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ORIGINAL ARTICLE

Predicting Successful Trial of Labor After Cesarean Delivery: Evaluation of Two Scoring Systems

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Abstract

Background Attempting vaginal birth after cesarean section (VBAC) places women at an increased risk of complications. Trial of labor after cesarean (TOLAC) calculators aim to predict the chance of successful vaginal birth after cesarean (VBAC) based on the patient's preexisting demographic and clinical factors.

Objective To assess the rate of successful TOLAC using two calculators: FLAMM and the Grobman calculator, and to compare the performance of the two calculators in the successful prediction of VBAC.

Methods Prospective cohort study in subjects with previous one caesarean section using well-defined inclusion and exclusion criteria.

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Results A total of 280 subjects with previous one cesarean section were enrolled. One hundred thirty-nine subjects consented for TOLAC, 90 (67%) underwent successful trial of vaginal birth, and 49 (32.8) required cesarean section. Cervical dilatation ($p < 0.0001$) and effacement ($p < 0.0001$), and any prior vaginal delivery ($p < 0.02$) were significantly associated with a successful outcome. At a cutoff score of 5, the sensitivity of the FLAMM score was 72% and specificity was 76%. For the Grobman calculator, the best sensitivity (69%) and specificity (67%) were seen at a cutoff score of 85%.

Conclusion Both prediction models, the FLAMM and the "close to delivery" nomogram, recommended by Grobman et al. are easy to use and could successfully estimate the chances of vaginal birth in previous caesarean, in this small cohort. The decision for women opting for TOLAC can be individualized, and patient-specific chances of success can be predicted by the use of these prediction models.

Keywords Previous caesarean · Successful · Trial vaginal birth

Introduction

Attempting vaginal birth after cesarean section (VBAC) places women at an increased risk for complications. After a first cesarean delivery, a woman has to choose between an elective repeat cesarean delivery (ERCD) and a trial of labor after cesarean (TOLAC) with the aim of achieving a vaginal birth (VBAC). In order to make this decision, both clinicians and patients require information that will help them to decide the mode of delivery and their chances of a successful vaginal birth.

There is a consensus [National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists (RCOG), American College of Obstetricians and Gynecologists (ACOG)/National Institutes of Health (NIH)] that planned VBAC is a clinically safe choice for the majority of women with a single previous lower segment cesarean delivery [1]. An obstetrician should be involved in the counseling regarding mode of delivery and the decision should be finalized by 36 weeks of pregnancy in most cases. Having information regarding the probability of successful VBAC will improve the decision-making process regarding the mode of delivery [1].

Trial of labor after cesarean (TOLAC) calculators aims to predict the chance of successful VBAC based on the patient's preexisting demographic and clinical factors [2–5]. In a 2010 meta-analysis, the two factors that increased the odds of successful TOLAC by at least three times were history of successful VBAC (odds ratio [OR] 4.4) and history of vaginal delivery (OR 3.4) [5].

Several calculators are available to predict the rate of successful TOLAC. The usefulness of TOLAC success calculators in counseling individual women with decision making remains unclear. The current study was undertaken to assess the rate of successful TOLAC in a prospective cohort of women with previous one cesarean delivery using two calculators: FLAMM [6] and the Grobman calculator (also known as MFMU calculator) [7] and to compare the performance of the two calculators in the successful prediction of VBAC.

Subjects and Methods

This was a prospective cohort study and subjects with previous one lower segment cesarean section with well-defined inclusion and exclusion criteria as follows:

Inclusion Criteria

1. Women with previous one low transverse cesarean section with, 37 or more weeks of gestation with, vertex singleton presentation and no known contraindication to Trial of Labor.
2. Should have given informed consent.

Exclusion Criteria

1. Expected Baby weight of >3.5 kg.
2. Morbid obesity.
3. Women presenting in early labor who subsequently undergo cesarean.
4. Multiple pregnancy.
5. Non-cephalic presentation.
6. Placenta previa/abruption.

Socio-demographic data (maternal age, parity, ethnicity as Asian, religion, residence, socio-economic status defined according to the Kuppusamy classification), obstetric parameters (indication for the index cesarean, the type of index cesarean performed (elective, emergency), preexisting conditions (hypertension, diabetes) and characteristics of the second pregnancy, including gestational diabetes, pre-eclampsia or eclampsia, premature rupture of membranes and birthweight, interval between last and index pregnancy in months), intrapartum and post partum events were recorded. Successful VBAC was defined as a vaginal delivery following attempted VBAC. Vaginal birth included instrumental delivery.

Monitoring in Labor

Partograph was charted. Continuous electronic fetal monitoring was used in active labor. Oxytocin augmentation was not contraindicated. Medical induction of labor with

prostaglandin E2 (dinoprostone) if indicated was used with caution and after counseling. Prostaglandin E1 (misoprostol) is associated with a high risk of uterine rupture and was not used as part of a TOLAC after cesarean section. Subject was monitored for tachycardia, uterine scar tenderness. TOLAC was terminated at the discretion of the supervising consultant on duty if maternal or fetal compromise was suspected or progress of labor was not found to be satisfactory.

Statistical Analysis

Data was recorded in the FLAMM [6] and Grobman "close-to-delivery" (CTD) models [7]. Maternal and perinatal outcomes were recorded in the groups with successful and failed TOLAC.

Data was entered in an excel sheet. Data analysis was performed using Medcalc software for comparison of means and proportions. SPSS trial version 24 was used to derive the ROC curves, for diagnostic tests and for logistic regression analysis.

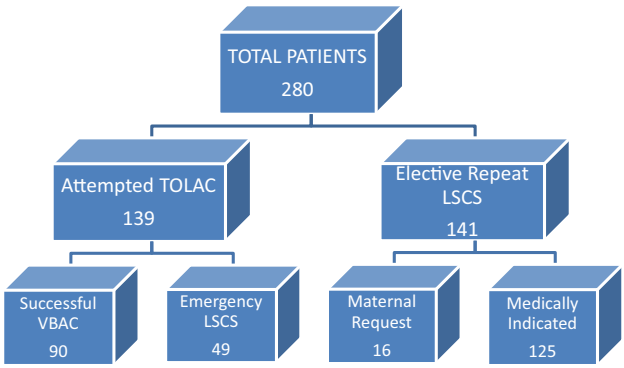

Fig. 1 Flow chart of subjects with previous one cesarean during study period

Categorical variables were analyzed with the use of the Chi-square test. Univariate analysis was performed to estimate Odd's ratios for the factors that predict success in TOLAC.

Results

During the study period of one year, 280 subjects with previous one cesarean section were enrolled. One hundred thirty nine subjects consented for TOLAC, 90 (67%) underwent successful trial of vaginal birth and 49 (32.8) required cesarean section (Fig. 1).

Table 1 shows that there was no difference in maternal age, parity, body mass index (BMI) and gestational age in the successful TOLAC and failed TOLAC group.

Table 2 shows the univariate analysis of variables associated with successful VBAC. The Odd's of having a successful vaginal birth with a cervical dilatation >3 cms was 6.46 (2.96–14.06, $p < 0.0001$). Cervical effacement >25% had an Odd's of successful vaginal birth of 6.7 (2.44–18.8, $p < 0.0002$).

Table 3 shows observed versus predicted successful TOLAC rate by Grobman model. Of the 45 subjects with a score of 4, 22 (48.8%) had successful TOLAC. Of the 57 subjects with a score of 5, 47 (82.4%) delivered vaginally. The area under the curve (AUC) for the receiver operating characteristic curve (ROC) curve for this model was 0.777 (95%CI 0.69,0.85, p value <0.0001) (Fig. 2).

Table 4 shows the successful and failed vaginal delivery rates by the predicted Grobman model. Of the 106 women with a score of ≥80%, 77 (72.6%) delivered vaginally. Using a ROC curve (Fig. 3), the model had an AUC of 0.725, (95% CI, 0.64, 0.81, $p < 0.01$). The best sensitivity (69%) and specificity (67%) was seen at a cut-off score of 85%.

Table 1 Characteristics of subjects

Characteristics	Successful TOLAC ($n = 90$)	Failed TOLAC ($n = 49$)	p value
Maternal age	25.74 ± 3.45 YRS	26.14 ± 3.36	0.5
Parity	2.25 ± 0.51	2.12 ± 0.43	0.1
Maternal height (CM)	156.12 ± 4.03	156.69 ± 3.92	0.4
Maternal weight (KG)	56.77 ± 4.28	57.8 ± 4.28	0.17
Body mass index (BMI) (at admission)	23.28 ± 1.42	23.57 ± 1.42	0.2
Any prior vaginal delivery	13 (14.44%)	01 (2.04%)	0.02
Any prior vaginal delivery since last cesarean	03 (3.33%)	01 (2.04%)	0.6
Gestational age (weeks ± days)	38.87 ± 9.17	38.65 ± 9.18	0.8
Pre-eclampsia	01 (1.11%)	05 (10.2%)	0.01
Cervical effacement (%)	45.0 ± 18.18	26.0 ± 18.44	0.0001
Cervical dilatation	4.42 ± 1.57	2.85 ± 1.59	0.0001
Labor induction required	15 (16.66)	05 (10.2)	0.3

Table 2 Univariate analysis of variables associated with successful VBAC

Variable	Successful VBAC ($N = 90$)	Failed VBAC ($N = 49$)	OR (95%CI)	p value
NO h/o still birth	0	0		
Prior successful vaginal delivery ($N = 4$)	3 (75.0)	1 (25.0)	1.65 (0.16–16.35)	0.66
Cervical dilatation >3 cm ($N = 76$)	63 (82.9)	13 (17.1)	6.46 (2.96–14.06)	0.0001
EFFACEMENT(<25%) ($N = 19$)	03 (15.78)	16 (84.21)	0.07 (0.019–0.26)	0.0001
EFFACEMENT (25–75%) ($N = 117$)	84 (71.8)	33 (28.2)	6.7 (2.44–18.8)	0.0002
EFFACEMENT (>75%) ($N = 03$)	03 (100.0)	0		
OP/OT position ($N = 8$)	2 (25.0)	6 (75.0)	0.16 (0.03–0.8)	0.03

Table 3 Observed versus predicted TOLAC success rate by FLAMM model

Flamm score	Total subjects	Successful TOLAC ($n = 90$) N (%)	Failed TOLAC ($N = 49$) N (%)
0 T0 2	0	0	0
3	17	3 (17.6%)	14 (82.35)
4	45	22 (48.8)	23 (51.1)
5	57	47 (82.4)	10 (21.9)
6	17	15 (88.2)	02 (11.8)
>6	3	3 (100.0)	0

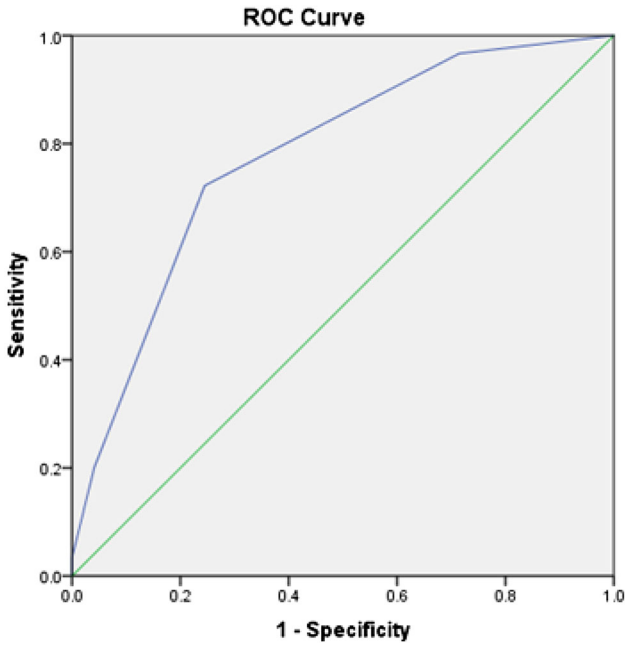

Fig. 2 ROC curve for FLAMM model (AUC.777) (95%CI 0 .69,0.85, p value <0.0001). At a cut-off score of 5, the sensitivity was 72% and specificity was 76%

There were two events of scar dehiscence or incomplete uterine rupture in the ERCD group and 3 in the failed TOLAC group; 8 women in the ERCD group required blood transfusion as compared to 2 in the successful TOLAC group. Both these women had moderate to severe anemia prior to labor. Wound infection was higher in the ERCD group ($n = 11$) versus ($n = 5$) in the failed TOLAC group.

NICU admission was required in 3 neonates in the successful TOLAC group, in 9 neonates, in the failed TOLAC group and in 15 neonates in the ERCD group. No neonate had an Apgar score of <7 in the successful TOLAC group.

Table 5 compares the accuracy of the scoring systems. When the Flamm score was less ≤ 4 the probability of vaginal birth was 40% and when the score was ≥ 6 the probability was 100%. For a MFMU score of >80%, 77/106 (72.64%) women had a successful vaginal birth.

Discussion

This small prospective study of 139 consecutively enrolled subjects with previous one cesarean section, evaluates two calculators (FLAMM and MFMU) in the successful prediction of vaginal birth after cesarean section.

The MFMU calculator predicts the chance of VBAC based on information available at the time of admission for delivery. In addition to factors such as maternal age, BMI at admission, race/ethnicity, other factors included are gestational age, cervical examination (effacement, dilation, station), pre-eclampsia (yes/no), and induction (yes/no). Inclusion of these additional factors slightly improved the performance of the calculator. The overall AUC for this model was 0.77 (95% CI 0.76–078) [7].

Table 4 Observed versus predicted successful TOLAC rate by Grobman model: comparison of present and other studies

MFMU Score	Successful TOLAC in present study ($N = 90$) N (%)	Failed TOLAC in present study ($N = 49$) N (%)	Costantine et al. ($N = 545$) successful TOLAC	Yokoi et al. ($N = 725$) successful TOLAC	Abdel-Aziz ($N = 203$) successful TOLAC
91–100 ($N = 38$)	34 (89.5)	4 (10.5)	54 (79.63)	NA	49 (84.5)
81–90 ($N = 68$)	43 (63.3)	25 (36.7)	120 (67.77)	239 (98.0)	38 (76.0)
71–80 ($N = 24$)	10 (41.6)	14 (58.3)	70 (60.29)	258 (93.0)	42 (71.4)
61–70 ($N = 8$)	3 (37.5)	5 (62.5)	75 (41.89)	58 (70)	22 (59.1)
51–60 ($N = 1$)	0	1 (100.0)	96 (31.87)	9 (53)	13 (38.5)

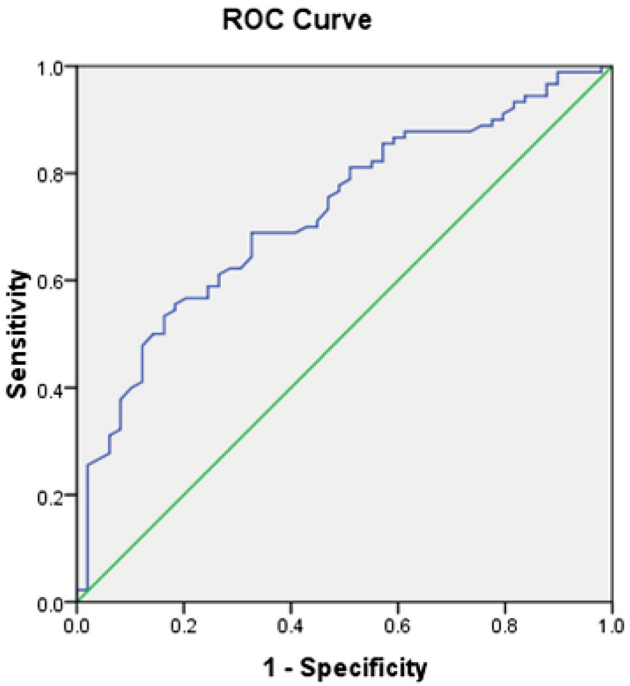

Fig. 3 Receiver operating curves for the MFMU scoring system (AUC.725) (95% CI, 0.64, 0.81, $p < 0.01$). At cut-off score of 85% the sensitivity was (69%) and specificity (67%)

The FLAMM calculator uses maternal age, history of vaginal birth, a reason other than failure to progress for first cesarean delivery, cervical effacement at admission, cervical dilation ≥4 cm at admission. Points are assigned to each of the predictors, the higher the score, more the chances of successful trial of labor [6].

In the present study, the rate of successful TOLAC was 66.7%. A recent meta-analysis [8] ($n = 103$ 188 VBAC labors) reported a pooled VBAC labor success rate of 74% (95% CI 72–75%). In an Australian cohort trial, of the 2345 women enrolled, 1108 (47.2%) were in the planned ERC and 1237 (52.8%) in the planned VBAC group. In the planned VBAC group, 535 (43.2%) women had a vaginal birth and 702 (56.8%) had a cesarean section; 334 (27.0%) as an elective and 368 (29.7%) as an emergency procedure [9].

Cervical dilatation ($p < 0.0001$) and effacement ($p < 0.0001$), and any prior vaginal delivery ($p < 0.02$) were significantly associated with a successful outcome. Spontaneous labor without augmentation was associated with a vaginal delivery rate of 80%, compared to a 74% success rate with oxytocin augmentation, and a 67% success rate with induction. Knight HE et al. [5] in a study set in the English National Health service, the largest cohort study to analyze the association between primary cesarean section and subsequent mode of delivery, found that younger women and women of white ethnicity had higher success rates. Black women had a particularly low success rate (OR, 0.54; 95% confidence interval [CI], 0.50–0.57).

When the FLAMM score was less ≤4, the probability of vaginal birth was 40% and when the score ≥6 the probability was 100%. At a cut-off score of 5, the sensitivity was 72% and specificity was 76%. In their original study, using a cut-off score of 5, Flamm et al. [6] found that the sensitivity and specificity for successful trial of labor were 69 and 65%, respectively. Rates of successful VBAC ranged from 49% in the score group of 0–2 to 95% in women scoring 8–10. Increasing score was linearly associated with increasing probability of vaginal birth.

For the Grobman calculator, the best sensitivity (69%) and specificity (67%) was seen at a cut-off score of 85%. For a cut-off of 70%, the sensitivity was 95% and specificity was 13%. For a cut-off score of 80%, the sensitivity was 85% and specificity was 41%. This finding differs from the observations of Grobman who recommended a threshold of >70% to counsel for successful VBAC outcome with no difference in maternal and neonatal morbidities between groups. Due to small sample size in this present study, it was not possible to demonstrate a

Table 5 Comparison of scoring systems in predicting vaginal delivery

Scoring system/score	Predictability
Flamm and Geiger (1997)	
≥6	100% vaginal delivery
≤4	40% vaginal delivery
Grobman et al. (2009)	
>80%	72.64% vaginal delivery
<70%	33.3% vaginal delivery

significant difference in maternal and neonatal outcomes in the successful and failed TOLAC groups.

The Grobman model has been externally validated in different populations by various researchers; Abdel-Aziz et al. [10] applied the Grobman model to a cohort of 203 Middle Eastern women; Yokoi et al. [11] applied the model to a Japanese cohort of 725 Japanese women; Costantine et al. [4] applied the model to an American cohort of 545 women; Schoorel et al. [12], to 763 women eligible in Netherlands and, Chaillet et al. [13], to 3113 women across 32 hospitals in Quebec. There was a high positive correlation between actual and predicted success rates across these studies.

Owing to the small number of adverse maternal and neonatal events in the present study, it is not possible to identify significant differences in outcome between the successful and failed TOLAC groups. The study by Soni et al. [14] found that 2 (0.4%) women had scar rupture, and 4 (0.8%) had scar dehiscence. The proportion of neonates who had to be admitted to intensive care did not differ significantly by mode of delivery ($p = 0.06$). Grobman et al. in 2008 [15] reported that of the 11,855 women analyzed, 83 (0.7%) had a uterine rupture. The model, with a c-statistic of .627, had poor discriminating ability and does not allow the determination of a clinically useful estimate of the probability of uterine rupture for an individual patient. Guise et al. in 2010 [16] in a systematic review of the safety of vaginal birth after cesarean found the risk of neonatal mortality was significantly higher for trial of labor compared with elective repeat cesarean delivery group (RR 2.06, 95% CI 1.35–3.13, $p < 0.001$).

Conclusion

Both prediction models, the FLAMM and the "close-to-delivery" nomogram recommended by Grobman et al., are easy to use and could successfully estimate the chances of vaginal birth in previous cesarean, in this small cohort. At a cut-off score of 5 for the FLAMM model, the sensitivity was 72% and specificity was 76%. For the Grobman model, the best sensitivity (69%) and specificity (67%) was seen at a cut-off score of 85%. The Grobman model has been studied more extensively and externally validated in different populations; hence, it might be better to use this model in practice.

The decision for women opting for TOLAC can be individualized and patient specific chances of success can be predicted by the use of these prediction models.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and Animal Rights All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki declaration of 1975 as revised in 2008.

Informed Consent Informed consent was obtained from all patents for being included in the study.

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