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Validation of Grobman's graphical nomogram for prediction of vaginal delivery in Indian women with previous caesarean section

Mahak Bhardwaj [a,*,1], Shalini Gainder [a], Seema Chopra [a], Rashmi Bagga [a], Shiv Sajan Saini [b]

[a] Department of Obstetrics and Gynaecology, Post Graduate Institute of Medical Education and Research (PGIMER) Chandigarh, India
[b] Department of Pediatrics, Post Graduate Institute of Medical Education and Research (PGIMER) Chandigarh, India

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ABSTRACT

Purpose: To validate Grobman's nomogram for prediction of trial of labour after caesarean section (TOLAC) success in the Indian population.
Methods: A prospective observational study of women with previous lower segment caesarean sections (LSCS) who were admitted for TOLAC between January 2019 and June 2020 at a tertiary care hospital We compared the Grobman's predicted VBAC success probability to the observed VBAC rate in the study population and devised a receiver-operator characteristics (ROC) curve for the nomogram.
Results: Among the 124 women with prior LSCS who chose TOLAC and were included in the study, 68 (54.8%) had a successful VBAC and 56 (45.2%) had a failed TOLAC. The mean Grobman's predicted success probability for the cohort was 76.7%, significantly higher in VBAC women versus CS women (80.6% vs. 72.1%; p 0.001). The VBAC rate was 69.1% with a predicted probability of > 75% and only 42.9% with a probability of 50%. Women in the > 75% probability group had a nearly similar observed and predicted VBAC rate (69.1% vs. 86.3%; p = 0.002), and a greater number of women in the 50% probability group had successful VBAC than predicted (42.9% vs. 39.5%; p = 0.018). The area under the ROC curve for the study was 0.703 (95% CI 0.609–0.797; p 0.001). Grobman's nomogram had a sensitivity of 57.35%, a specificity of 82.14%, a positive predictive value (PPV) of 79.59%, and a negative predictive value (NPV) of 61.33% at a predicted probability cut-off of 82.5%.
Conclusions: Women who had a higher Grobman's predicted probability had greater VBAC success rates than those with low predicted probability scores. The prediction ability of the nomogram was highly accurate at higher predicted probabilities, and even at lower predicted probabilities, women did have good odds of delivering vaginally.

Introduction

The constantly evolving field of obstetrics has led to a steady increase in the rate of caesarean sections (CS), both in India and worldwide. This change in practice has led to a large population of women with uterine scars who need more focused obstetric care in their following pregnancies. These women are to choose between two delivery options: TOLAC or elective repeat caesarean section (ERCS). The probability of TOLAC success depends on a large number of factors and varies according to each woman's individual characteristics. It is expected for a woman with a scarred uterus to fear TOLAC because of the associated negative reports of uterine rupture [1]. Researchers have confirmed that TOLAC may be more widely attempted if the success of VBAC could be predicted [2]. There is a dire need to provide women with a more individualised and evidence-based risk assessment during TOLAC [3]. Obstetricians have used various methods to counsel women regarding their probability of having a VBAC. The most naïve (simple but does not individualise prediction) strategy used was informing women of the reported success rate of the general population of women who underwent TOLAC as a whole. The other, more individualised approach is for an obstetrician to evaluate how much an individual woman's probability differs from that of the general population by using the various factors associated with successful VBAC. But this is essentially qualitative and does not give a calculated probability of success. Predictive models were proposed for reproducing a quantitative value of VBAC success probability while also taking into account the individual

* Corresponding author.
E-mail address: drmahak37@gmail.com (M. Bhardwaj).
[1] ORCID ID: 0000-0001-6003-565X

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demographics of women. Out of the several models made available for this purpose, the most utilised and accepted model is the one proposed in 2007 by Grobman and associates based on a U.S. cohort of 11,000 women who pursued TOLAC. The nomogram takes into account maternal parameters like age, ethnicity, BMI of the mother, history of prior vaginal birth or prior VBAC, and the indication of previous CS. The nomogram was evolved from a population of women who had a previous one-lower segment caesarean section, presented at 36 weeks or later with a singleton foetus in vertex presentation, and underwent TOLAC [4]. The predictive accuracy of the nomogram has been studied and established in the U.S. [5], Japanese [6], European [7], and French [8] cohorts; however, ambiguity prevails over its generalisability in populations with different demographic profiles. In this study, Grobman's predictive nomogram was applied to an Indian population cohort, and the estimated VBAC success probability was compared to the actual success rate obtained in the population.

Materials and methods

This prospective observational study was carried out in a tertiary hospital between January 2019 and June 2020 after approval by the institute ethics committee and was registered in the Clinical Trials Registry of India. Following informed consent, 124 women with previous LSCS at term and singleton pregnancy with cephalic presentation and no contraindications to TOLAC were recruited.Detailed history and maternal characteristics like maternal age, BMI, ethnicity, prior vaginal delivery (VBAC), and an indication of the prior Caesarean section were recorded. If pre-pregnancy BMI was not available, the earliest available BMI in pregnancy was used. Using these variables, each woman's predicted VBAC success probability was calculated using Grobman's prenatal nomogram [9]. Even if the probability, as per Grobman's nomogram, was low and the patient was willing to undergo TOLAC with no existing contraindication, a trial of labour was given [10]. On admission of the woman for delivery, her most recent BMI (within 2 weeks of delivery), estimated gestational age, and presence or absence of preeclampsia and gestational diabetes mellitus were checked and recorded. Cervical examination findings were noted and the need for induction of labour (IOL) assessed. After adding these new variables, a recalculation of the predicted VBAC success probability was done using the nomogram [9]. The nomogram was used by locating each characteristic of the woman on the nomogram and finding the number of points on the uppermost scale to which that characteristic approximately corresponded. Then the number of points generated from all of a woman's characteristics were added together, and that sum was found on the scale of "total points." Thereafter, the predicted probability of VBAC was calculated using the lowermost probability scale by drawing a vertical line from the "total points" scale to the "probability" scale [11]. Women were divided into three groups based on their predicted VBAC success rate: 50%, 50–75%, and > 75%, and the observed VBAC success rate was compared to the predicted success rates to determine the accuracy and applicability of this predictive nomogram in Indian women.

Statistical analysis

The means were compared for continuous variables using the Student t test or Anova and Chi square or fisher exact test was used for categorical variables. Data were analysed using Statistical Package for the Social Sciences (SPSS), version 20.

Results

124 women met the inclusion criteria and were enroled in the study, out of which 68 (54.8%) had VBAC and 56 (45.2%) had repeat CS. Grobman's predicted VBAC success probability ranged from 27% to 99% for women in the study population.The mean calculated success probability for the overall population was 76.7%, whereas the actual VBAC rate that was observed in the present study was 54.8%. Women who had VBAC had a significantly higher calculated Grobman's success probability than those who had repeat CS (80.6% vs. 72.17; p 0.001). Women were distributed into 3 groups based on Grobman's probability: 50% probability (5.6%), 50–75% probability group (39.5%), and > 75% probability group (54.8%). Significant differences in the VBAC and CS rates were observed at different predicted probabilities ($p = 0.002$). The VBAC rate was 69.1% at a predicted probability of > 75% and only 42.9% at a predicted probability of 50%. For women in the > 75% probability group, the mean predicted Grobman's probability was 86.36%, whereas the actual observed VBAC success was 69.1% ($p = 0.002$). For women in the 50–75% probability group, 68.84% was the mean predicted probability, and the actual observed VBAC success was 36.7% ($p = 0.008$), compared to women in the 50% probability group who had a mean predicted probability of 39.57% but ended up having a higher actual VBAC success rate of 42.9% ($p = 0.014$). The ROC curve produced for the study population after multivariate analysis and logistic regression in Grobman's predicted VBAC success probabilities AUC was computed to be 70.3% (AUC 0.703; 95% CI 0.609–0.797; p 0.001). In our study cohort, at an 82.5% predicted VBAC success probability, the Grobman's nomogram had 57.35% sensitivity, 82.14% specificity, and an accuracy rate of 68.55%. The positive predictive value of the nomogram was 79.59%, along with a negative predictive value of 61.33% in the study population.

Discussion

The goal of managing an antenatal woman with a scarred uterus is to provide her with a well-informed choice as well as efficient and robust statistical data of the estimated risks associated with TOLAC and ERCS, as well as an individualised prediction of her estimated likelihood of having a successful VBAC if she chooses TOLAC. Grobman's nomogram was used for the prediction of individualised VBAC success for every woman who was enroled in the present study. The success probability calculated for women in the study population ranged from as low as 27% to as high as 99%. The mean VBAC success predicted for the entire study population was 76.7%, compared to the actual observed VBAC success of 54.8%. The mean predicted Grobman's VBAC success probability for women who had VBAC was significantly higher than for those who had CS (80.6% vs. 72.17%). Hence, Grobman's nomogram was observed to be an accurate model for VBAC success prediction in the present study.

A significant difference was present in the VBAC and CS rates at different predicted VBAC success probabilities. A high VBAC rate of 69.1% was observed in the cohort at a calculated probability of > 75%, whereas a low VBAC rate of only 50% was observed at a calculated probability of 50%. This observation was similar to that of Maykin et al., who observed higher VBAC rates at higher predicted success rates for Grobman's VBAC success probability [10].

The study population was divided into three groups based on Grobman's predicted probability: G1: > 75% probability, G2: 50–75% probability, and G3: 50% probability. The mean calculated probability for the > 75% group was higher than the actual observed VBAC rate (86.3% vs. 69.1%), for the 50–75% group was higher than the actual observed VBAC rate (68.84% vs. 36.7%), and for the 50% group was lower than the actual observed VBAC success rate (39.5% vs. 42.9%). Hence, the present study concluded that Grobman's nomogram was highly accurate for calculating individualised VBAC success at higher predicted probabilities, and even at a lower predicted probability, it offers a good chance at VBAC success. Therefore, no woman who is highly motivated for TOLAC should be refused a trial because of a lower predicted probability.

The Grobman's model was found to have a sensitivity of 57.3%, a specificity of 82.1%, and an accuracy of 68.5% in the study (51, 53, 56) population. It exhibited a positive predictive value of 79.5% and a negative predictive value of 61.3% in the present study. The AUC was 0.703, which was comparable to the AUC in the studies by Grobman

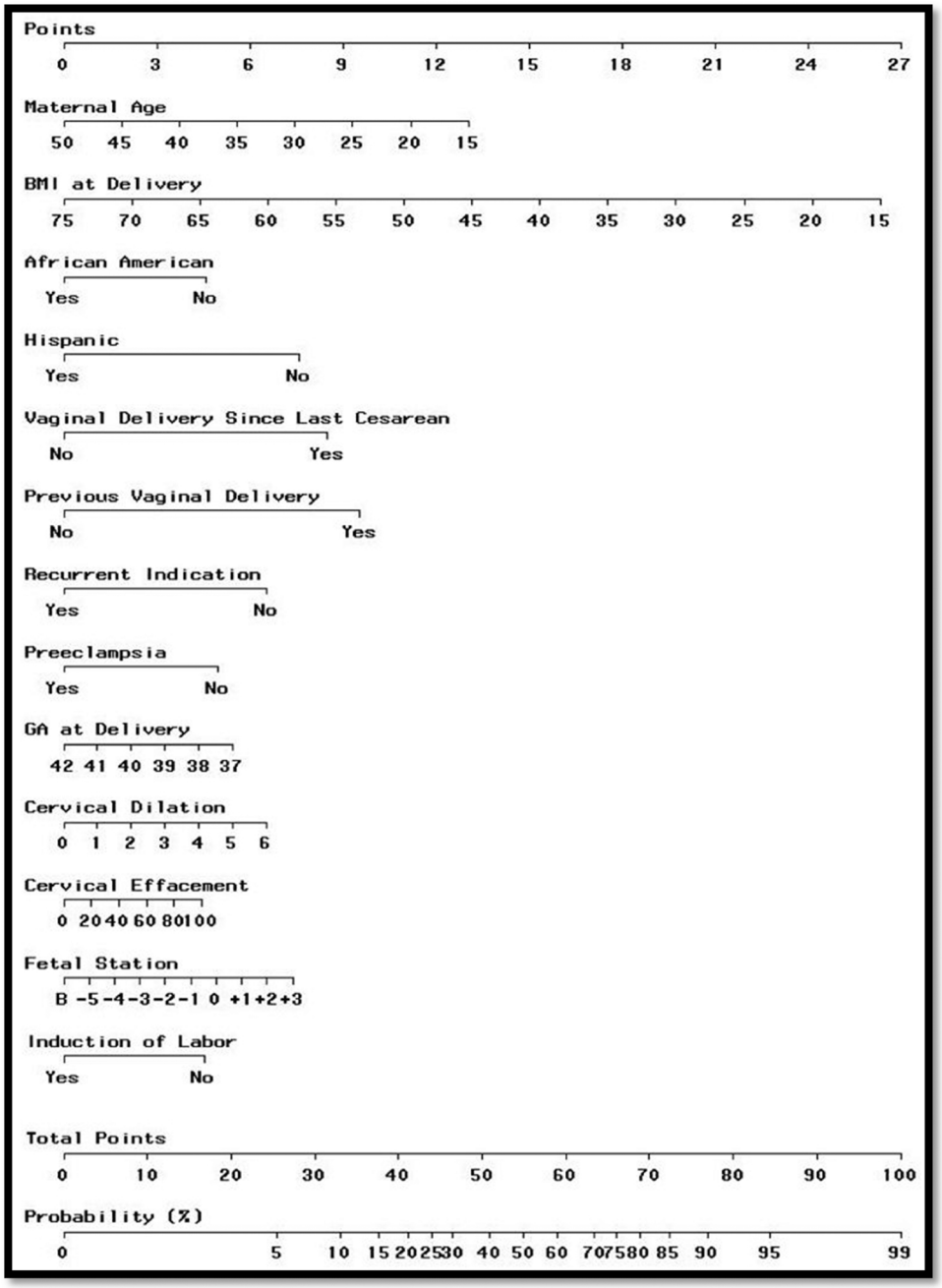

Fig. 1. Grobman's normogram.

et al., Haumonte et al., and Mooney et al. [4,8,9,12].

Thus, the current study's findings show Grobman's graphical nomogram to be an accurate functional tool for predicting (individualised) quantitative odds of success for women undergoing TOLAC, and it was validated for predicting VBAC success in Indian women.

Conclusion

Women who had a higher Grobman's predicted probability had greater VBAC success rates than those with low predicted probability scores. The prediction ability of the nomogram was highly accurate at higher predicted probabilities, and even at lower predicted probabilities, women did have good odds of delivering vaginally. Hence, Grobman's nomogram proves to be a valid tool for prediction of VBAC success in Indian women and has accurate predictability. Figs. 1 and 2.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Ethics Committee of Post Graduate Institute of Medical Education and Research (PGIMER) Chandigarh, India (Dated 17.05.2019, No. INT/IEC/2019/601169).

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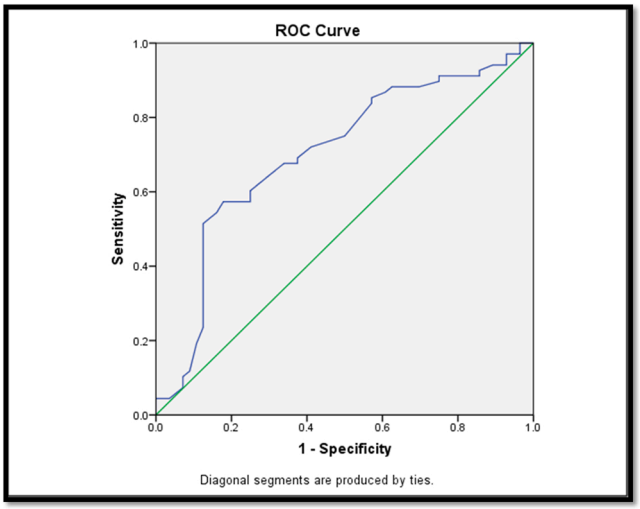

Fig. 2. ROC curve.

CRediT authorship contribution statement

Material preparation, data collection and analysis were performed by Mahak Bhardwaj and Shalini Gainder. The first draft of the manuscript was written by Mahak Bhardwaj and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

No conflict of interest.

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Informed Consent

Written Informed consent was obtained from all individual participants included in the study.

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