Prediction of Vaginal Birth after Cesarean Section Using Scoring System at the Time of Admission for Trial of Labor: A One-year Prospective Cohort Study

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ABSTRACT

Aims and objectives: To assess the prediction of a successful trial of labor after cesarean section (TOLAC) using a predictive scoring system at the time of labor.

Materials and methods: The present study was a prospective cohort study. Women with one previous lower segment cesarean section (LSCS) in labor admitted to the labor room, willing for a vaginal birth after cesarean section (VBAC) were included in the study and explained about the option of TOLAC with the predictive score (integer score) and its success. The predictive validity of the VBAC score was assessed by the receiver operating curve (ROC) analysis.

Results: A total of 194 women were included in the study. The proportion of successful VBAC was 43.30% in the current study. The most common indication for previous LSCS in the patients who underwent repeat LSCS was nonprogress of labor (17.53%) followed by fetal distress in 12.89%. The VBAC score had good predictive validity in predicting successful VBAC, as indicated by the area under the curve of 0.853 (95% CI 0.798 to 0.908, p value < 0.001). The sensitivity of a VBAC score of 13.5 or more in predicting successful VBAC was 83.3% (95 CI 75.36% to 91.3%) and specificity was 78.2% (95 CI 70.46% to 85.9%). Positive predictive value was 74.5% (95 CI 65.65% to 83.3%), negative predictive value was 86% (95 CI 79.2% to 92.8%), and the total diagnostic accuracy was 80.4% (95 CI 74.83% to 86%). After controlling the effect of other values in the equation, the history of previous vaginal birth and high modified Bishop score were the factors that were significantly associated with successful VBAC. The symptomatic uterine rupture occurred in 0.1% of women who underwent TOLAC. No perinatal morbidity or mortality is seen.

Conclusion: Vaginal birth after cesarean section score has demonstrated as a good predictive validity in predicting successful VBAC. TOLAC should be encouraged in most of the women who are willing to attempt it, provided no obstetric contraindication exists.

Keywords: Predictive validity, Trial of labor after primary cesarean delivery, Vaginal birth after cesarean section score.

Journal of South Asian Federation of Obstetrics and Gynaecology (2020): 10.5005/jp-journals-10006-1809

BACKGROUND

The choice of mode of delivery in women who had delivered by cesarean section in a previous pregnancy is quite challenging. The risks and benefits of elective repeat cesarean section (ERCS) and trial of labor after cesarean section (TOLAC) have to be weighed against each other in each woman in making a choice.[1–3]

For some time, ERCS was considered as almost inevitable in women who underwent first cesarean delivery. The proportion of lower segment cesarean section (LSCS) deliveries in this group of women was reported to be as high as 75% in many settings. Apart from perceived benefits, fear of liability in case of any complication during vaginal birth after cesarean section (VBAC) and preferences of the antenatal women have largely contributed to this significantly higher proportion of ERCS in many settings.[4]

But as per the findings of recent studies and according to various clinical practice guidelines issued by various professional bodies, VBAC is associated with fewer complications as compared to ERCS. Hence, TOLAC is recommended in women with a high probability of achieving VBAC. As failed TOLAC is reported to be associated with a higher risk of maternal and fetal complications, as compared to ERCS, the selection of the women for TOLAC is vitally important to achieve a high VBAC success rate.[5] According to recent clinical practice recommendations by the American College of Obstetricians and Gynecologists (ACOG), "Most women with one previous cesarean delivery with a low-transverse incision are candidates for and should be counselled about and offered TOLAC".[6]

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The guidelines clearly specify that TOLAC can be attempted in all the centers capable of providing emergency cesarean services and basic neonatal care services, after clear discussion with the mother regarding the risks and benefits associated with it and according to their choice.

Various predictive models and scoring systems have evolved and have been used in various settings, to identify women with a high probability of VBAC. Some of these models consider factors in the early antenatal period, whereas other scoring systems consider factors in the second trimester and some other models consider factors at the time of labor to identify women with a high probability of VBAC.[7–15]

Even though multiple scoring systems have been developed, none of them were tested extensively. Considering the differences in the demographic, anthropometric, and clinical parameters across population groups, a particular model developed and tested in one subgroup of the population cannot be generalized. Hence, it is of paramount importance to test these models in individual population subgroups to assess their utility, before using them in regular clinical practice. This study was taken up to assess the prediction of successful TOLAC using a predictive scoring system at the time of labor.

MATERIALS AND METHODS

This prospective cohort study was conducted in the Department of Obstetrics and Gynaecology, from January 1, 2016 to December 31, 2016 at Dr Prabhakar Kore's charitable hospital attached to Jawaharlal Nehru Medical College's teaching hospital located in Belagavi, Karnataka. Women with one previous LSCS in labor admitted to the labor room, who met with inclusion criteria and were willing to participate were enrolled in the study. Inclusion criteria were women having a spontaneous onset of labor, one previous LSCS with a transverse incision on uterus with or without previous history of vaginal delivery, single viable fetus, vertex presentation, gestational age ≥37 weeks. Women who were not willing to participate, not a candidate for VBAC, any indication for elective cesarean section in the current pregnancy-related to fetal malpresentation, placenta previa, or any other maternal complications, such as, preeclampsia, diabetes mellitus were excluded. Women were counseled about the option of TOLAC with the predictive score and its success. The consort flow diagram (Flowchart 1) outlines the patient selection process. Before the commencement, the study was approved by the Ethical and Research Committee of the institute.

All the women fulfilling the selection criteria were explained about the purpose of the study and written informed consent in their own vernacular language was obtained from all of them before enrolment.
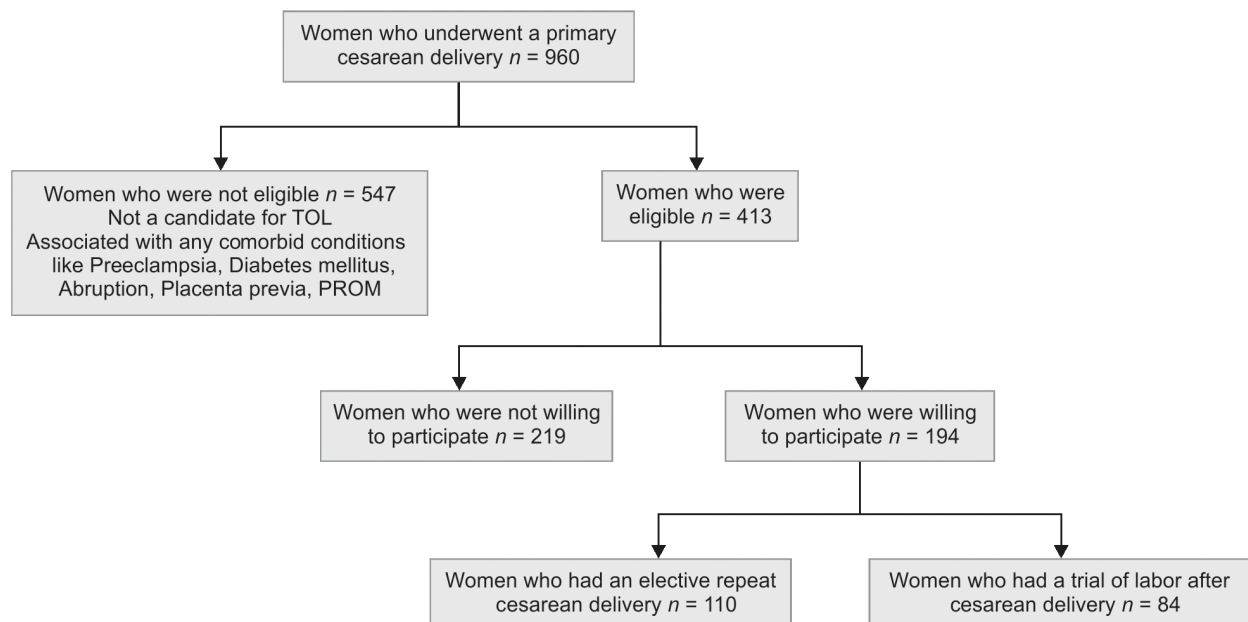
When women who have had a previous cesarean section (CS) presented to the labor room with true labor pains, they were counseled regarding appropriate options for delivery. Gravidity, parity, abortion, preterm labor, history of the previous cesarean including spacing between previous CS and current pregnancy, an indication of previous CS, intrapartum or postpartum complications, and wound healing were also inquired from the women. Present obstetric history, such as, last menstrual period and gestational age were also taken. The discussion begun at the time of admission was completed by 37 weeks of gestation when possible. Women with one previous LSCS admitted to the labor room, who met with inclusion criteria and were willing to participate were enrolled in the study.

Integer scoring[15] was applied to women who gave consent for TOLAC. Labor was monitored by a partogram. The fetal condition was assessed using cardiotocography (CTG). A fetal and maternal condition during the first stage of labor was assessed every 30 minutes. Uterine contractions "intensity, duration, and frequency" were also assessed every 30 minutes. The modified Bishop score was calculated using the first digital cervical examination at the time of admission by a resident (second-year or a third-year resident in a university-based program) or by the attending obstetrician. Fetal monitoring by CTG was done for each enrolled women throughout labor, under the supervision of attending obstetrician. Termination of the vaginal birth trial was done if fetal distress, fetal tachycardia, nonprogress of labor, or scar dehiscence were suspected. Inactive stage of labor oxytocin was used. In the second stage of labor, a prophylactic vacuum was applied to cut short the second stage of labor. Active management of the third stage of labor was followed as per WHO guidelines. Any postpartum complications were recorded.

Women were explained about the option of TOLAC with the predictive score (integer score) and its success.

The variables included in the model were selected based on predictors of successful VBAC previously reported in the literature.[15] Maternal and neonatal assessment was done after labor and signs of impending complications were reported and recorded. Points

Flowchart 1: Consort flow diagram

were assigned to these characteristics, with weightage based on the coefficients in the regression model to calculate an integer VBAC score. The VBAC score was correlated with the TOLAC success rate and was externally validated in an independent cohort using a logistic regression model.

The ability of the VBAC score in predicting successful VBAC was assessed by receiver operating curve (ROC) analysis. To assess the relative strength of the association of individual components of VBAC score with successful VBAC, multivariate binary logistic regression was performed. The adjusted odds ratio of each component with its 95% CI and p value was presented.

The data obtained was coded and entered into a Microsoft Excel spreadsheet. p value <0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.[16]

Results

A total of 194 women were included in the study. Among the 194 women, 84 (43.30%) women were delivered successfully by VBAC, and the remaining 110 (56.70%) were delivered by LSCS (Table 1).

Maternal age, body mass index (BMI), and gestational age at the time of labor had no statistically significant association with the success of VBAC. The factors in our study which have shown statistically significant association with successful VBAC were the previous history of vaginal birth, Bishop Score more than 5, and lower estimated fetal weight. Out of 84 women who underwent VBAC, a history of previous vaginal birth was present in 37 women and 75.68% of them ($n = 28$) had a successful TOLAC and it was significantly associated with the prediction of the mode of delivery (p value < 0.001). The mean modified Bishop score in the VBAC group was 7.52 ± 1.70 and in the women, with a history of repeat LSCS, it was 5.30 ± 1.66. Among 84 women who had a VBAC, 70 (83.33%) had a modified Bishop score of >5. In contrast, out of 110 women who underwent a repeat cesarean section only 42 (38.18%) had a modified Bishop score of >5, whereas 82 (61.82%) had a bishop score of <5. The modified

Bishop score was another significant variable in predicting the success of TOLAC (p value < 0.001). The expected fetal weight (EFW) in the VBAC pregnancies was 2.89 ± 0.27 whereas in the women with repeat cesarean section it was 3.03 ± 0.31. The association of EFW with the mode of delivery was statistically significant (p value < 0.001). All the women in the successful VBAC category had good uterine contractions and favorable cervix (Table 1).

Out of 194 women in our study population, 43 women in which breech was an indication for the primary cesarean section underwent successful TOLAC (67.44%).

Out of 36 women whose indication for primary cesarean section was cephalopelvic disproportion (CPD) only 7 (19.44%) had a successful TOLAC, whereas 29 (80.56%) had a repeat C section. The most common indication for previous LSCS in the patients who underwent repeat LSCS was nonprogress of labor (17.53%) followed by fetal distress in 12.89% (Table 2). The VBAC score had good predictive validity in predicting successful VBAC, as indicated by the area under the curve of 0.853 (95% CI 0.798 to 0.908, p value < 0.001) (Fig. 1 and Table 3).

Based on the ROC analysis, 13.5 and above were identified as the best cut-off value to predict the successful VBAC. All the women were classified as high and low probability groups based on this cut-off value. Among people with successful VBAC, 70 (83.33%) had a VBAC score of 13.5 and above and 14 (16.67%) had VBAC score up to 13.49. The difference in VBAC score category proportion between successful VBAC and unsuccessful VBAC was statically significant (p value < 0.001) (Table 4).

The sensitivity of a VBAC score of 13.5 or more in predicting successful VBAC was 83.3% (95 CI 75.36% to 91.3%) and specificity was 78.2% (95 CI 70.46% to 85.9%). The false-positive and false-negative rates were 21.8% (95 CI 14.10% to 29.5%) and 16.7% (95 CI 8.70% to 24.6%), respectively. Positive predictive value was 74.5% (95 CI 65.65% to 83.3%), negative predictive value was 86% (95 CI 79.2% to 92.8%), and the total diagnostic accuracy was 80.4% (95 CI 74.83% to 86%) (Table 5).

Table 1: Comparison of various maternal parameter between VBAC and LSCS group ($N = 194$)

Various maternal parameter	VBAC (N = 84)	LSCS (N = 110)	p value
Maternal age (mean ±SD)	24.69 ± 1.95	24.22 ± 2.15	0.117
BMI (mean ± SD)	24.89 ± 1.98	24.72 ± 2.36	0.585
Gestational age (in weeks) (mean ± SD)	38.96 ± 1.2	38.95 ± 1.35	0.951
History of vaginal birth			
Yes	28 (33.3%)	9 (8.2%)	<0.001
No	56 (66.7%)	101 (91.8%)	
Bishop score	7.52 ± 1.7	5.3 ± 1.66	<0.001
Bishop score levels			
≤5	14 (16.7%)	68 (61.8%)	<0.001
>5	70 (83.3%)	42 (38.2%)	
EFW	2.89 ± 0.27	3.03 ± 0.31	0.001
Uterine contraction			
Yes	84 (100%)	92 (83.6%)	*
No	0 (0%)	18 (16.4%)	
Favorable cervix			
Yes	84 (100%)	106 (96.4%)	*
No	0 (0%)	4 (3.6%)	
Birth weight (mean ± SD)	2.78 ± 0.33	3 ± 0.43	<0.001

*No statistical test of association was possible, considering "0" number of subjects in one of the cells

Table 2: Comparison between types of delivery (VBAC and LSCS) with previous LSCS Indications

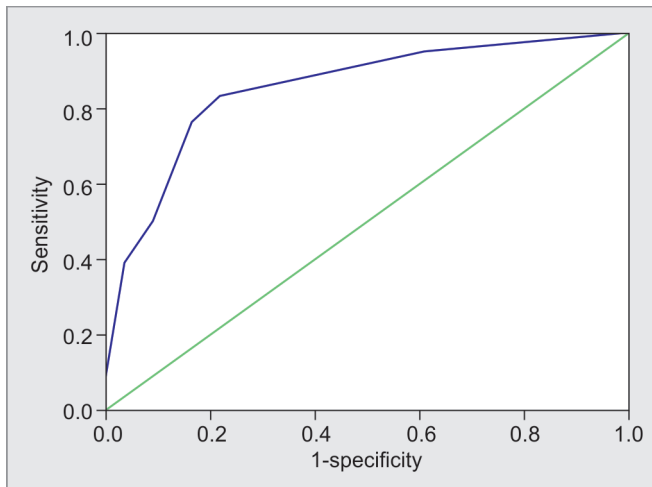| Previous LSCS indications	VBAC	%	LSCS	%	Total	%
Breech	29	67.44	14	32.56	43	22.16
Cephalopelvic disproportion	7	19.44	29	80.56	36	18.56
Fetal distress	6	23.08	20	76.92	26	13.40
Failed induction	6	33.33	12	66.67	18	9.28
Fetal tachycardia	1	100.00	0	0.00	1	0.52
Macrosomia	0	0.00	3	100.00	3	1.55
Meconium stained liquor	3	37.50	5	62.50	8	4.12
Non-progress of labor	19	57.58	14	42.42	33	17.01
Oligohydramnios	3	50.00	3	50.00	6	3.09
PPROM	0	0.00	1	100.00	1	0.52
PROM	5	71.43	2	28.57	7	3.61
Thick meconium stained liquor	5	50.00	5	50.00	10	5.15
Transverse lie	0	0.00	1	100.00	1	0.52

Fig. 1: Predictive validity of vaginal birth after cesarean section (VBAC) score in predicting successful VBAC (ROC analysis)

Table 3: Test result variable(s): vaginal birth after cesarean section (VBAC) score

Area under the curve (AUC)	Standard error	95% confidence interval of AUC		p value
		Lower bound	Upper bound	
0.853	0.028	0.798	0.908	<0.001

Table 4: Association of Successful vaginal birth after cesarean section (VBAC) with VBAC score category of study population (N = 194)

VBAC score category	Successful VBAC		Chi-square	p value
	Yes	No		
VBAC (13.5 and above)	70 (83.33%)	24 (21.82%)	72.162	<0.001
VBAC (up to 13.49)	14 (16.67%)	86 (78.18%)		

After controlling the effect of other values in the equation, a history of previous vaginal birth was strongly associated with successful VBAC the odds of which were 4.726 (95% CI 1.581 to 12.066, p value < 0.001) followed by Bishop score 2.037 (95% CI 1.639 to 2.532, p value < 0.001), BMI 1.024 (95% CI 0.871 to 1.204,

Table 5: Predictive validity of successful vaginal birth after cesarean section (VBAC) as compared to VBAC score category (N = 194)

Parameter	Value (%)	95% CI	
		Lower (%)	Upper (%)
Sensitivity	83.3	75.36	91.3
Specificity	78.2	70.46	85.9
False-positive rate	21.8	14.10	29.5
False-negative rate	16.7	8.70	24.6
Positive predictive value	74.5	65.65	83.3
Negative predictive value	86.0	79.20	92.8
Diagnostic accuracy	80.4	74.83	86.0

p value 0.771), and maternal age 1.057 (95% CI 0.882 to 1.267, p value 0.547). The symptomatic uterine rupture occurred in 0.1% of women who underwent TOLAC. No perinatal morbidity or mortality was seen (Table 6).

DISCUSSION

The proportion of women undergoing cesarean section is constantly on the rise globally and in India. Hence, the number of women seeking obstetric care with a history of primary cesarean section is also on the rise. The choice of mode of delivery in these women between ERCS and TOLAC is challenging and fraught with many uncertainties. Despite multiple scoring systems developed by researchers, none of the scores were tested extensively and the level of the evidence available on the subject is still poor.

In the current study, which was conducted in a tertiary care teaching hospital in southern India, the proportion of successful VBAC was 43.30%. Gonen et al.[10] have reported a VBAC success rate of 82% in their study. In the study by Haumonte et al.,[17] a trial of labor was attempted in 49% with a 75% successful rate. As per the study by Knight et al.,[18] the proportion of women with successful VBAC was 63.4%. Tamrakar and Chawla[19] have reported only an 18.3% success rate of VBAC in their study. Gardner et al.[20] have

Table 6: Multivariate logistic regression analysis of individual components of vaginal birth after cesarean section (VBAC) score with successful VBAC

Parameters	Adjusted odds ratio	95% CI for EXP(B)		p value
		Lower	Upper	
Maternal age	1.057	0.882	1.267	0.547
Body mass index	1.024	0.871	1.204	0.771
Bishop score	2.037	1.639	2.532	<0.001
History of vaginal birth	4.726	1.851	12.066	<0.001

reported a success rate of 64.4%. This wide variation in the success rate of VBAC in various settings can be attributed to differences in the choice of women for VBAC, obstetric management protocols and variations in the critical decision points to convert the delivery into an elective cesarean section.

In the current study, after controlling the effect of other values in the equation, the history of previous vaginal birth is strongly associated with successful VBAC the odds of which were 4.726 (95% CI 1.581 to 12.066, p value < 0.001) followed by Bishop score 2.037 (95% CI 1.639 to 2.532, p value < 0.001), BMI 1.024 (95% CI 0.871 to 1.204, p value 0.771), and maternal age 1.057 (95% CI 0.882 to 1.267, p value 0.547). As per the study by Gonen et al.,[10] indication for the primary C section (OR, 7.4; 95% CI 2.8 to 19.2), a previous VBAC (OR, 7.2; 95% CI 2.1 to 24.8), cervical dilation (OR, 2.5; 95% CI 1.3 to 4.9), gestational age ≤41 weeks (OR, 2.8; 95% CI 1.1 to 7.1), and lower gestational age at the primary CS (OR, 1.2; 95% CI 1.02 to 1.4) were the variables strongly associated with successful VBAC. As per the study by Knight et al.,[18] the factors associated with successful VBAC were younger age, ethnicity, and previous elective cesarean section. As per the study by Birara and Gebrehiwot,[21] independent factors determining successful VBAC were history of successful VBAC in the past, rupture of membrane at admission, and cervical dilatation of more than 3 cm at admission. The presence of meconium, malposition, and history of stillbirth was associated with failed VBAC. Factors like maternal age, past cesarean indications, inter-delivery interval, and birth weight were not found to be significant determinants of success. The most common reason for repeat cesarean section after trial of labor was labor dysfunction because of the absence of a policy for augmentation on a scarred uterus in these hospitals. As per the study by Brill and Windrim,[22] a non-recurrent indication for previous CS, such as, a breech presentation or fetal distress, is associated with a much higher successful VBAC rate than recurrent indications, such as, CPD. In a study by Haumonte et al.,[17] two factors strongly associated with VBAC were prior history of vaginal delivery and spontaneous labor.

In the current study, the VBAC score had good predictive validity in predicting successful VBAC, as indicated by the area under the curve of 0.853 (95% CI 0.798 to 0.908, p value < 0.001).

The sensitivity of a VBAC score of 13.5 or more in predicting successful VBAC was 83.3% (95 CI 75.36% to 91.3%) and specificity was 78.2% (95 CI 70.46% to 85.9%). The false-positive and false-negative rates were 21.8% (95 CI 14.10% to 29.5%) and 16.7% (95 CI 8.70% to 24.6%), respectively. Positive predictive value was 74.5% (95 CI 65.65% to 83.3%), negative predictive value was 86% (95 CI 79.2% to 92.8%), and the total diagnostic accuracy was 80.4% (95 CI 74.83% to 86%). The symptomatic uterine rupture occurred in 0.1% of women who underwent TOLAC. No perinatal morbidity or mortality is seen. The proposed VBAC score in the study by Gonen et al.[10] had a value assigned between 0 and 3 to each of the four

most significant variables based on the probability for prediction of VBAC. A score ≤2 was associated with a success rate of 42%, a score between 3 and 6 was associated with a rate of 81%, and a score between 7 and 10 was associated with a 98% successful VBAC rate (p < 0001). The proposed VBAC score may help obstetricians while counseling their women regarding the individual likelihood of a successful VBAC.

Catling-Paull et al.[23] in their systematic review have concluded that induction of labor using an artificial rupture of membranes, prostaglandins, oxytocin infusion, or a combination was associated with lower vaginal birth rates. Cervical ripening agents, such as, prostaglandins and transcervical catheters, may result in lower vaginal birth rates compared with spontaneous labor. The impact of epidural anesthesia in labor on vaginal birth after cesarean success is inconclusive. Nilsson et al.[24] have evaluated the effectiveness of women-centered interventions during pregnancy and birth to increase rates of vaginal birth after cesarean and have concluded that few studies evaluated women-centered interventions, designed to improve VBAC rates, and all interventions were applied in pregnancy only, none during the birth. So, there is an urgent need to develop and evaluate the effectiveness of all types of women-centered interventions during pregnancy and birth, which will help to improve VBAC rates.

Implications for Practice

Decision-aids and information programs during pregnancy should be provided for women, as even though they do not affect the rate of VBAC, they decrease women's decisional conflict and increase their knowledge about possible modes of birth.

Conclusion

- The proportion of successful VBAC was 43.30% in the current study.
- The factors which have shown statistically significant association with successful VBAC were the previous history of vaginal birth, higher mean Bishop score, Bishop score category more than 5, and lower estimated fetal weight. All the women in the successful VBAC category had shown good uterine contractions and favorable cervix.
- The most common indication for previous LSCS in the patients who underwent repeat LSCS was nonprogress of labor (17.53%) followed by fetal distress in 12.89%.
- The VBAC score had good predictive validity in predicting successful VBAC, as indicated by the area under the curve of 0.853 (95% CI 0.798 to 0.908, p value < 0.001).
- The sensitivity of a VBAC score of 13.5 or more in predicting successful VBAC was 83.3% (95 CI 75.36% to 91.3%) and specificity was 78.2% (95 CI 70.46% to 85.9%). Positive predictive value was 74.5% (95 CI 65.65% to 83.3%), negative predictive

value was 86% (95 CI 79.2% to 92.8%), and the total diagnostic accuracy was 80.4% (95 CI 74.83% to 86%).

- After controlling the effect of other values in the equation, the history of previous vaginal birth and high Bishop score were the factors, which were significantly associated with successful VBAC.
- Symptomatic uterine rupture occurred in 0.1% women who underwent TOLAC. No perinatal morbidity or mortality was seen.

RECOMMENDATIONS

- The ERCS is not mandatory in women with primary cesarean section, as a significant proportion of these women are likely to deliver by VBAC.
- The choice of the women to be subjected to TOLAC has to be made with careful consideration of various maternal and obstetric parameters as per the best level of evidence available.
- Vaginal birth after cesarean section predictive scoring system appears to be a useful tool for the prediction of successful VBAC. But this has to be tested for consistency in different settings and population groups by large-scale controlled trials, before recommending its routine use in clinical practice.

LIMITATIONS

- The limited sample size available for the study did not permit extensive multivariate analysis to rule out the role of various other potential confounding factors.
- Adequate caution must be exercised in generalizing the study findings to other ethnic groups within and outside the country.

ACKNOWLEDGMENTS

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