Labor Onset, Oxytocin Use, and Epidural Anesthesia for Vaginal Birth after Cesarean Section and Associated Effects on Maternal and Neonatal Outcomes in a Tertiary Hospital in China: A Retrospective Study

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Abstract

Background: In the mainland of China, the trial of labor after cesarean section is still a relatively new technique. In this study, we aimed to investigate the effects of labor onset, oxytocin use, and epidural anesthesia on maternal and neonatal outcomes for vaginal birth after cesarean section (VBAC) in a tertiary hospital in China.

Methods: This was a retrospective study carried out on 212 VBAC cases between January 2015 and June 2017 in Beijing Obstetrics and Gynecology Hospital, Capital Medical University. Relevant data were acquired on a form, including maternal age, gravidity and parity, body mass index before pregnancy, weight gain during pregnancy, type of labor onset, gestational age, the use of oxytocin and epidural anesthesia, birth mode, the duration of labor, and neonatal weight. The factors affecting maternal and neonatal outcomes for cases involving VBAC, especially with regards to postpartum hemorrhage (PPH) and fetal distress, were evaluated by univariate analysis and multivariable logistic regression.

Results: Data showed that 36 women (17.0%) had postpartum hemorrhage (PPH) and 51 cases (24.1%) featured fetal distress. Normal delivery took place for 163 infants (76.9%) while 49 infants (23.1%) underwent operative vaginal deliveries with forceps. There were 178 cases (84.0%) of spontaneous labor and 34 cases (16.0%) required induction. Oxytocin was used in 54 cases (25.5%) to strengthen uterine contraction, and 65 cases (30.7%) received epidural anesthesia. The rate of normal delivery in cases involving PPH was significantly lower than those without PPH (61.1% vs. 80.1%; $\chi^2 = 6.07$, $P = 0.01$). Multivariate logistic analysis showed that the intrapartum administration of oxytocin (odds ratio [OR] = 2.47; 95% confidence interval [CI] = 1.07–5.74; $P = 0.04$) and birth mode ($OR = 0.40$; 95% $CI = 0.18$–0.87; $P = 0.02$) was significantly associated with PPH in VBAC cases. Operative vaginal delivery occurred more frequently in the group with fetal distress than the group without (49.0% vs. 14.9%, $\chi^2 = 25.36$, $P = 0.00$). Multivariate logistic analysis also revealed that the duration of total labor ($OR = 1.01$; 95% $CI = 1.00$–1.03; $P = 0.04$) and the gestational week of delivery ($OR = 1.08$; 95% $CI = 1.05$–1.11; $P = 0.00$) were significantly associated with fetal distress in VBAC.

Conclusions: The administration of oxytocin during labor and birth was identified as a protective factor for PPH in VBAC while birth mode was identified as a risk factor. Finally, the duration of total labor and the gestational week of delivery were identified as risk factors for fetal distress in cases of VBAC. This information might help obstetricians provide appropriate interventions during labor and birth for VBAC.

Key words: Fetal Distress; Postpartum Hemorrhage; Risk Factor; Vaginal Birth after Cesarean Section

INTRODUCTION

Since China modified its birth control policy to a "universal two-child policy," many women of childbearing age have opted to have a second child. Accumulating evidence shows that 32.7–50% of such women undergo cesarean sections.[1-4] Following a cesarean section, the mode of subsequent birth

could include either repeated cesarean section (RCS) or vaginal birth after cesarean section (VBAC). However, recent data show that trial of labor after cesarean (TOLAC) is the most effective delivery method because it is considerably less expensive than RCS while also reducing the risk of postpartum hemorrhage (PPH) and pelvic adhesions.[5] A recent practice bulletin from the American Congress of Obstetricians and Gynecologists revisited VBAC and emphasized the importance of discussing this procedure with all patients who qualify.[6]

TOLAC remains in its infancy in the mainland of China because of the unique medical environment in this country. Obstetricians concerned about medical litigation in VBAC due to severe PPH and neonatal asphyxia due to the rupture of the uterus. High rates of cesarean section not only bring economic burden to society but also bring some complications to pregnant women. Hence, a growing number of medical institutions in China are beginning to use TOLAC. With conscientious intrapartum management, there is a high probability of a safe and successful vaginal birth. However, such management involves significant caution during the induction and augmentation of labor to avoid over stimulating contractions, vigilant surveillance for the potential signs of uterine rupture.[7,8] One problem with this, however, is that very few studies have investigated the relationships between specific intrapartum interventions, such as induction, the use of oxytocin, and maternal and neonatal outcomes.[9,10]

In the present study, we retrospectively investigated VBAC cases to investigate the risk factors associated with different interventions during labor and birth in terms of maternal and neonatal outcomes, particularly PPH and fetal distress after VBAC in cases who had experienced one prior cesarean section in a tertiary hospital in China.

Methods

Ethical approval

The study was conducted in accordance with the *Declaration of Helsinki* and was approved by our Local Ethics Committee (No. 2017-KY-055-01). Informed written consent was obtained from all patients before their enrollment in this study.

Patients

Between January 2015 and June 2017, 301 cases of TOLAC were recorded; 212 of these cases met with success in Beijing Obstetrics and Gynecology Hospital, Capital Medical University. The inclusion criteria for TOLAC were as follows: (1) pregnant women and their husbands intended to undergo TOLAC and accepted the possible risks associated with this technique; (2) patients were healthy pregnant women without contraindications of vaginal delivery; (3) patients had a history of Pfannenstiel incision cesarean section; (4) more than 1 year has elapsed since previous cesarean section; (5) there was no history of uterine rupture; (6) there was immediate access to emergency surgery; and (7) patient provided informed written consent.

Induction

All cases were first assessed by a deputy chief physician, and the risks of TOLAC were explained to all patients. In all cases, physicians waited for the spontaneous onset of labor unless there was evidence of an indication for induction for medical reasons, such as prolonged pregnancy or if the membrane ruptured prematurely. Induction approaches were selected on the basis of the cervical Bishop score. If the score was 6 points or more, then low-dose oxytocin was administered. For scores less than 6, mechanical agents were deployed, such as a transcervical Foley catheter or a double balloon cervical ripening catheter.

Intrapartum management

All women undergoing TOLAC were observed in the delivery room and were fitted with intravenous access. Initial laboratory evaluation was performed, including blood type and complete count. Patients were also screened to facilitate the rapid availability of blood products, if necessary. Throughout labor, all women undergoing TOLAC underwent continuous electronic fetal monitoring. Arrested labor, abnormal fetal heart rates (FHRs), suspected uterine rupture, or the rejection of TOLAC by the patient was all indications for the immediate emergency cesarean section. Oxytocin was used to strengthen contractions if the progress of labor was delayed due to inadequate uterine contraction. Oxytocin was used at a low dose; the maximum dose of oxytocin was defined as 20 mIU/min.[11] Regional anesthesia was encouraged for women undergoing TOLAC to provide pain control. Epidural catheters were placed early to facilitate the subsequent used of analgesia or for anesthesia (ropivacaine) should an operative delivery become necessary. We used forceps for operative vaginal delivery in accordance with maternal and fetal indications.

Data collection

For each patient, we collected a range of data, including age, gravidity, parity, body mass index (BMI) before pregnancy, weight gain during pregnancy, gestational week of delivery, onset of labor, and the use of oxytocin. We also recorded birth mode, labor duration, maternal and neonatal results (including neonatal weight and birth mode), and PPH (defined as a total blood loss >500 ml). In addition, we noted fetal distress, which was defined as (1) Category III FHR tracing,[12] (2) meconium amniotic fluid with an abnormal FHR, or (3) an umbilical cord blood pH <7.2.

All VBAC cases were divided into two groups (PPH or fetal distress) according to the complications encountered. We then analyzed the risk factors associated with PPH and fetal distress.

Statistical analysis

All data were entered and analyzed in SPSS (version 19.0, IBM, Armonk, NY, USA). Continuous variables, which were normally distributed, were expressed as mean ± standard deviation (SD). Continuous study variables, which were not normally distributed, were expressed as medians with an interquartile range. Categorical variables were expressed

as relative frequencies. Continuous variables from the two groups (PPH and fetal distress) were compared using the Student's *t*-test or the Mann–Whitney *U*-test. Categorical variables from the two groups were compared using Pearson's Chi-square test, the continuity correction test or Fisher's exact test. Finally, we used multivariable logistic regression to identify risk factors affecting PPH and fetal distress in cases undergoing VBAC. We defined PPH cases as 0 and absent PPH cases as 1, while we defined absent oxytocin during labor as 0 and the administration of oxytocin as 1 in the multivariable logistic regression. Similarly, we defined absent fetal distress cases as 0 and fetal distress cases as 1, while the duration of total labor and the gestational week of delivery were continuous variables. A value of $P < 0.05$ was considered to be statistically significant.

Results

In total, 301 cases intended to undergo TOLAC between January 2015 and June 2017. Of these, 212 cases (70.4%) and 89 cases underwent VBAC and RCS, respectively. There were no maternal or fetal deaths. The reasons for RCSs included suspected uterine rupture (12 cases, 13.5%), abnormal FHR (23 cases, 25.8%), rejection of TOLAC (30 cases, 33.7%), and abnormal labor progress (24 cases, 27.0%). Six (2.0%) of the cases undergoing RCS experienced uterine rupture; 5 of these cases were diagnosed from abnormalities on the fetal heart traces, which is the most common sign of rupture. One other case of uterine rupture was diagnosed by PPH and ultrasound scanning. In all cases of uterine rupture,

fetal presentation had been seen in the maternal abdominal cavity during surgery.

There were 178 cases (84.0%) of spontaneous labor and 34 cases (16.0%) required induction. Oxytocin was used in 54 cases (25.5%) to strengthen uterine contraction, and 65 cases (30.7%) received epidural anesthesia. The total and mean time of oxytocin administration was 0.5–10.0 h and 5.0 ± 4.0 h, respectively. The rate of oxytocin infusion ranged from 2.0 mU/min to 20 mU/min. The total duration of epidural anesthesia ranged from 0.7 to 9.0 h, and the mean duration of epidural anesthesia was 4.5 ± 2.0 h.

All cases were divided into groups according to whether they experienced PPH or fetal distress. There were no significant differences between these two groups in terms of age, gravidity and parity time, BMI, weight gain, the duration of the first stage, total labor time, the gestational week of delivery, or neonatal weight [Table 1]. The duration of the second stage in patients with PPH was significantly longer than those without PPH (39.0 [21.3–61.0] min vs. 22.0 [15.0–35.0] min; $P = 0.00$). The proportion of cases experiencing induction and the administration of oxytocin during labor and birth in cases complicated by PPH during VBAC was similar to those without PPH [Table 1]. The proportion of cases experiencing operative vaginal delivery and labor anesthesia in the group with PPH was significantly higher than that in the group without PPH (38.9% vs. 19.9%, $P = 0.01$; 44.4% vs. 27.8%, $P = 0.05$; [Table 1]). Multivariate logistic analysis revealed that intrapartum oxytocin and birth mode were significantly associated

Table 1: Univariate analysis of PPH in VBAC

Characteristics	PPH (*n* = 36)	Without PPH (*n* = 176)	Statistical value	*P*
Age (years)	33.6 ± 3.1	33.6 ± 3.7	−0.01*	0.99
Gravidity time (times)	2.0 (1.0–3.0)	2.0 (1.0–2.0)	−0.52‡	0.61
Parity time (times)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	−0.60‡	0.55
BMI (kg/m²)	22.14 ± 2.65	21.95 ± 2.84	0.38*	0.71
Weight gain (kg)	12.98 ± 4.27	14.48 ± 5.11	−1.65*	0.10
The duration of the first stage (min)	367.5 (245.0–517.5)	307.5 (210.0–480.0)	−0.90‡	0.37
The duration of the second stage (min)	39.0 (21.3–61.0)	22.0 (15.0–35.0)	−3.74‡	0.00
The duration of total labor (min)	425.0 (289.0–575.0)	355.0 (260.0–538.8)	−1.07‡	0.28
Delivery weeks (weeks)	38.00 (38.00–39.00)	38.00 (38.00–39.00)	−0.98‡	0.33
The onset of labor, *n* (%)				
Induction	9 (25.0)	25 (14.2)	2.59†	0.11
Spontaneous	27 (75.0)	151 (85.8)		
Oxytocin during labor, *n* (%)				
Using oxytocin	11 (30.6)	43 (24.4)	0.59†	0.44
Without oxytocin	25 (69.4)	133 (75.6)		
Labor anesthesia, *n* (%)				
With labor anesthesia	16 (44.4)	49 (27.8)	3.88†	0.05
Without labor anesthesia	20 (55.6)	127 (72.2)		
Birth mode, *n* (%)				
Normal delivery	22 (61.1)	141 (80.1)	6.07†	0.01
Operative vaginal delivery	14 (38.9)	35 (19.9)		
Neonatal weight (g)	3342.8 ± 489.1	3236.1 ± 534.7	1.11*	0.27

Data are presented as *n* (%) or mean ± SD or median (interquartile range). *t* value; †χ² value; ‡Mann–Whitney *U*-test. BMI: Body mass index; PPH: Postpartum hemorrhage; VBAC: Vaginal birth after cesarean section; SD: Standard deviation.

with PPH during VBAC (odds ratio [OR] = 2.47, 95% confidence interval [CI] = 1.07–5.74, P = 0.04; OR = 0.40, 95% CI = 0.18–0.87, P = 0.02; [Table 2]).

There were no significant differences in terms of age, gravidity and parity time, BMI, weight gain, the duration of the first stage and the second stage, total labor time and neonatal weight when compared between groups with fetal distress and without fetal distress. Operative vaginal delivery occurred more frequently in the group with fetal distress than the group without (49.0% vs. 14.9%, P = 0.00; [Table 3]). The proportion of patients experiencing induction, labor anesthesia, or the administration of oxytocin during labor and birth in the cases complicated by fetal distress during VBAC was similar when compared between the two groups. Multivariate logistic analysis revealed that the duration of total labor, and the gestational week of delivery were significant risk

Table 2: Multivariate analysis of PPH in VBAC

Variables	β	Wald	P	OR	95% CI
Intrapartum oxytocin	0.91	4.44	0.04	2.47	1.07–5.74
Birth mode	−0.92	5.31	0.02	0.40	0.18–0.87
Constant	1.14	1.44	0.23	3.32	

We defined PPH cases as 0 and absent PPH cases as 1, while we defined absent oxytocin during labor as 0 and the administration of oxytocin as 1 in the multivariable logistic regression. The results showed that intrapartum oxytocin and birth mode were significantly associated with absent PPH cases: Intrapartum oxytocin as a protective factor while birth mode as a risk factor for PPH in VBAC. PPH: Postpartum hemorrhage; OR: Odds ratio; CI: Confidence interval; VBAC: Vaginal birth after cesarean section.

factors for fetal distress during VBAC (OR = 1.01, 95% CI = 1.00–1.03; P = 0.04; OR = 1.08, 95% CI = 1.05–1.11, P = 0.00; [Table 4]).

DISCUSSION

In the present study, we observed significantly more operative vaginal deliveries with PPH than those reported in the literature, but with a significantly lower number of cases with fetal distress. For example, Balachandran et al.[13] reported 96 cases of VBAC, in which 4 patients experienced PPH, 5 cases required operative vaginal delivery, and 33 cases experienced fetal distress. Another study reported that 18.5% of the cases investigated underwent operative vaginal delivery with VBAC, which was only slightly smaller than the incidence seen in the current study.[14] Abnormal FHRs have been reported[15-17] as the most common clinical manifestation of uterine rupture.

The present study revealed that that use of oxytocin during labor and birth was a protective factor for PPH in VBAC, and that birth mode was a significant risk factor for PPH in VBAC. Previous research has indicated that PPH results from an atonic uterus, in which the loss of myometrial tone allows maternal blood flow to the placental bed (500 ml/min during pregnancy) to continue unchecked.[18] Oxytocin enhances uterine contractions through its receptor in the uterus and is therefore responsible for hemostasis. When oxytocin is administered during labor and birth, it may lead to the saturation of uterine oxytocin receptors. A combination of endogenous and exogenous oxytocin cannot promote uterine

Table 3: Univariate analysis of fetal distress in VBAC

Characteristics	Fetal distress (n = 51)	Without fetal distress (n = 161)	Statistical value	P
Age (years)	34.1 ± 3.6	33.5 ± 3.6	1.06*	0.29
Gravidity time (times)	2.0 (1.0–3.0)	2.0 (1.0–2.0)	−0.87‡	0.39
Parity time (times)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	−1.13‡	0.90
BMI (kg/m²)	22.08 ± 3.06	21.94 ± 2.72	0.30*	0.77
Weight gain (kg)	13.56 ± 4.53	14.44 ± 5.14	−1.07*	0.27
The duration of the first stage (min)	370.0 (200.0–480.0)	315.0 (215.0–510.0)	−0.25‡	0.80
The duration of the second stage (min)	25.0 (15.0–48.0)	32.0 (18.5–57.5)	−1.63‡	0.10
The duration of total labor (min)	415.0 (245.0–535.0)	370.0 (262.5–550.0)	−0.36‡	0.72
Delivery weeks (weeks)	39.0 (38.0–40.0)	38.0 (38.0–39.0)	−1.97‡	0.05
The onset of labor, n (%)				
Induction	9 (17.7)	25 (15.5)	0.13†	0.72
Spontaneous	42 (82.4)	136 (84.5)		
Oxytocin during labor, n (%)				
Using oxytocin	9 (17.7)	45 (28.0)	2.17†	0.14
Without oxytocin	42 (82.4)	116 (72.01)		
Labor anesthesia, n (%)				
With labor anesthesia	17 (33.3)	48 (29.8)	0.23†	0.64
Without labor anesthesia	34 (66.7)	113 (70.2)		
Birth mode, n (%)				
Normal delivery	26 (51.0)	137 (85.1)	25.36†	0.00
Operative vaginal delivery	25 (49.0)	24 (14.9)		
Neonatal weight (g)	3272.4 ± 492.8	3248.4 ± 539.6	0.67*	0.78

Data are presented as n (%) or mean ± SD or median (interquartile range). *t value; †χ² value; ‡Mann–Whitney U-test. BMI: Body mass index; VBAC: Vaginal birth after cesarean section; SD: Standard deviation.

Table 4: Multivariate analysis of fetal distress in VBAC

Variables	β	Wald	*P*	*OR*	95% *CI*
The duration of total labor	0.014	4.12	0.04	1.01	1.00–1.03
Delivery week	0.074	26.85	0.00	1.08	1.05–1.11

We defined absent fetal distress cases as 0 and fetal distress cases as 1, while the duration of total labor and the gestational week of delivery were continuous variables. The results revealed that the duration of total labor and the gestational week of delivery were significantly associated with fetal distress in VBAC: Both as risk factors for fetal distress in VBAC. *OR*: Odds ratio; *CI*: Confidence interval; VBAC: Vaginal birth after cesarean section.

contraction due to uterine oxytocin receptor deficiency in cases of uterine inertia, and instead, increases the risk of bleeding. However, oxytocin can accelerate the labor progress and reduce the risk of PPH because the main risk factor for PPH is the prolongation of labor duration. In addition, vaginal perineal laceration during operative vaginal delivery tends to be relatively deeper than normal vaginal delivery. From a maternal standpoint, operative vaginal deliveries are associated with a higher risk of third-degree and fourth-degree perineal lacerations, particularly when forceps are used.[19] In addition, even though episiotomy should not be performed routinely for all operative vaginal deliveries,[20] many cases of operative vaginal delivery do require episiotomy. A previous study reported that episiotomy occurred in 65.8% of cases undergoing operative vaginal delivery.[21] Consequently, the blood loss in such cases is much greater than during normal vaginal delivery, thus increasing the risk of PPH. Therefore, pregnant women who undergo VBAC during labor and birth should receive only minimal labor intervention to reduce the consequential risk of PPH.

In the present study, multivariate logistic analysis revealed that the duration of total labor and the gestational week of delivery were identified as significant risk factors for fetal distress during VBAC. Prolonged labor can lead to increased maternal and neonatal mortality, as well as morbidity, due to the increased risk of maternal exhaustion, PPH and sepsis, fetal distress, and asphyxia.[22] It is also known that because of the reduction in uteroplacental perfusion conferred by uterine contractions during labor, fetuses are exposed to a significantly increased risk of asphyxia, neurological injury, and death. As the number of gestational weeks increases, placental function decreases. Consequently, there may also be a reduction in oxygen exchange between the maternal and fetal circulations, which in turn increases the risk of fetal distress.

Obstetricians worry about uterine rupture during VBAC, even though the actual rate of uterine rupture is approximately 1%.[6] A long duration of labor may increase the risk of uterine rupture; as such, it is recommended that obstetricians should avoid excessively long periods of labor during VBAC by shortening the second stage of labor by operative vaginal delivery and by reducing the occurrence of fetal distress.[20]

In the present study, our VBAC rate was only 70.4%, which is similar to other studies described in the published literature.[23] However, the rate of uterine rupture in our patient cohort was significantly higher than reported previously.[6,24] The number of our cases undergoing TOLAC was unfortunately very low. This was because both the pregnant women and the obstetricians were concerned about uterine rupture and also because we have little experience of TOLAC in the mainland of China. In particular, we lack experience in terms of intrapartum management and the early recognition of uterine rupture.

There were some limitations to our study, which should be considered when interpreting our findings. First, our study was conducted in a single center, and randomization was not possible. Second, our sample size was small, and our study was retrospective. A multi-center, randomized trial, featuring a large number of patients, is now needed to validate the effect of intrapartum interventions and VBAC.

In conclusion, the administration of oxytocin during labor and birth was identified as a protective factor for PPH during VBAC, while birth mode was identified as a significant risk factor. The duration of total labor and the gestational week of the delivery week were revealed as significant risk factors for fetal distress during VBAC. Thus, obstetricians should provide appropriate interventions during labor and birth when performing VBAC.

Conflicts of interest

There are no conflicts of interest.

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临产方式、产程中缩宫素使用及分娩镇痛对剖宫产术后阴道分娩母婴结局的影响：一项来自中国三级医院的回顾性研究

摘要

目的： 探讨临产方式、缩宫素及分娩镇痛对剖宫产术后阴道分娩（VBAC）母婴结局的影响。

方法： 采用回顾性队列研究分析选取2015年1月至2017年6月在首都医科大学附属北京妇产医院实施剖宫产术后阴道分娩的产妇共212例。采用自制表格收集孕妇年龄、孕产次、孕前体重指数、孕期增重、临产方式、分娩孕周、缩宫素使用、分娩镇痛、分娩方式、产程时限及新生儿体重。采用单因素分析及多因素Logistic回归分析母婴结局如产后出血及胎儿窘迫的危险因素。

结果： 36例（17.0%）发生了产后出血，51例(24.1%)胎儿窘迫。163例（76.9%）自然分娩，49例（23.1%）产钳助产。178例产妇自然临产，占84.0%，引产34例，占16.0%。有54例（25.5%）使用缩宫素加强宫缩，65例（30.7%）使用了分娩镇痛。产后出血中的自然分娩比率明显低于无产后出血组（61.1% vs 80.1%,χ^2=6.07, P=0.01）。多因素Logistic回归分析显示产程中使用缩宫素和分娩方式与VBAC产后出血相关（OR=2.47, 95% CI: 1.07~5.74, P=0.04; OR=0.40, 95% CI 0.18~0.87, P=0.02）。胎儿窘迫组的产钳助产率明显高于非胎儿窘迫组(49.0% vs 14.9%,χ^2=25.36, P=0.00)。多因素Logistic回归分析显示总产程及分娩孕周是VBAC胎儿窘迫的影响因素(OR=1.01, 95% CI 1.00~1.03, P=0.04; OR=1.08, 95% CI 1.05~1.11, P=0.00)。

结论： 产程中使用缩宫素是VBAC发生产后出血的保护性因素，而分娩方式是VBAC发生产后出血的危险因素。总产程时限及分娩孕周是VBAC胎儿窘迫的危险因素。产科医生应为VBAC提供恰当的产时干预。