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Predicting the success of vaginal birth after caesarean delivery: a retrospective cohort study in China

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ABSTRACT

Objectives To develop a nomogram to predict the likelihood of vaginal birth after caesarean section (VBAC) among women after a previous caesarean section (CS).

Design A retrospective cohort study.

Setting Two secondary hospitals in Guangdong Province, China.

Participants Inclusion criteria were as follows: pregnant women with singleton fetus, age ≥18 years, had a history of previous CS and scheduled for trial of labour after caesarean delivery (TOLAC). Patients with any of the following were excluded from the study: preterm labour (gestational age <37 weeks), two or more CSs, contradictions for vaginal birth, history of other uterine incision such as myomectomy, and incomplete medical records.

Primary outcome measure The primary outcome was VBAC, which was retrospectively abstracted from computerised medical records by clinical staff.

Results Of the women who planned for TOLAC, 84.0% (1686/2006) had VBAC. Gestational age, history of vaginal delivery, estimated birth weight, body mass index, spontaneous onset of labour, cervix Bishop score and rupture of membranes were independently associated with VBAC. An area under the receiver operating characteristic curve (AUC) in the prediction model was 0.77 (95% CI 0.73 to 0.81) in the training cohort. The validation set showed good discrimination with an AUC of 0.70 (95% CI 0.60 to 0.79).

Conclusions TOLAC may be a potential strategy for decreasing the CS rate in China. The validated nomogram to predict success of VBAC could be a potential tool for VBAC counselling.

Strengths and limitations of this study

- This is the largest study to date to develop a nomogram model for predicting successful vaginal birth after caesarean section (VBAC) in China.
- We generated a validated nomogram to predict success of VBAC with a relative high area under the receiver operating characteristic curve of 0.76 (95% CI 0.73 to 0.80).
- Our obstetric population is from two secondary hospitals in Guangdong Province, which may limit the generalisability.
- The retrospective nature of the study may discount the data quality of electronic medical records.

INTRODUCTION

The rates of caesarean section (CS) have increased steadily all over the world in the past two decades.[1] Women undergoing CS may face health risks, including haemorrhage, blood transfusion, anaesthesia-associated complications and surgical risks.[2] The WHO has reported that China has one of the highest CS rates in the world,[3] especially in the northeastern province of Jilin (62% in 2014) and Shanghai (60% in 2010).[4 5] To reduce CS rates, the Chinese government has introduced various policies and programmes at the national, provincial, district, county and hospital levels, including education of pregnant women, physician training, supervision of non-medically indicated CS (inspection and monitoring periodically conducted by national and provincial health authorities to identify any unnecessary CS, which was interpreted as an indicator of the quality of obstetric care), setting targets for CS rates and establishing incentives for lowering CS rates.[4 6 7] China has made significant progress in achieving milestone goals, CS rates declined steadily between 2012 and 2016 (from 45.3% to 41.1%).[8] CS rates declined from 60% in 2009 to 43% in 2014.[4]

The policy for allowing women to have a second child established in China in November 2015 has resulted in new challenges for controlling CS rates considering the increasing number of repeat CS. In addition, repeat CS is associated with increased health risk, including placenta accreta, infection, vein thrombosis and uterine rupture.[8–10] The increasing number of women with a previous CS is an urgent matter and should be given close attention by clinicians and policymakers. Trial of labour after caesarean delivery (TOLAC) is an alternative to repeat

CS and vaginal birth after caesarean section (VBAC) is an accepted practice. Current evidence suggests that women who undergo repeated CS have significantly higher risk of maternal and perinatal morbidity compared with women who deliver vaginally after CS.[7] Major complications associated with TOLAC include scar dehiscence, hysterectomy and uterine rupture, but successful TOLAC is associated with less blood loss, significantly lower risk of neonatal respiratory morbidities and placenta previa, and a shorter hospital stay with a more rapid recovery.[11–13] TOLAC should be considered among women with a uterine scar if there are no contraindications, and successful TOLAC can be safely achieved for both mother and infant in most cases.[14]

Globally, TOLAC is considered a reasonable and safe option. However, in China, repeat CS rates remain high among women with a history of previous CS.[15] Therefore, TOLAC would be highly effective at decreasing the overall CS rates considering the primary CS rates in China. Although relatively few women with TOLAC experience serious complications, there is still concern among patients and their clinicians. Few prediction models have been developed to forecast the probability of successful TOLAC in China, although multiple screening tools have been developed in other countries.[16 17] The aim of the present study was to determine the factors associated with successful TOLAC in Chinese hospitals and to develop a nomogram based on the selected variables to predict the likelihood of successful TOLAC among women after a previous CS.

MATERIALS AND METHODS

Study population

This was a retrospective cohort study conducted between January 2011 and December 2017 in two secondary hospitals (Tangxia Hospital in Dongguan city and Longhua District Central Hospital in Shenzhen city) in Guangdong Province, China. Hospitals in China are classified as primary, secondary or tertiary institutions according to the ability to provide medical care, medical education and conduct medical research. TOLAC has been practiced in the two centres for decades. Inclusion criteria were as follows: pregnant women with singleton fetus, age ≥18 years, had a history of a previous CS and scheduled for TOLAC. Patients with any of the following were excluded from the study: preterm labour (gestational age <37 weeks), two or more previous CS, contradictions for vaginal birth, congenital fetal anomalies, history of other uterine incision such as myomectomy, and incomplete medical records. This study received approval from institutional review board of the two participating hospitals. Informed consent was not obtained as this was a retrospective cohort study.

Data collection

Data on demographic and obstetric characteristics, as well as, data on delivery outcomes and delivery complications were retrospectively abstracted from computerised medical records by clinical staff. The data collected at baseline included maternal age, education level, prepregnancy body mass index (BMI), gestational age, parity, history of abortion, history of vaginal delivery, time from previous delivery, medical history (diabetes or pregestational diabetes, hypertension), estimated birth weight, recurrence of previous caesarean indications and onset of labour. In addition, information from childbirth was also collected, including oxytocin augmentation, analgesic administration, rupture of membranes and cervix Bishop score. Common ultrasound biometric measurements, including biparietal diameter, head circumference, abdominal circumference, femur length and humerus length, were used to estimate fetal birth weight based on WHO fetal growth charts.[18] Those pregnant women with delayed pregnancy, prolonged pregnancy, gestational diabetes mellitus, gestational hypertension, premature rupture of membrane or women who made a request for labour induction were in consideration for receiving oxytocin augmentation. Women with a cervix Bishop score ≥5 or having premature rupture of membrane were directly induced with oxytocin, otherwise a single or double balloon catheter was used to promote cervical ripening followed by induction of labour with oxytocin.

The primary outcome was success rate of TOLAC (vaginal birth). Secondary outcomes were maternal and neonatal adverse events, including uterine rupture, maternal infection, blood transfusion, maternal death, Apgar score <7, neonatal intensive care unit (NICU) admission and neonatal death.

Statistical analysis

Analyses were carried out using SAS software V.9.4. Of the eligible participants, 80% were randomly assigned to the training set, while the remaining 20% were assigned to the external validation set. Categorical variables were reported as frequency (percentage) and the differences between groups were compared using the χ^2 test or Fisher's exact test, as appropriate.

In the training cohort, univariate and multivariate logistic regression models were used to determine the factors associated with successful TOLAC, and the associations between related factors and successful TOLAC were presented as ORs with corresponding 95% CIs. Variables found to be significant in univariate analysis were included in a stepwise multivariate logistic regression model with entry criteria of $p<0.20$ and exit criteria of $p>0.05$. A nomogram was constructed based on the results of the multivariate logistic regression analysis and the selected variables were incorporated in the nomogram to predict the probability of successful TOLAC. The model performance was evaluated using the C statistic, which is equivalent to the receiver operating characteristic curve (ROC) area under the receiver operating characteristic curve (AUC). The calibration performance (agreement between observed outcome frequencies and predicted

probabilities of successful TOLAC) was assessed by Hosmer-Lemeshow χ^2 statistics.

For external validation, the nomogram was then applied to the validation cohort, and the discrimination and calibration performance of the model was also analysed. The optional cut-off point of the nomogram was determined by the area under the ROC and Youden index. In addition, sensitivity, specificity, accuracy rate, positive predictive value (PPV), negative predictive value (NPV) and 95% CI for predicting successful TOLAC were calculated. All tests were two-sided and p<0.05 was considered statistically significant for all analyses.

Table 1 Women's characteristics of training and validation cohorts

Characteristics		Training cohort (N=1491)	Validation cohort (N=373)	P value
Research centre	Hospital in Shenzhen	898 (60.2)	220 (59.0)	
	Hospital in Dongguan	593 (39.8)	153 (41.0)	0.66
Age (years)	<35	1311 (87.9)	340 (91.1)	
	≥35	180 (12.1)	33 (8.9)	0.08
Education (years)	<9	847 (56.8)	219 (58.7)	
	≥9	644 (43.2)	154 (41.3)	0.51
Gestational age (weeks)	≥41	209 (14.0)	55 (14.8)	
	<41	1282 (86.0)	318 (85.2)	0.72
Parity	One previous delivery	1264 (84.8)	333 (89.3)	
	≥2 previous deliveries	227 (15.2)	40 (10.7)	0.03
Number of abortions	<3	1405 (94.2)	353 (94.6)	
	≥3	86 (5.8)	20 (5.4)	0.76
History of vaginal delivery	No	1266 (84.9)	334 (89.5)	
	Yes	225 (15.1)	39 (10.5)	0.02
Success of TOLAC	No	142 (9.5)	36 (9.7)	
	Yes	1349 (90.5)	337 (90.3)	0.94
Time from previous delivery (years)	≤2	61 (4.1)	10 (2.7)	
	>2	1430 (95.9)	363 (97.3)	0.20
BMI (kg/m^2)	≥30	150 (10.1)	32 (8.6)	
	<30	1341 (89.9)	341 (91.4)	0.39
Diabetes or pregestational diabetes	Yes	126 (8.5)	30 (8.0)	
	No	1365 (91.5)	343 (92.0)	0.80
Hypertension	Yes	23 (1.5)	7 (1.9)	
	No	1468 (98.5)	366 (98.1)	0.65
Estimated birth weight (kg)	≥4	46 (3.1)	14 (3.7)	
	<4	1445 (96.9)	359 (96.3)	0.51
Previous caesarean indications	Recurrent	3 (0.2)	1 (0.3)	
	Non-recurrent	1488 (99.8)	372 (99.7)	0.80
Onset of labour	Induced	291 (19.5)	66 (17.7)	
	Spontaneous	1200 (80.5)	307 (82.3)	0.42
Oxytocin augmentation	Yes	294 (19.7)	69 (18.5)	
	No	1197 (80.3)	304 (81.5)	0.59
Analgesic	Yes	4 (0.3)	0 (0.0)	
	No	1487 (99.7)	373 (100.0)	0.32
Cervix Bishop score	<5	660 (44.3)	165 (44.2)	
	≥5	831 (55.7)	208 (55.8)	0.99
Ruptured of membranes	Yes	297 (19.9)	72 (19.3)	
	No	1194 (80.1)	301 (80.7)	0.79

BMI, body mass index; TOLAC, trial of labour after caesarean delivery.

Table 2 Univariate logistic analysis of factors predicting successful TOLAC in the training set of women

Characteristics		Failure of TOLAC (N=142)	Success of TOLAC (N=1349)	OR (95% CI)
Age (years)	<35	125 (9.5)	1186 (90.5)	1.0
	≥ 35	17 (9.4)	163 (90.6)	1.01 (0.59 to 1.72)
Education (years)	<9	73 (8.6)	775 (91.4)	1.0
	≥9	69 (10.7)	574 (89.3)	0.78 (0.55 to 1.11)
Gestational age (weeks)	≥41	30 (14.4)	179 (86.6)	1.0
	<41	112 (8.7)	1170 (91.3)	1.75 (1.14 to 2.70)
Parity	One previous delivery	130 (10.3)	1134 (89.7)	1.0
	≥2 previous deliveries	12 (5.3)	215 (94.7)	2.05 (1.12 to 3.78)
Number of abortions	<3	133 (9.5)	1272 (90.5)	1.0
	≥3	9 (10.5)	77 (89.5)	0.90 (0.44 to 1.83)
History of vaginal delivery	No	130 (10.3)	1136 (89.7)	1.0
	Yes	12 (5.3)	213 (94.7)	2.03 (1.11 to 3.74)
Time from previous delivery (years)	≤2	4 (6.6)	57 (93.4)	1.0
	>2	138 (9.6)	1292 (90.4)	0.66 (0.24 to 1.84)
BMI (kg/m^2)	≥30	25 (16.7)	125 (83.3)	1.0
	<30	117 (8.7)	1224 (91.3)	2.09 (1.31 to 3.35)
Diabetes or pregestational diabetes	Yes	12 (9.5)	114 (90.5)	1.0
	No	130 (9.5)	1235 (90.5)	1.00 (0.54 to 1.86)
Hypertension	Yes	2 (8.7)	21 (91.3)	1.0
	No	140 (9.5)	1328 (90.5)	0.90 (0.21 to 3.89)
Estimated birth weight (kg)	≥4	17 (37.0)	29 (63.0)	1.0
	<4	125 (8.6)	1320 (91.4)	6.19 (3.31 to 11.58)
Previous caesarean indications	Recurrent	1 (33.3)	2 (66.7)	1.0
	Non-recurrent	141 (9.5)	1347 (90.5)	4.78 (0.43 to 53.02)
Onset of labour	Induced	65 (22.3)	226 (77.7)	1.0
	Spontaneous	77 (6.4)	1123 (93.6)	4.20 (2.93 to 6.01)
Oxytocin augmentation	Yes	68 (23.1)	226 (76.9)	1.0
	No	74 (6.2)	1123 (93.8)	4.57 (3.19 to 6.54)
Analgesic	Yes	0 (0.0)	4 (100.0)	1.0
	No	142 (9.6)	1345 (90.5)	<0.01 (<0.01 to >99.9)
Cervix Bishop score	<5	105 (15.9)	555 (84.1)	1.0
	≥5	37 (4.5)	794 (95.5)	4.06 (2.75 to 6.00)
Rupture of membranes	Yes	44 (14.8)	253 (85.2)	1.0
	No	98 (8.2)	1096 (91.8)	1.95 (1.33 to 2.85)

BMI, body mass index; TOLAC, trial of labour after caesarean delivery.

Patient and public involvement

Patients were not involved in study design, recruitment or implementation. Major findings from the study will be disseminated through international conference posters and social media.

RESULTS

During the study period, 2006 women with a history of previous CS who planned for TOLAC were included in the study: 1175 in Shenzhen Longhua District Central Hospital (58.6%) and 831 in Dongguan Tangxia Hospital (41.4%). The majority of participants were <35 years of age (88.7%) and had one previous delivery (86.5%). More than one-tenth (N=267, 13.3%) of participants reported a history of vaginal delivery. Less than one-tenth (N=171, 8.5%) women had diabetes or pregestational diabetes, while 35 (1.7%) had hypertension. The demographic and clinical characteristics of women in training

Table 3 Multivariate logistic analysis of factors predicting successful TOLAC in the training set of women

Demographical and clinical characteristics	OR (95% CI)	P value
Gestational age (weeks) (<41 vs ≥41)	1.69 (1.05 to 2.71)	0.0299
History of vaginal delivery (yes vs no)	1.72 (1.17 to 2.68)	0.0179
Estimated birth weight (kg) (<4 vs ≥4)	5.33 (2.63 to 10.84)	<0.0001
BMI (kg/m^2) (<30 vs ≥30)	1.81 (1.09 to 3.01)	0.0209
Onset of labour (spontaneous vs induced)	2.50 (1.69 to 3.69)	<0.0001
Cervix Bishop score (≥5 vs <5)	3.39 (2.22 to 5.16)	<0.0001
Rupture of membranes (no vs yes)	2.50 (1.65 to 3.79)	<0.0001

BMI, body mass index; TOLAC, trial of labour caesarean section.

cohort (N=1604, 80%) and the validation cohort (N=402, 20%) are shown in table 1. Comparison of the baseline data indicated that the training and validation groups showed no significant differences.

Of the women who planned for TOLAC, 1686 (84.0%) had a successful TOLAC, while 320 (16.0%) had a repeated CS. The reasons for failed TOLAC were request of repeated CS by patients or their family members (142, 44.4%), followed by fetal distress (63, 19.7%), abnormal stage of labour (59, 18.4%), failed induction of labour (35, 10.9%) and others (21, 6.6%). There were six (0.3%) women with uterine rupture, six (0.3%) with blood transfusion, seven (0.3%) with maternal infection and one (0.05%) with hysterectomy, but fortunately no maternal deaths were reported during the study period. Five-minute Apgar scores were 10 in most newborns (N=1987, 99.1%), but <7 in three newborns (2 with 0 score and 1 with 2 score). There were 21 (1.0%) cases of neonatal asphyxia (7 cases with repeat CS), 128 (6.4%) cases of NICU admission and 2 (0.1%) neonatal deaths (1 case with repeat CS) recorded.

Participants with repeated CS requested by themselves or their family members rather than medical indications were excluded when developing the prediction model. The demographic and clinical characteristics of women in the training cohort (N=1491, 80%) and the validation cohort (N=373, 20%) are shown in table 1. Comparison of the baseline data indicated that the training and validation groups showed no significant differences, with the exception of parity (p=0.03) and history of vaginal delivery (p=0.02).

Table 2 presents the univariate relationships between successful TOLAC and demographic and clinical characteristics of women in the training cohort. Women with <41 weeks of gestational age, ≥2 previous deliveries, with a history of vaginal delivery, lower BMI (<30 kg/m^2), lower estimated birth weight and women with spontaneous onset of labour were significantly more likely to achieve success of TOLAC. In addition, in the delivery process, women with a cervix Bishop score ≥5 had a higher probability of successful TOLAC, whereas women with rupture

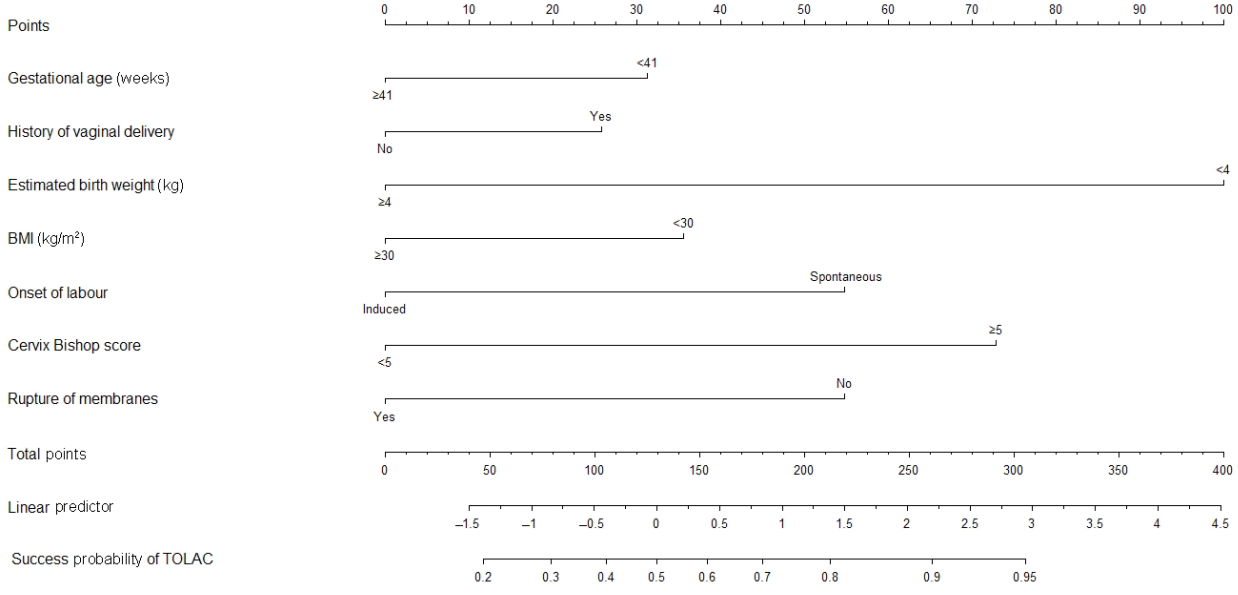

Figure 1 Nomogram for predicting success rate of TOLAC. BMI, body mass index; TOLAC, trial of labour after caesarean delivery.

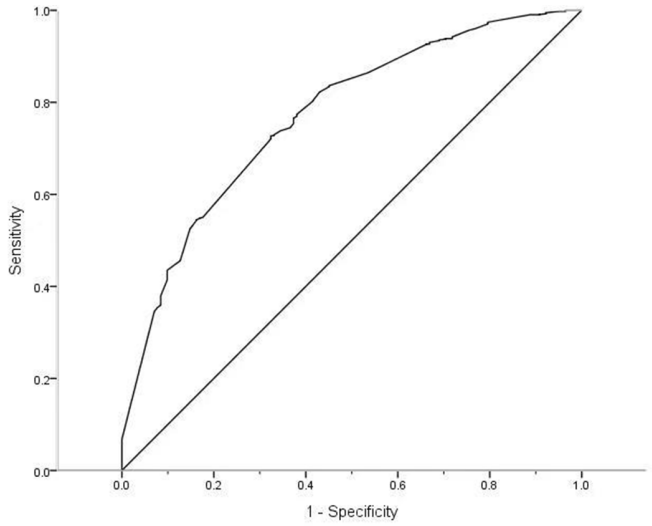

Figure 2 ROC curve in training set of women. ROC, receiver operating characteristic.

of membranes and women using oxytocin augmentation were significantly less likely to achieve success of TOLAC.

The following variables remained statistically significant in the multivariate logistic regression model for the training cohort (table 3): gestational age <41 (OR=1.69), history of vaginal delivery (OR=1.72), estimated birth weight (OR=5.33), BMI (OR=1.81), spontaneous onset of labour (OR=2.50), cervix Bishop score ≥5 (OR=3.39) and rupture of membranes (OR=2.50). The nomogram prediction model of successful TOLAC, which included these independent variables, was developed based on multivariate logistic regression analysis (figure 1).

AUC in the prediction model was 0.77 (95% CI 0.73 to 0.81), and the Hosmer-Lemeshow test result was not significant (p=0.82). The AUC in the external validation model is 0.70 (95% CI 0.60 to 0.79) and the Brier score is 0.08, suggesting that the nomogram prediction model has moderate discrimination (figures 2 and 3).

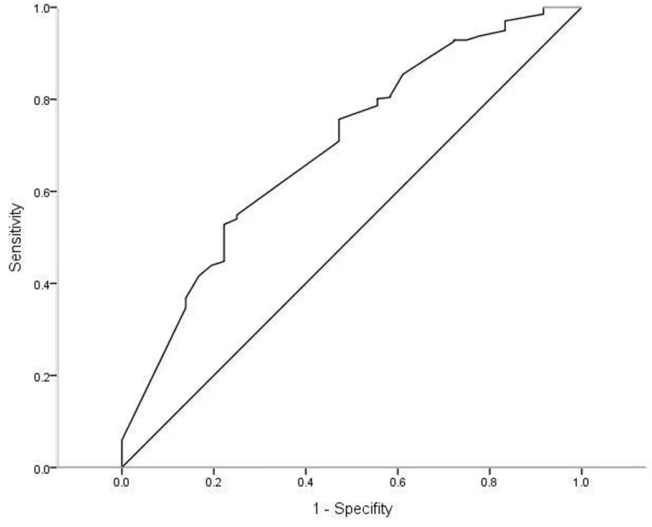

Figure 3 ROC curve in validation set of women. ROC, receiver operating characteristic.

Table 4 Success rate of TOLAC according to nomogram prediction model

Prediction by nomogram model (%)	Mode of delivery: Failed TOLAC, N (%)	Mode of delivery: Success of TOLAC, N (%)	Total
<20	0 (0.0)	0 (0.0)	0
20, 40	2 (100.0)	0 (0.0)	2
40, 60	1 (25.0)	3 (75.0)	4
60, 80	7 (25.0)	21 (75.0)	28
80, 90	9 (11.7)	68 (88.3)	77
≥90	17 (7.1)	245 (93.5)	262
<85	15 (18.7)	65 (81.3)	80
≥85	21 (7.2)	272 (92.8)	293

TOLAC, trial of labour after caesarean delivery.

Table 4 shows the success rate of TOLAC in the validation cohort according to the nomogram prediction model. According to the distribution at each probability of TOLAC success, two groups were identified: a high-probability TOLAC success group (TOLAC success probability ≥0.85, 78.6% of the validation cohort and TOLAC success rate 92.8%) and low-probability TOLAC success group (TOLAC success probability <0.85, 21.4% of the validation cohort and TOLAC success rate 81.3%). With a cut-off of 0.85, a sensitivity of 80.7% (95% CI 76.5% to 84.9%), specificity of 41.7% (95% CI 25.6% to 57.8%), PPV 92.8% (95% CI 89.9% to 95.8%), NPV 18.8% (95% CI 10.2% to 27.3%) and a correctly classified proportion of 76.9% (95% CI 72.7% to 81.2%) were found.

DISCUSSION

There are few studies reporting the rate of TOLAC in China due to the former one-child policy.[15 19] The results from the current study indicate that the success rate of TOLAC (84.0%) was relatively high with relatively low incidence of serious complications (0.3% uterine rupture), which implies the potential benefit of TOLAC among women with a uterine scar in China. We have developed and validated a simple nomogram prediction model based on common antenatal predictors, which are independently associated with successful TOLAC, including gestational age, history of vaginal delivery, estimated birth weight, BMI, spontaneous onset of labour, cervix Bishop score and rupture of membranes.

Success rates of TOLAC reached up to 84% in the current study. However, repeat CSs are the preferred mode of delivery for women with a previous history of CS in China.[15] Negative attitudes regarding TOLAC from clinical staffs are rare but serious complications from TOLAC (especially potential uterine rupture) and women's fear are the main obstacles for conducting TOLAC in China. Realising the high chance of VBAC success, some women who planned a repeat CS may instead decide to pursue

TOLAC as their first choice, which can result in a significant reduction in the number of CS deliveries. Considering both the high CS rates and newly adopted two-child policy in 2015, TOLAC is an important public health strategy in China and TOLAC should be widely recommended for the appropriately selected pregnant women with previous CS.

As far as we know, this is the largest study to date to develop a nomogram model for predicting successful TOLAC among women with a uterine scar in China. The model has best performance at the high estimated probability of successful TOLAC for about 93% of women with an estimated ≥90% having a vaginal birth. The proposed prediction model could be a clinically important tool as it can be used to identify women with greater chance of a successful TOLAC. Those women with an estimated high probability of successful TOLAC could be counselled and informed that pursuing a TOLAC is worthwhile since a successful TOLAC is associated with a shorter postpartum recovery time with fewer complications.

Similar factors associated with a successful TOLAC have also been found by other studies. Women with <41 weeks of gestational age were more likely to have successful TOLAC. A cohort study conducted in Thailand also showed that late gestational age was significantly associated with a higher failure rate.[20] Consistent with previous reports,[20 21] BMI is another predictor incorporated into our prediction model. Previous studies have identified high maternal BMI to be significantly associated with a higher risk of failed TOLAC.[20 21] van der Merwe *et al* found that obese patients were almost 50% less likely to have a successful VBAC (OR 0.47, 95% CI 0.24 to 0.91).[22] Women with prior vaginal birth were three times more likely to achieve success of TOLAC. Similar findings regarding a history of vaginal births have been reported by numerous studies.[20 23] As was also concluded in the study by Haumonte *et al*, Bishop's score was an important predictor of successful VBAC.[16 24] Kalok *et al* demonstrated that a modified Bishop score ≥6 was independently associated with successful VBAC after adjusting for confounding variables.[23] Various studies have been conducted to evaluate the influence of neonatal birth weight on the success of TOLAC, and have found consistent results that lower estimated birth weight have a greater chance of having a successful VBAC than their counterparts.[20] As was seen in studies conducted by Kruit *et al*, women with spontaneous onset of labour were more likely to have successful VBAC.[25] The rate of repeat CS was higher in women undergoing induction of labour (38% vs 20.2%; p<0.001).[25]

This study was subject to several limitations. First, a high percentage of women (44.4%, 142/320) made a request of repeated CS by themselves or their family members among all participants with repeated CS. Although those participants were excluded when developing the prediction model, the potential impact on the model cannot be neglected; however, this is a subject, which could provide an important direction for future research by exploring related factors and establishing new measures to encourage persistent TOLAC. Second, missing data are unavoidable due to the retrospective nature of the study; however, the nursing staff were trained in abstracting data from high-quality electronic medical records. Third, our obstetric population is from two secondary hospitals in Guangdong Province, which may not represent the population in China and limit the generalisability to more heterogeneous populations. The sample size is too limited to estimate maternal and neonatal adverse events which are the secondary outcomes in our study. In addition, the development of the prediction model was based on a cohort of women who attempted TOLAC, while some women who were good candidates for TOLAC chose an elective repeat caesarean delivery.

CONCLUSIONS

A relatively high success rate of TOLAC (84.0%) was established in women with a previous history of CS, which implies that TOLAC is a potential important strategy for decreasing CS rates in China. The nomogram predicting success of TOLAC generated in the study could be a potential tool for more directed TOLAC counselling for women with a primary caesarean delivery. Further prospective validation studies with larger sample sizes and in the general population should be undertaken to confirm efficacy before pervasive application among Chinese women and to estimate maternal and neonatal adverse events of TOLAC.

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Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Original data are available on request by emailing the corresponding author who will delete the personal identification information.

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