

# Safety and feasibility of trial of vaginal labor after cesarean section

## A retrospective study

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### Abstract

By observing and analyzing the success rate of Tai'an City central hospital TOLAC and VBNC and various indicators after delivery, we make sure whether TOLAC is safe and feasible to be promoted in Tai'an area.

Between January and December 2017, data of 144 cases undergoing TOLAC, 152 cases undergoing VBNC, 152 cases undergoing RCS and 142 case undergoing PCS in Tai'an City Central Hospital were retrospectively analyzed. The success rate of vaginal delivery, labor time, 24 hours postpartum hemorrhage, hospital stay, Apgar score of newborns and puerperal morbidity were observed.

Primary study outcomes: The success rates of the TOLAC and VBNC groups were 93.06% and 93.42%, respectively, where the difference was not statistically significant ( $P = .901$ ). Secondary study outcomes: There were no significant differences in labor time ( $P = .0249$ ), amount of 24 hours postpartum hemorrhage ( $P = .206$ ), Apgar score of newborns ( $P = .582$ ), hospital stay ( $P = .194$ ) and puerperal morbidity ( $P = .942$ ) between the VBAC group and VBNC group. There were statistically significant differences in amount of 24 hours postpartum hemorrhage ( $P < .001$ ), hospital stay ( $P < .001$ ) and puerperal morbidity ( $P = .018$ ), but no difference in Apgar score of newborns ( $P = .228$ ) between the VBAC group and RCS group. There were significant differences in operation time ( $P = .011$ ), amount of 24 hours hemorrhage ( $P = .001$ ), hospital stay ( $P = .001$ ) and puerperal morbidity ( $P = .041$ ), but no significant difference in Apgar score of newborns ( $P = .300$ ) between the RCS and PCS groups.

The TOLAC is as safe and feasible as VBNC, and more favorable to the safety of mother and fetus than RCS in Tai'an area.

**Abbreviations:** PCS = primary cesarean section, RCS = repeat cesarean section, TOLAC = trial of labor after cesarean section, VBAC = vaginal labor after cesarean section, VBNC = vaginal labor of the noncesarean section.

**Keywords:** cesarean section, natural delivery, pregnancy, scar uterus

## 1. Introduction

Since the 21st century, the cesarean section rate has continued to rise and remains high around the world.<sup>[1,2]</sup> Maternal women

who give birth for the first time and those who have a history of cesarean section seems to prefer cesarean section more than ever. The cesarean section rate in China was once as high as 47.6%. This phenomenon is caused by an increase of the cesarean section without medical indications and a decline in the cesarean section threshold over a period of time.<sup>[1]</sup>

In recent years, with the issuance of intervention and relevant laws, and the liberalization of the two-child policy in early 2016, a large number of women in China who have undergone cesarean section will be pregnant again, and they favor vaginal delivery.<sup>[3]</sup> If the status of "cesarean section will continue once it occurs", these pregnant women will receive 2 or even multiple cesarean sections. Nonetheless, reoperation is characterized by long operation time, increased difficulty, high incidences of intraoperative blood transfusion, thromboembolism and postoperative infection, as well as poorer postoperative incision healing and higher incidences of urine retention, pelvic adhesions and other complications compared with those of the first cesarean section,<sup>[4,5]</sup> which not only affects the safety of mother and infant, but also causes serious decline in the quality of obstetrics and waste of medical resources.

The feasibility and safety of vaginal labor in repregnant women with scar uterus have been the focus of these women and obstetricians, and the reason for the decline in TOLAC (trial of labor after cesarean section) in the past 10 years.<sup>[6]</sup> At present, pregnant women and obstetricians are cautious in choosing TOLAC. Thus, more evidence is needed to prove the safety and feasibility of TOLAC for the mother and infant.<sup>[2]</sup> TOLAC has

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The study was approved by the ethics committee of Tai'an City Central Hospital, and all pregnant women signed informed consent forms.

The authors of this work have nothing to disclose.

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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been implemented in our hospital since 2014, and the technology has become mature due to the dramatic increase in VBAC women after the two-child policy. Herein, we are intended to retrospectively analyze the TOLAC in our hospital in 2017.

## 2. Materials and methods

### 2.1. Clinical data

Between January and December 2017, a total of 144 women undergoing TOLAC in the Obstetrics Department, Tai'an City Central Hospital were selected, from which 10 cases were converted to surgery, and the rest 134 cases of successful birth were enrolled in the VBAC (vaginal labor after cesarean section) group, with a mean age of  $29.07 \pm 2.84$  years, mean gestational age of  $38.97 \pm 3.18$  weeks and BMI (body mass index) of  $28.50 \pm 3.07 \text{ kg/m}^2$ . In the meantime, 152 women undergoing VBNC (vaginal labor of non-cesarean section) at the same period were included (VBNC group), with a mean age of  $28.54 \pm 2.45$  years, mean gestational age of  $39.54 \pm 1.24$  weeks and BMI of  $28.75 \pm 3.21 \text{ kg/m}^2$ . One hundred fifty twowomen undergoing re-cesarean section during the same period were included (RCS group), with a mean age of  $8.69 \pm 2.14$ , mean gestational age of  $38.65 \pm 1.64$  weeks and BMI of  $28.97 \pm 3.00 \text{ kg/m}^2$ . And a total of 146 women undergoing primary cesarean section (PCS) were included in the PCS group, with a mean age of  $28.67 \pm 3.40$  years, mean gestational age of  $39.32 \pm 1.50$  weeks and BMI of  $28.86 \pm 3.45 \text{ kg/m}^2$ . The age, gestation age and BMI of each group were in line with normal distribution, and the differences were not statistically significant.

Inclusion criteria were determined according to the VBAC guidelines developed by countries, such as Europe and the United States.<sup>[7,8]</sup> TOLAC group:

1. Women had only one history of cesarean section which occurred  $\geq 24$  months ago, and they had no postoperative infection, postpartum hemorrhage and other poor healing, and had no other histories, such as uterine myomectomy or repair for perforation of uterus.
2. Women had no history of first and second-trimester abortion.
3. With continued muscle layer at the scar under an ultrasound examination.

VBNC group:

1. Women were primipara.
2. Women had no history of first and second-trimester abortion.

TOLAC and VBNC groups:

1. Singleton pregnancy.
2. Gestational age of 32 to 42 weeks.
3. No cephalopelvic disproportion.
4. Without surgical diseases that were not suitable for vaginal labor.
5. With comprehensive medical measures for emergency cesarean section for this pregnancy.
6. Voluntary to select trial of vaginal labor.

RCS group:

1. Women with only one history of cesarean section.
2. Women who were not accorded with the conditions for trial of vaginal labor.

PCS group:

1. Women who were confirmed with indications of cesarean section, such as macrosomia, stenosis of pelvis, placenta praevia, breech presentation, placental abruption and fetal distress, etc.
2. Women who had severe dysfunction with her liver, heart, kidney and coagulation were excluded.

The study was approved by the ethics committee of the hospital (NO.2019-05-10), and all pregnant women signed informed consent.

### 2.2. Methods

The willingness of natural delivery was fully understood. The pregnant women and their families were explained the indications as well as the pros and cons of vaginal labor and cesarean section. For cases in the TOLAC and VBNC group, their indications were strictly controlled before entering the pre-delivery room, and they were given psychological guidance. During the first stage of labor, electronic fetal heart rate monitoring was continuously applied, the pressure, heart rate and uterine contracts of the pregnant women were monitored in real-time, and vaginal bleeding and fluidity, presence of abnormal fetal heart rate, appearance of pathologic retraction ring were observed, and the progress of labor was accurately recorded. For the second stage of labor in the TOLAC group, vacuum extractor or instruments could be used to assist the delivery, oxytocin could be applied and lateral episiotomy indicators could be relaxed to shorten the duration when needed, while abdominal pressurization was prohibited. If there appeared abnormal phenomena, such as fetal distress, cephalopelvic disproportion or threatened rupture of uterus during trial birth, the women should be quickly converted to cesarean section. When the second stage of parturition in VBNC group needed to strengthen uterine contraction, we applied a dosage of oxytocin as 1–2 U, and in the TOLAC group we usually chose a 1/2 VBNC contraction measurement, which is, 0.5–1 U. And both VBNC and TOLAC group when being in the third stage, routine application as 10 U dosage of oxytocin was used to strengthen the uterine contraction. Women in the RCS and PCS groups received routine cesarean section without any special treatment.

### 2.3. Observation indicators

For the TOLAC and VBNC groups, the following indicators were observed: success rate of transvaginal natural delivery, total labor time, cumulative amount of 24 hours postpartum hemorrhage, Apgar score of newborns (breathing, heart rate, laryngeal reflex, muscular tension and skin color, total score of 10 points, 2 points for each), postpartum hospital stay, and puerperal morbidity. For the RCS and PCS groups, the following indicators were observed: cesarean operation time, cumulative amount of 24 hours postpartum hemorrhage, Apgar score of newborns, postpartum hospital stay, and puerperal morbidity.

### 2.4. Calculation of postpartum hemorrhage

The volumetric method + weighing method were adopted. After delivery, the blood was collected using a container, and was placed into a measuring cup for measurement. The blood remained in the dressing was measured using weighing method [wet weight of dressing (g) after collection – dry weight of dressing before collection (g)]/1.05 blood specific gravity (g/ml).<sup>[9]</sup>

The results of the trial of vaginal labor groups were assessed by a midwife with middle or senior title and with more than 5 years of work experience, while those of the surgical delivery groups were assessed by a physician with middle or senior title and with more than 5 years of work experience.

### 2.5. Statistical analysis

Statistical analyses were performed using SPSS23.0 software. Measurement data were expressed as mean  $\pm$  standard deviation ( $x \pm s$ ), and were performed *t*-test. Count data were expressed as percentage (%), and were performed  $\chi^2$  test. Repeated measurement data were analyzed using repetitive measures analysis of variance (ANOVA), while non-repeated measurement data were compared using *t*-test. A difference with  $P < .05$  was considered statistically significant.

## 3. Results

### 3.1. Primary study outcomes

Table 1 compares the success rate of natural delivery, labor time, amount of postpartum hemorrhage and Apgar scores between the VBAC and VBNC groups.

A total of 154 cases undergoing TOLAC were selected, from which 4 cases were excluded due to a history of abortion in the second trimester, 3 cases were excluded due to twin pregnancy, 3 cases were excluded due to induced labor because of fetal death and severe fetal heart malformation. Ultimately 144 cases of TOLAC were included, in which VBAC accounted for 93.06% (134/144). The VBNC group consisted of 152 women, and the success rate of transvaginal delivery was 93.42% (142/152). There was no significant difference in the success rate of transvaginal delivery between the TOLAC and VBNC groups ( $P = .901$ ).

### 3.2. Secondary study outcomes

The labor times of VBAC group and VBNC group were  $239.55 \pm 30.96$  minutes and  $234.22 \pm 38.27$  minutes, respectively (Table 1), where the difference was not statistically significant ( $P = .249$ ). The amount of 24 hours postpartum hemorrhage of the VBAC group ( $239.55 \pm 30.96$  ml) was more than that of the VBNC group ( $234.22 \pm 38.27$  ml), but the difference was not statistically

significant ( $P = .206$ ). The Apgar scores of the 2 groups were respectively  $9.93 \pm 0.31$  and  $9.94 \pm 0.23$ , where the difference was not statistically significant ( $P = .582$ ). The hospital stays of the 2 groups were respectively  $5.16 \pm 2.73$  d and  $4.80 \pm 1.60$  d, where the difference was not statistically significant ( $P = .194$ ). Finally, the puerperal morbidities of the 2 groups were respectively 8.21% and 8.45%, where the difference was also not statistically significant ( $P = .942$ ).

Table 2 compares amount of 24 hours postpartum hemorrhage, Apgar score, puerperal morbidity and hospital stay between the VBAC group and RCS group.

The amount of 24 hours postpartum hemorrhage of the VBAC group and RCS group were respectively  $239.55 \pm 30.96$  ml and  $275.31 \pm 44.31$  ml, where the difference was statistically significant ( $P < .001$ ). The puerperal morbidities of the VBAC group and RCS group were respectively 8.21% and 17.76%, where the difference was statistically significant ( $P = .018$ ). The hospital stays of the 2 groups were respectively  $5.16 \pm 2.73$  d and  $6.41 \pm 2.26$  d, where the difference was statistically significant ( $P < .001$ ). The Apgar scores of the 2 groups were respectively  $9.93 \pm 0.31$  and  $9.95 \pm 0.30$ , where the difference was not statistically significant ( $P = .228$ ).

The Table 3 compares the amount of 24 hours postpartum hemorrhage, operation time and puerperal morbidity between the RCS and PCS groups.

The operation time of the RCS group and the first cesarean section time of the PCS group were respectively  $56.43 \pm 22.84$  minutes and  $50.54 \pm 16.32$  minutes, where the difference was statistically significant ( $P = .011$ ). The amount of 24 hours postpartum hemorrhage of the RCS and PCS groups were respectively  $275.31 \pm 44.31$  ml and  $257.40 \pm 46.42$  ml, where the difference was statistically significant ( $P = .001$ ). The puerperal morbidities of the 2 groups were respectively 17.76% and 9.59%, where the difference was statistically significant ( $P = .041$ ). And the Apgar scores of newborns in the 2 groups were respectively  $9.95 \pm 0.30$  and  $9.90 \pm 0.41$ , where the difference was not statistically significant ( $P = .300$ ).

Table 4 Maternal puerperal disease details and percentage in VBAC groups and VBNC groups and RCS groups and PCS groups

The mattress disease rate of VBAC groups, VBNC groups, RCS groups and PCS groups was 8.21%, 8.45%, 17.76%, and

**Table 1**  
Comparison of indicators between VBAC and VBNC groups.

Group	Number of cases	Success rate of transvaginal delivery (%)	Labor time (min)	Amount of 24 hours postpartum hemorrhage (ml)	5-minute Apgar score of newborn	Hospital stay (d)	Puerperal morbidity (%)
VBAC	134	93.06%(134/144)	410.67 $\pm$ 134.64	239.55 $\pm$ 30.96	9.93 $\pm$ 0.31	5.16 $\pm$ 2.73	8.21%(11/134)
VBNC	142	93.42% (142/152)	429.74 $\pm$ 139.44	234.22 $\pm$ 38.27	9.94 $\pm$ 0.23	4.80 $\pm$ 1.60	8.45%(12/142)
<i>P</i>		0.901	0.249	0.206	0.582	0.194	0.942

**Table 2**  
Comparison of indicators between VBAC and RCS groups.

Group	Number of cases	Amount of 24 hours postpartum hemorrhage (ml)	Apgar score	Puerperal morbidity (%)	Hospital stay (d)
VBAC	134	239.55 $\pm$ 30.96	9.93 $\pm$ 0.31	8.21%(11/134)	5.16 $\pm$ 2.73
RCS	152	275.31 $\pm$ 44.31	9.95 $\pm$ 0.30	17.76%(27/152)	6.41 $\pm$ 2.26
<i>p</i>		<0.001	0.228	0.018	<0.001

**Table 3****Comparison of indicators between RCS and PCS groups.**

Group	Number of cases	Operation time (min)	Amount of 24 hours postpartum hemorrhage (ml)	Apgar score	Puerperal morbidity	Hospital stay (d)
RCS	152	56.43 ± 22.84	275.31 ± 44.31	9.95 ± 0.30	17.76%(28/152)	6.41 ± 2.26
PCS	146	50.54 ± 16.32	257.40 ± 46.42	9.90 ± 0.41	9.59%(14/146)	5.53 ± 2.44
<i>p</i>		0.011	0.001	0.300	0.041	0.001

**Table 4****Maternal puerperal rates in groups VBAC and VBNC and RCS and PCS.**

Group	Puerperal rate	Puerperal infection				Other infections		
		perineal lateral incision infection	perineal laceration wound infection	Uterine infections	Remaining pregnant tissue	Acute pelvic inflammatory disease or peritonitis	Urinary infections	Upper respiratory tract infection
VBAC	8.21%(11/134)			5.22%(7/134)			2.99%(4/134)	
VBNC	8.45%(12/142)	3	2	5.63%(8/142)	2	0	2.85%(4/142)	-
RCS	17.76%(27/152)	3	2	11.18%(17/152)	3	0	6.58%(10/152)	-
PCS	9.59%(14/146)	-	-	5.48%(8/146)	0	11	4.11%(6/146)	5
		-	-	3	0	5	2	2

9.59%, respectively. Puerperal infections in VBAC and VBNC groups accounted for 5.22% and 5.63%, respectively. Other infections accounted for 2.99% and 2.85%, respectively. Puerperal infections in RCS and PCS groups accounted for 11.18% and 5.48%, other infections accounted for 6.58% and 4.11%, respectively.

#### 4. Discussion

In the present retrospective study, the success rate of delivery did not show significant difference between the TOLAC group (93.06%), which consisting of 144 cases, and the VBNC group (93.42%), which consisting of 152 cases. This result excluded the influences of age, BMI, induced labor and twin pregnancy. There were no significant differences in the labor time, the amount of 24 hours postpartum hemorrhage, Apgar score of newborns, hospital stay and puerperal morbidity between VBAC group and VBNC. Comparison between VBAC group and RCS showed there were significant differences in the amount of 24 hours postpartum hemorrhage, puerperal morbidity and hospital stay ( $P < .05$ ), but no significant difference in Apgar score of newborns ( $P = .228$ ). Comparison between RCS group and PCS group revealed there were significant differences in cesarean operation time, the amount of 24 hours postpartum hemorrhage, hospital stay and puerperal morbidity ( $P < .05$ ), but no difference in Apgar score of newborns ( $P = .300$ ).

In the TOLAC group, 10 cases were converted to caesarean delivery, of which 4 cases were due to mental and psychological factors, 2 cases due to cephalopelvic disproportion, 3 cases due to fetal distress and 1 case due to pathologic retraction ring of uterus. In the VBNC group, 10 cases were also converted to surgery, of which 1 case was due to mental and psychological factors, 3 cases due to cephalopelvic disproportion and 6 cases due to fetal distress. For these cases converted to surgery, the mothers and infants were safe, without any complication. In addition, the TOLAC group had the same success rate as the

VBNC group, which was consistent with the results reported previously.<sup>[10]</sup> Some scholars believed that mothers with failed TOLAC often suggested a high risk of pregnancy and postpartum complications.<sup>[11]</sup> Therefore, TOLAC must be conducted in a medical unit that can perform emergency cesarean section and have strict obstetric monitoring and care conditions.<sup>[12]</sup> In this study, the amount of 24 hours postpartum hemorrhage in the VBAC group was  $238.55 \pm 30.96$  ml, which was more than the  $234.22 \pm 38.27$  ml in the VBNC group, but the difference was not statistically significant. It may be because that we applied a smaller dose of oxytocin (0.5–1.0U) to strengthen the uterine contractions in the VBAC group compared with the VBNC group (1.0–2.0U) in order to avoid uterine rupture during labor. Although the dosage of oxytocin during labor was reduced in the VBAC group, the labor time ( $410.67 \pm 134.64$  minutes) did not show significant difference compared with that of  $429.74 \pm 139.44$  minutes in the VBNC group, which may be related to the small sample size. In the present study, the VBAC group did not show significant differences in Apgar score, puerperal morbidity and hospital stay compared with the VBNC group, which was consistent with the results by other scholars. Thus, TOLAC has the same effect as the VBNC. Furthermore, we compared the amount of postpartum hemorrhage, puerperal morbidity and hospital stay between the VBAC group and RCS group, and found that these indicators in the VBAC group outperformed significantly compared with those in the RCS group, which indicates obvious benefits of VBAC. Comparison between the RCS group and PCS group demonstrated that the operation time of the RCS group ( $56.43 \pm 22.84$  minutes) was significantly longer than that of the PCS group ( $50.54 \pm 16.32$  minutes), and the amount of 24 hours postpartum hemorrhage of the RCS group ( $275.31 \pm 44.31$  ml) was also significantly more than that of the PCS group ( $257.40 \pm 46.42$  ml). This is because that the previous cesarean section can cause varying degrees of pelvic adhesions in women after RCS, and the reconstructed vessels are unorganized after destruction of normal anatomical structures,



which results in a long operation time, increased surgery difficulty, and high incidences of intraoperative blood transfusion, thromboembolism and postoperative infections.<sup>[13,14]</sup> There was also a statistically significant difference in puerperal morbidity between the RCS group and PCS group ( $P=.041$ ), which resulted in a longer hospital stay in the RCS group than in the PCS group ( $P=.001$ ). Meanwhile, there was no significant difference in Apgar score between the 2 groups, which is closely related to the good medical conditions, and high-quality obstetrics, pediatrics and anesthesiology departments in our hospital, and also a basic guarantee for the implementation of TOLAC.<sup>[12]</sup> In addition, the gestational ages ranged 34 to 42 weeks in all pregnant women. The enrollment of some pregnant women of a gestational age of 40 to 42 weeks did not reduce the success rate of TOLAC, which was consistent with the confirmation that more than 40 weeks of gestation alone was not the only factor affecting the success rate of TOLAC.<sup>[15]</sup> Although some studies showed a declined success rate of VBAC and an increased risk of uterine rupture in pregnant women of more than 40 weeks of gestation,<sup>[16]</sup> this tendency was not found in this study. In addition, current studies on the effect of fetal weight on TOLAC success rate are mixed, and some pregnant women in this study were found to have a baby with a weight greater than 4000g by prenatal evaluation, but the overall success rate of TOLAC was not reduced, which was different from results reported by other scholars.<sup>[17]</sup> Some studies showed that a fetal weight greater than 4500g led to a decrease in TOLAC.<sup>[18]</sup> Despite that macrosomia alone is not a contraindication, TOLAC can be performed in the exclusion of other contraindications for trial of vaginal labor,<sup>[19-21]</sup> and studies have confirmed that macrosomia and old-age pregnancy will significantly increase the incidence of postoperative anal sphincter injury.<sup>[22]</sup>

Moreover, our high success rate of TOLAC (93.6%) is attributed to our strict screening conditions and our experience of obstetric colleagues and obstetric care at Tai'an Central Hospital since TOLAC started in 2014 here. And this is also the most different point of our study from other studies, with our rich experience in obstetric clinical operation, in order to ensure the safety of mother and child, we have established more stringent TOLAC standards based on the existing operating norms. And the additional standards are as following:

1. all mothers have received a cesarean section in the lower segment of the uterus in the past, and the incision is restored after resection;
2. the control age is less than 35 years, and the physical strength and endurance of the elderly women during delivery are reduced;
3. pregnant women BMI between 18.5–24.9 kg/m<sup>2</sup>;
4. although this study included single pregnancy;
5. parturient did not use epidural anesthesia to relieve pain during vaginal delivery;
6. Central Tai'an Hospital is the largest regional medical center in Tai'an City.

The level is the tertiary health center. The delivery room can carry out emergency cesarean section. It has strict obstetric monitoring and nursing conditions. It is also very important that the regional neonatal intensive care center meet the technical and hardware conditions for TOLAC.

What makes you, it will limit you. This study has shortcomings. This is a single-center retrospective study which can

only reflect the local status and is limited in research method. There are certain limitations in selecting TOLAC samples:

1. Pregnant women with a BMI greater than 40 kg/m<sup>2</sup> were not included. Studies have shown that the higher the BMI, the lower the VBAC success rate of TOLAC.<sup>[23]</sup> Although a BMI greater than 40 kg/m<sup>2</sup> or above is not the single influencing factor, a higher BMI is often associated with a higher risk of potential pregnancy and postpartum complications.<sup>[24]</sup> Therefore, in order to eliminate the influence of BMI on the success rate of trial birth, we enrolled pregnant women with BMI of insignificant difference, so our research cannot prove the effect of BMI on the success rate of TOLAC.
2. As age is also one of the factors affecting the success rate of trial of vaginal labor,<sup>[25]</sup> we did not include the elderly women that had trial birth. But in future studies, we will expand the sample size to study the effects of relevant factors on TOLAC.
3. In this study, we excluded pregnant women with a history of cesarean section via a longitudinal incision at the lower part of the uterus due to a small number of cases, although it has been confirmed that the risk of uterine rupture is unlikely to increase in pregnant women undergoing cesarean section via the longitudinal incision at the lower part of uterus,<sup>[26-28]</sup> and confirmed by a study published this year that the mode of previous surgery does not affect the success rate of TOLAC.<sup>[29]</sup>
4. Furthermore, we also excluded women who had received more than 2 times of cesarean section via a transverse incision at the lower part of the uterus. Some studies have confirmed that there is an increased risk of uterine rupture in women who have undergone more than 2 times of cesarean section via a transverse incision at the lower part of the uterus.<sup>[30]</sup>
5. It has been pointed out that the shorter the interval from the last surgical delivery, the higher the risk of uterine rupture in TOLAC,<sup>[31]</sup> especially less than 19 months.<sup>[32,33]</sup> In this study, we only included women who underwent surgical delivery more than 24 months ago. Therefore, the results of the present study are unlikely to reflect the impact of the abovementioned factors of previous cesarean section on TOLAC, but we will include these pregnant women in our future research.
6. We only included women with singleton pregnancy. But studies reported that for women who had undergone cesarean section via the transverse incision at the lower part of the uterus, the success rate of TOLAC in twin pregnancy women was comparable with that in singleton pregnancy women in the absence of other complications.<sup>[34]</sup>
7. We did not include pregnant women undergoing epidural analgesia during labor.

During clinical practice, we have not found that analgesia affects judging the symptoms of threatened uterine rupture, which thus threatens the safety of mother and infant, since the abnormal heart rate of fetus found by continuous electronic fetal heart rate monitoring during TOLAC is the most sensitive clinical manifestation of uterine rupture.<sup>[35]</sup> In our future studies, we will collect relevant data for analysis.

In summary, through appropriate screening, almost all pregnant women who have undergone cesarean section in the lower segment of the uterus can be TOLAC reached VBAC, We recommend that medical institutions with the same level of obstetric care or higher than that level of medical unit in the central hospital of Tai'an City, where other birth contraindications are fully discussed and excluded with pregnant

women, their obstetric personnel should encourage the TOLAC of these pregnant women.

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Dear Editors, It would be very kind of you if you could allow me to express my sincerely thank to my mother, because next month is her birthday. I did not know my mother was so great until I became a real obstetrician. Thirty years ago, my mother gave birth to me at 3.8 kg, and only an obstetrician could be able to appreciate how great it was and how much pain she suffered. I love you forever, mom. And I would like to thank all the TOLAC mothers again for your courage and dedication.

### Author contributions

XXXX.

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