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Original article

French validation and adaptation of the Grobman nomogram for prediction of vaginal birth after cesarean delivery

J.-B. Haumonte [a,b,*], M. Raylet [c], M. Christophe [d], F. Mauviel [e], A. Bertrand [f], R. Desbriere [a], C. d'Ercole [g]

[a] Obstetrics and Gynaecology unit, Hospital Saint-Joseph, Marseille, France
[b] Hôpital Nord, Assistance publique–hôpitaux de Marseille, Marseille, France
[c] Obstetrics and Gynaecology unit, centre hospitalier du Pays d'Aix, Aix-en-Provence, France
[d] Obstetrics and Gynaecology unit, CHG de Martigues, Martigues, France
[e] Obstetrics and Gynaecology unit, CHIC de Toulon-La-Seyne, Toulon-La-Seyne, France
[f] Obstetrics and Gynaecology unit, CHG de Salon-de-Provence, Salon-de-Provence, France
[g] Obstetrics and Gynaecology unit, hôpital Conception, Assistance publique–hôpitaux de Marseille, Marseille, France

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ABSTRACT

Objective. – To validate Grobman nomogram for predicting vaginal birth after cesarean delivery (VBAC) in a French population and adapt it.
Study design. – Multicenter retrospective study of maternal and obstetric factors associated with VBAC between May 2012 and May 2013 in 6 maternity units. External validation and adaptation of the prenatal and intrapartum Grobman nomograms for vaginal birth prediction after cesarean delivery in a French cohort.
Results. – The study included 523 women with previous cesarean deliveries; 70% underwent a trial of labor for a subsequent delivery ($n = 367$) with a success rate of 65% ($n = 240$). In the univariate analysis, 5 factors were associated with successful VBAC: previous vaginal delivery before the cesarean ($P < 0.001$), the number of previous vaginal deliveries ($P < 0.001$), and a favorable cervix at delivery room admission, cervical effacement ($P = 0.035$), or cervical dilatation at least 3 cm ($P < 0.001$), or a Bishop score > 6 ($P = 0.03$). A potentially recurrent indication (defined as arrest of dilation or descent as the indication for the previous cesarean) ($P = 0.039$), a hypertensive disorder during pregnancy ($P = 0.05$), and labor induction ($P = 0.017$) were each associated with failed VBAC. External validation of the prenatal and intrapartum Grobman nomograms showed an area under the ROC curve of 69% (95% CI: 0.638, 0.736) and 65% (95% CI: 0.599, 0.700) respectively. Adaptation of the nomogram to the French cohort resulted in the inclusion of the following factors: maternal age, body mass index at last prenatal visit, hypertensive disorder, gestational age at delivery, recurring indication, cervical dilatation, and induction of labor. Its area under the curve to predict successful VBAC was 78% (95% CI: 0.738, 0.825).
Conclusion. – The nomogram to predict VBAC developed by Grobman et al. is validated in the French population. Adaptation to the French population, by excluding ethnicity, appeared to improve its performance. Impact of the nomogram use on the caesarean section rate has to be validated in a randomized control trial.

Introduction

The cesarean rate has not stopped climbing worldwide over the past decade [1]. In France, it appears to have stabilized between 2010 and 2014 at around 20% after a period of constant progression [2]. With the increase in the number of cesareans for nulliparous women, the mode of delivery for women with a history of these deliveries has become a daily concern in French maternity units: they account for nearly 11% of parturients and 18% of multiparous women [3]. The issue for obstetricians is to advise women to help them determine which mode of delivery is best for them. That is, after a cesarean delivery, women have a choice between a planned

* Corresponding author. Sainte-Monique Maternity, Saint-Joseph Hospital, 26, boulevard de Louvain, 13285 Marseille, France.
E-mail address: jb.haumonte@gmail.com (J.-B. Haumonte).

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elective repeat cesarean and a trial of labor (TOL) for a vaginal delivery after cesarean (VBAC). Several studies have compared the benefits and risks between TOL and an elective repeat cesarean. The success of VBAC has several short-term benefits for maternal health: lower rates of infection and post-partum hemorrhage, as well as a shorter hospitalization than after planned cesarean [4]. The same is true for the long-term benefits for women who want future pregnancies, with a better possibility of subsequent vaginal deliveries and a reduction in the risks of such obstetric complications as abnormal placental insertion (placenta previa and accreta), placental abruption, and in utero fetal death [5]. The potential risks of TOL for both the mother and the fetus are emergency cesarean delivery and uterine rupture [6].

Success rates for VBAC vary worldwide from 49% to 87% [7]. According to the 2010 national perinatal survey, this rate is 75% in France [3]. The probability of success has been shown to vary according to women's individual characteristics. It would therefore be interesting to be able to predict an individual probability of VBAC success for each woman. Such a tool could be useful in the decision-making process about mode of delivery after a first cesarean.

Several models of scores to predict individual probabilities of VBAC success have already been described [8,9]. The most relevant model is the nomogram published by Grobman et al. from a prospective cohort of more than 11,000 women who had a TOL in the United States [10,11]. This model can be used at the first prenatal visit (prenatal nomogram) [10] and at admission for delivery at the onset of labor (intrapartum nomogram) to predict the likelihood of VBAC success [11]. This nomogram was first validated on another cohort in the United States [12], and then in Japan [13] and Europe [14]. It has never been validated in the French general population. These countries vary quite substantially, however, in their demographic characteristics and obstetric management. The clinical practice guidelines for deliveries after cesareans released by the French College of Obstetrics and Gynecology (CNGOF) in 2012 did not recommend the use of a score or nomogram, considering them of limited value in the absence of validation in the French general population [2]. In this study, we sought to validate Grobman's predictive score in a French cohort and then to develop a predictive model for successful VBAC by adjusting the existing model to our cohort.

Material and methods

This retrospective cohort study in six maternity units in the Provence-Alpes-Côte d'Azur (PACA) region conducted from May 1, 2012, and April 30, 2013 in two level-3 university hospital centers and four level-I and -2B hospitals. The study included all women at term (> 37 weeks of gestation) with one previous cesarean delivery admitted to the delivery room. The exclusion criteria were: multiple pregnancy, more than one previous cesarean, and in utero fetal death. Data were collected from the eligible women's medical files. CEROG (the ethics committee for research in obstetrics and gynecology) (CEROG OBS 2014-11-03) approved the study protocol. The factors influencing VBAC success previously reported in the literature were collected, together with the data necessary to develop a score to predict this success [15,16]:

- demographic characteristics: age, ethnicity, body mass index (BMI) at the first and last prenatal consultations, hypertension (chronic or pregnancy-related) or preeclampsia, preexisting disease (asthma, heart disease, kidney disease, and connective tissue disorder;
- obstetric history: history of cesareans before 37 weeks, number of previous vaginal deliveries, time since the previous cesarean, potentially recurrent indication for cesarean (defined by arrest of dilatation or descent as the indication for the first cesarean);
- criteria based on the examination at delivery room admission: term, Bishop score at arrival, rupture of the membranes, cervical dilatation (0, 1, or 2 fingers and in cm), cervical effacement, need for induction of labor, and methods of induction (oxytocin or cervical ripening balloon).

Univariate and multivariable analysis of the factors influencing VBAC success

The factors significantly influencing mode of delivery (success or failure of VBAC) in the univariate analysis ($P < 0.10$) were introduced into multivariate analysis together with clinically relevant factors.

Validation of the prenatal and intrapartum nomograms of Grobman et al.

To validate the model for predicting successful VBAC developed by Grobman et al., we analyzed the variables included in their nomogram [10,11]. For the prenatal model, the following data were included: maternal age, BMI at first prenatal visit, maternal ethnicity (we used Caucasian and sub-Saharan African but replaced Hispanic by "other" because more representative of our population), vaginal delivery before cesarean, vaginal delivery after the cesarean, and recurring indication.

The following formula was applied for this nomogram: $\text{Exp}(w)/[1 + \text{Exp}(w)]$, where $w = 3.766 - 0.039(\text{age}) - 0.060$ (BMI at first visit) $- 0.671$ (sub-Saharan African ethnicity) $- 0.680$ ("Hispanic" ethnicity) $+ 0.888$ (vaginal delivery before cesarean) $+ 1.003$ (vaginal delivery after cesarean) $- 0.632$ (recurring indication) [10].

The variables for the intrapartum model were maternal age, BMI at the last prenatal visit, maternal ethnicity (modified as above), vaginal delivery before cesarean, vaginal delivery after cesarean, recurring indication, gestational age at delivery room admission, hypertension during pregnancy, need for induction of labor, cervical effacement/cervical dilatation, and presentation (breech/vertex) at admission. The intrapartum nomogram used the following equation: $\text{Exp}(w)/[1 + \text{Exp}(w)]$, where $w = 7.059 - 0.037(\text{age}) - 0.044$ (BMI) $- 0.460$ (sub-Saharan African ethnicity) $- 0.761$ (Hispanic ethnicity) $+ 0.955$ (vaginal delivery before cesarean) $+ 0.851$ (vaginal delivery after cesarean) $- 0.655$ (recurring indication) $- 0.109$ (term at delivery room entry) $- 0.499$ (hypertension) $+ 0.044$ (cervical effacement) $+ 0.109$ (cervical dilatation) $+ 0.082$ (presentation) $- 0.452$ (induction of labor) [11]. The accuracy of the model was assessed by comparing ROC curves.

Adaptation of the Grobman prenatal nomogram to the study cohort

The logistic regression model was used to identify the factors predictive of vaginal delivery. The fit of the logistic model data was assessed with the Hosmer-Lemeshow test. Based on the probabilities predicted by the multivariate logistic model, a cut-off was determined with the aid of the ROC curve, and a formula was proposed to predict individual outcomes of VBAC.

Statistical analyses

The statistical analyses were performed with IBM SPSS Statistics software, version 20.0. Statistical significance was set at $P < 0.05$ for all tests. The continuous variables are presented as means (± standard deviation) or as medians with their range (minimum, maximum); the qualitative variables are presented as

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