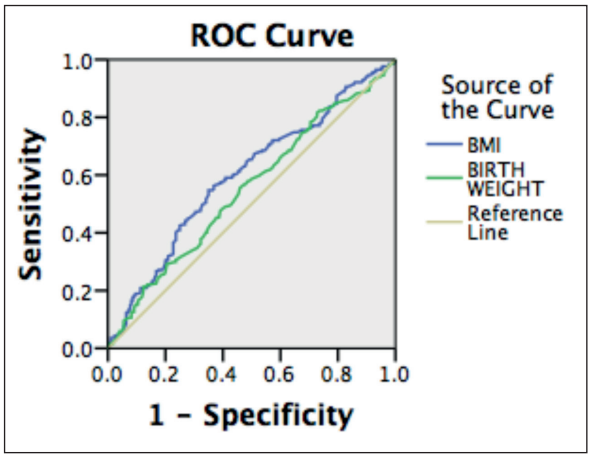

Figure 1. ROC analysis showed significant predictive values of BMI and birth weight for VBAC.

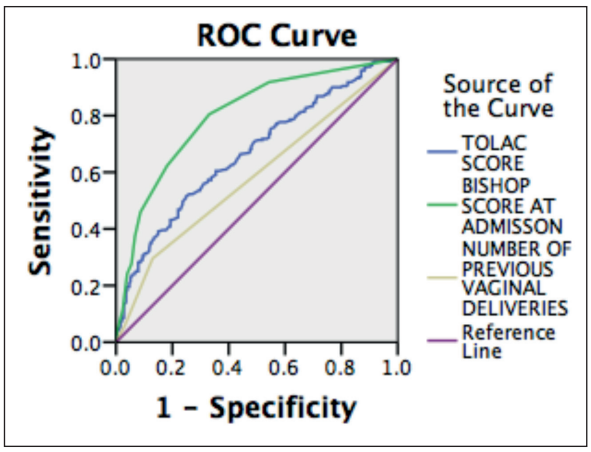

Figure 2. ROC analysis showed significant predictive values of the BISHOP and TOLAC scores and the number of previous vaginal deliveries for VBAC.

Table III. Gestational age of index pregnancy, estimated foetal weight, birth weight and the BISHOP score at admission were compared between the two groups.

	VBAC Group (n=216)		Repeat Cesarean Group (n=258)		
	Mean	SD	Mean	SD	*p*-value
GA of index pregnancy	39.07	1.6	39.3	1.2	0.006
EFW (gr)	3416.8	374.8	3543.2	373.8	<0.001
Birth weight (gr)	3342.1	425.05	3424.9	478.1	0.05
Bishop score at admission	5.2	3.6	1.8	2.6	<0.001

GA: Gestational age, EFW: Estimated fetal weight.

Table IV. ROC analysis showed significant predictive values of BMI, the TOLAC score, number of previous VBAC and previous vaginal deliveries, birth weight and the BISHOP score at admission.

			Asymptotic 95% Confidence Interval		
Test Result Variable(s)	Area	Std. Error[a]	*p*-value	Lower Bound	Upper Bound
BMI	.598	.026	< 0.001	.547	.649
Birth Weight	.551	.026	0.05	.499	.603
TOLAC Score	.666	.025	< 0.001	.617	.715
Bishop Score at Admission	.799	.020	< 0.001	.759	.840
Number Of Previous Vaginal Deliveries	.582	.026	< 0.001	.530	.634

BMI: Body mass index. TOLAC: Trial of labor after cesarean.

the success rate was higher in women with a prior VBAC compared with patients with no prior vaginal delivery. Two cases with uterine rupture had no previous vaginal delivery in our study. Higher rates of successful VBAC in women with a previous vaginal delivery have been demonstrated by some studies[11-13]. In addition, a prior vaginal delivery was associated with a lower risk of uterine rupture and overall maternal morbidities[14,15]. Therefore, women with a previous vaginal delivery are good candidates for TOLAC.

Birth weight was found to be another factor for a successful vaginal delivery. Estimated birth weight should be calculated by ultrasonographic measurement during the patient's hospitalization. Jastrow et al[16] found that birth weight was directly correlated to the rate of failed trials of labor. A birth weight of less than 3,500 g increased the success of vaginal delivery in comparison to macrosomic fetuses. Patients should be informed about the risks for trial of vaginal delivery when the estimated fetal weight is over 4,000 g.

Among all the cases, there were two cases of uterine rupture; the other complications were postpartum hemorrhage (n = 1), urinary bladder injury (n = 1) and deep vaginal laceration (n = 1). The previous review showed that uterine rupture incidence ranged from 0.15-0.98% in spontaneous labor, 0.3-1.5% in stimulation and induction with oxytocin and 0.68-2.3% in prostaglandin inductions. The authors indicated that the success of a vaginal birth after a caesarean delivery depends on some optimal conditions. While the induction of labor with oxytocin and/or prostaglandins was found to be the main risk factors, the spontaneous onset of labor and a prior vaginal birth were shown to be protective factors for uterine rupture[14]. The rate of uterine rupture was 0.42 in our series. There were two cases with a uterine rupture; in one of these, labor induction was achieved by balloon application, and in the other, oxytocin was used for labor augmentation. Vaginal PGE2 were used for labor induction in 10 cases; these cases had neither uterine ruptures nor dehiscence. Additionally, our data revealed a favorable outcome with oxytocin and prostaglandin E2 labor induction in terms of the rate of successful VBAC.

No randomized study[17] has evaluated the benefits and harms of a planned repeat caesarean delivery *vs.* the induction of labor. Nonetheless, in two retrospective cohort studies, TOLAC induction was compared to expectant management. These two studies[18,19] showed that labor induction reduced the odds of caesarean delivery at term but was associated with a higher risk of uterine rupture. Consistently, our data showed that cases with labor induction had a 2.5 times higher probability of VBAC. The studies evaluating the outcomes of prostaglandin

induction of labor after caesarean delivery revealed vaginal delivery rates ranging from 53.8%-81%. In these studies[20,21], the risk of uterine rupture differed from zero to 1.8% when prostaglandin was used for induction of labor. In our study, prostaglandin E2 use resulted in a high rate of vaginal delivery, and no uterine ruptures occurred.

Conclusions

Major determinants for successful VBAC are the BISHOP score at admission, the calculated TOLAC score, BMI, number of previous vaginal deliveries and birth weight. BMI < 29, previous vaginal delivery and estimated fetal weight lower the risk of failed labor. All these factors should be considered when recommending a vaginal delivery after a caesarean to patients.

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Authors' Contributions
Sadik Sahin: project development, data collection, manuscript writing and editing. Enis Ozkaya: data analysis and interpretation, manuscript writing and editing. Mustafa Eroglu.: data collection, reviewed manuscript. Ilhan Sanverdi: data collection, reviewed manuscript Zeynep Celik: data collection Aylin Cakiroglu: project development, data collection.

Ethics Approval
The study protocol was approved by the Zeynep Kamil Maternity and Children's Hospital Institutional Ethics Committee (35-2020) and was carried out in accordance with the principles set forth in the Helsinki Declaration 2008.

Consent to Participate
Informed consent was not required due to the retrospective nature of the study.

Conflicts of Interest
The authors declare no conflicts of interest.

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