ANNALS OF MEDICINE
2022, VOL. 54, NO. 1, 1112–1117
https://doi.org/10.1080/07853890.2022.2067353

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

Prolonged duration of epidural labour analgesia decreases the success rate of epidural anaesthesia for caesarean section

Zhang Jian[a]*, Ran Longqing[b]*, Wei Dayuan[c]*, Jia Fei[d], Liu Bo[d], Zhang Gang[a], Zhu Siying[a] and Gao Yan[a]

[a]Sichuan Provincial Maternity and Child Health Care Hospital (Women's and Children's Hospital Affiliated of Chengdu Medical College), Chengdu; [b]Chengdu Women's and Children's Central Hospital (School of Medicine, University of Electronic Science and Technology of China), Chengdu; [c]Chengdu Medical College, Chengdu; [d]Jinjiang Maternity and Child Health Hospital, Chengdu

ABSTRACT

Objective: To summarise the process of conversion of epidural labour analgesia to anaesthesia for caesarean delivery and explore the relationship between duration of labour analgesia and conversion.

Methods: Parturients who underwent conversion from epidural labour analgesia to anaesthesia for caesarean delivery between May 2019 and April 2020 at the Chengdu Women's and Children's Central Hospital, Sichuan Maternal and Child Health Hospital, and Jinjiang District Maternal and Child Health Hospital were selected. If the position of the epidural catheter was correct and the effect was good, patients were converted to epidural surgical anaesthesia. If epidural labour analgesia was ineffective, spinal anaesthesia (SA) was administered immediately. For category-1 emergency caesarean sections, general anaesthesia (GA) was administered.

Results: A total of 1084 parturients underwent conversion. Of these, 19 (1.9%) received GA due to the initiation of category-1 emergency caesarean section. 704 (64.9%) were converted to epidural surgical anaesthesia, 2 (0.2%) had failed conversions and were administered GA before delivery, and 357 (32.9%) were converted to SA. Logistic regression analysis showed that prolonged duration of epidural labour analgesia ([Crude odds ratio (OR)=1.065; 95% confidence interval (CI), 1.037–1.094; $p < .01$]; [Adjusted OR = 1.060; 95% CI, 1.031–1.091; $p < .01$]) was an independent risk factor for conversion failure. A receiver operating characteristic curve constructed using duration of epidural labour analgesia showed that parturients with a duration of epidural labour analgesia ≥8 h, more frequently required a change of anaesthesia technique during conversion, and the relative risk of conversion failure was 1.54 (95% CI, 1.23–1.93; $p < .01$).

Conclusion: Prolonged duration of epidural labour analgesia increases the possibility of having an invalid epidural catheter, resulting in an increased risk of conversion failure from epidural labour analgesia to epidural surgical anaesthesia. Further, this risk is higher when the time exceeds 8 h.

KEY MESSAGES

- Prolonged duration of epidural labour analgesia > 8 h is associated with conversion failure.
- If it is impossible to judge whether the conversion is successful immediately, spinal anaesthesia should be administered to minimise complications.

ARTICLE HISTORY
Received 28 May 2021
Revised 15 January 2022
Accepted 11 April 2022

KEYWORDS
Labour analgesia; caesarean section; epidural anaesthesia; spinal anaesthesia; duration of epidural labour analgesia

1. Introduction

Currently, epidural labour analgesia (ELA) is the most effective and commonly used method of labour analgesia [1,2]. Not only does it provide analgesia for the parturient, but it can also be converted to epidural surgical anaesthesia (ESA) for delivery *via* a caesarean section (CS). However, this conversion is not 100% successful, and unexpected change of anaesthesia technique could pose additional risks to the parturient and baby [3,4]. With the promotion of ELA, the number of patients requiring a change of anaesthetic technique has also increased significantly [5]. Therefore, it is necessary for anaesthesiologists to be able to accurately predict the effectiveness of conversion and reduce maternal and infantile adverse outcomes.

This study retrospectively analysed the process of conversion. The main purpose was to explore the effect of ELA duration on conversion. The secondary

CONTACT Gao Yan rs7got@foxmail.com Sichuan Provincial Maternity and Child Health Care Hospital (Women's and Children's Hospital Affiliated of Chengdu Medical College), Chengdu

*Zhang Jian, Ran Longqing, and Wei Dayuan contributed the same to this article.

objective was to clarify other factors that may affect conversion and compare the maternal and infantile outcomes with different anaesthesia techniques.

2. Materials and methods

2.1. Object and grouping

Parturients who underwent conversion from ELA to other techniques of anaesthesia between May 2019 and April 2020 at the Chengdu Women's and Children's Central Hospital, Sichuan Maternal and Child Health Hospital, and Jinjiang District Maternal and Child Health Hospital were included. Based on the success of conversion and degree of emergency for CS, they were divided into three groups: ELA, SA, and GA groups.

2.2. Ethics statement

The study was approved by the ethics committee of Sichuan maternal and Child Health Hospital-20210109-01, Jinjiang Maternal and Child Health Hospital-202111, and Chengdu Women's and Children's Central Hospital-B2019(12).

2.3. Epidural labour analgesia

Epidural labour analgesia was administered to consenting parturients when the cervix dilated to 2–4 cm. The procedure was as follows: (1) The patient was placed in the left-lateral position and the L2–L3 or L3–L4 intervertebral space was punctured. (2) An ordinary epidural catheter is inserted into the epidural space to a depth of 4–5 cm. (3): A 50 mL mixture of 0.08–0.1% ropivacaine (Yichang Humanwell Pharmaceutical Co Ltd., China) + 0.4 μg/mL sufentanil (Yichang Humanwell Pharmaceutical Co Ltd., China), was administered using the Programmed Intermittent Epidural Bolus technique at a rate of 1 pulse/h and 10 mL/pulse. The self-control volume was 5 mL and the lock time was 30 min. The treatment of analgesia insufficient (VAS score $>$ 4 points) include adjusted position of conduit, increased medication, attempted ELA again, et al.

2.4. Exclusion criteria

The exclusion criteria were as follows: multiple regnant, gestational age less than 37 weeks, vaginal delivery after ELA, and unintended dural puncture.

2.5. Selection of anaesthesia technique for CS

2.5.1. Epidural surgical anaesthesia

The absence of cerebrospinal fluid or blood on suctioning the catheter confirmed that the catheter was positioned correctly. Then, we injected 10–12 mL of 1.72% lidocaine carbonate through the catheter, and adjusted the block level until it reached T4–T6 prior to starting the operation.

2.5.2. Spinal anesthesia

The epidural catheter was removed after judging that it was invalid. Next, we selected the L3–L4 intervertebral space to administer SA. We injected 15 mg of 0.5% isobaric ropivacaine into the subarachnoid space and then inserted an epidural catheter to a depth of 4–5 cm.

2.5.3. General anaesthesia

General anaesthesia (GA) was selected for category-1 emergency CSs [6] or for cases where conversion failed. According to the guidelines of [7] the Department of Anaesthesiology, the standard procedure for GA for category-1 emergency CSs was as follows: the parturient entered operating room, vital signs were monitored, high-flow oxygen was administered using a mask, a suction device was prepared, and rapid sequence intubation was performed using propofol + rocuronium. Other intravenous anaesthetics were added after delivery.

2.6. Data collection

Parturient, infant, and operation- and anaesthesia-related data, including parturient age, body mass index (BMI), artificial rupture of membranes (ARM), gestational age, pregnancy comorbidities, ELA duration, size of the cervical orifice before operation, operation time, delivery time, amniotic fluid condition, APGAR score, and infantile weight, were collected retrospectively.

2.7. Statistical analysis method

Normally distributed measurement data were expressed as mean ± standard deviation, and count data were expressed as rate (%). The measurement data were compared between the groups using *t*-tests and the rates were compared using the chi-square test. Logistic regression analysis was used to evaluate the relationship between ELA duration and conversion. Confounders in the regression analysis model were selected based on previous research and the

Goodness-of-Fit study model. The crude odds ratio (OR) and adjusted OR were calculated. A receiver operating characteristic (ROC) curve was used to further explore the relationship between ELA duration and the change of anaesthesia techniques for CS. The cut off value of analgesia time was found by Youden index, and the parturients were divided into two groups according to the cut off value. The relative risk (RR) of each group was calculated by cross tabulations.Statistical significance was set at $p < .05$.

3. Results

A total of 7596 parturients received ELA, of whom, 1084 (14.3%) underwent conversion to CS. Of these, 19 (1.9%) parturients received GA, 2 (0.2%) had failed conversions and were administered GA before delivery, 357 (32.9%) were converted to SA, and 704 (64.9%) underwent conversion to ESA. Demographic data are shown in Table 1.

There was no significant difference in the time of breaking-water, operation time, delivery time, the character of amniotic fluid, neonatal Apgar score, and birth weight between the ESA and SA groups ($p > .05$). The ELA duration in the ESA group (8.1 ± 4.6)h was less than that in the SA group (9.5 ± 4.9)h. The average size of the cervical orifice before operation in the ESA group (4.2 ± 3.1)cm was less than that in the SA group (5.0 ± 3.4)cm and the difference was statistically significant ($p < .05$) (Table 2).

The results of the logistic regression analysis were as follows: before excluding confounders (Table 3), univariate analysis showed that the crude OR for each hour of prolongation of ELA duration was 1.065 (95% CI, 1.037–1.094; $p < .01$); after excluding confounders (Table 4), multivariate analysis showed that the adjusted OR was 1.060 (95 CI%, 1.031–1.091; $p < .01$). In addition, a 1 cm increase in cervical orifice size (OR = 1.060, 95% CI, 1.018–1.104; $p = .013$) was also an independent risk factor for conversion failure. However, diabetes (OR = 0.517; 95% CI, 0.352 − 0.760;

Table 1. Patient characteristics.

	ESA ($n = 704$)	SA ($n = 357$)	GA ($n = 23$)	All ($n = 1084$)	p Value of ESA and SA
Age (years)	29.2 ± 3.6	28.8 ± 3.5	28.4 ± 4.0	29.0 ± 3.6	.14
BMI* (kg/m^2)	26.9 ± 2.8	27.0 ± 3.3	26.4 ± 2.8	26.9 ± 3.0	.38
Gestational age (weeks)	39.4 ± 1.2	39.9 ± 1.2	39.1 ± 1.5	39.4 ± 1.2	.22
ARM* (*n* [%])	216 (30.7)	100 (28.0)	5 (21.7)	321 (29.6)	.37
Oxytocin (*n* [%])	336 (47.7)	159 (44.5)	14 (60.9)	509 (47.0)	.33
Causes of CS (*n* [%])					
FD*	250 (35.5)	126 (35.3)	15 (65.2)	391 (36.1)	1
RCD*	149 (21.2)	48 (13.4)	1 (4.3)	198 (18.3)	.81
ACV*	51 (7.2)	21 (5.9)	0 (0)	71 (6.6)	.44
TDAF*	64 (9.1)	16 (4.5)	0 (0)	80 (7.4)	.07
FHDS*	53 (7.5)	38 (10.6)	3 (13.0)	94 (8.7)	.10
Complications (*n* [%])					
Diabetes	150 (21.3)	42 (11.8)	3 (13.0)	195 (18.0)	<.01
thyroid disease	51 (7.2)	38 (10.6)	1 (4.3)	90 (8.3)	.06
Anemia	21 (3.0)	10 (2.8)	1 (4.3)	32 (3.0)	.87
hypertension	59 (8.4)	37 (10.4)	1 (4.3)	97 (8.9)	.29

*BMI: Body mass index; ARM: artificial rupture of membranes; FD: foetal distress; RCD: relative cephalopelvic disproportion; FHDS: foetal head drop stagnation; ACV: acute chorionic villitis; TDAF: third degree faecal staining of amniotic fluid.

Table 3. Univariate analysis for ELA duration*.

Factors	OR	95% CI	*p*
Each 1 h prolongation of ELA duration	1.065	1.037–1.094	<.01

*ELA: epidural labour analgesia; OR: odds ratio; CI: confidence interval.

Table 4. Multivariate analysis for ELA duration*.

Factors	OR	95% CI	*p*
Per hour prolongation of ELA*	1.060	1.031–1.091	<.01
per cm increase in cervical orifice	1.060	1.018–1.104	.013
Diabetes	0.517	0.352–0.760	<.01
Age	0.979	0.943–1.017	.281
Oxytocin	0.911	0.689–1.203	.510
ARM*	0.990	0.731–1.340	.946
Anemia	0.910	0.417–1.985	.813
BMI*	1.016	0.973–1.061	.482
Gestational age	1.010	0.891–1.145	.876
Hypertension	1.174	0.748–1.843	.484
Thyroid disease	1.468	0.931–2.316	.099

*ELA: epidural labour analgesia; ARM: artificial rupture of membranes; BMI: body mass index; OR: odds ratio; CI: confidence interval.

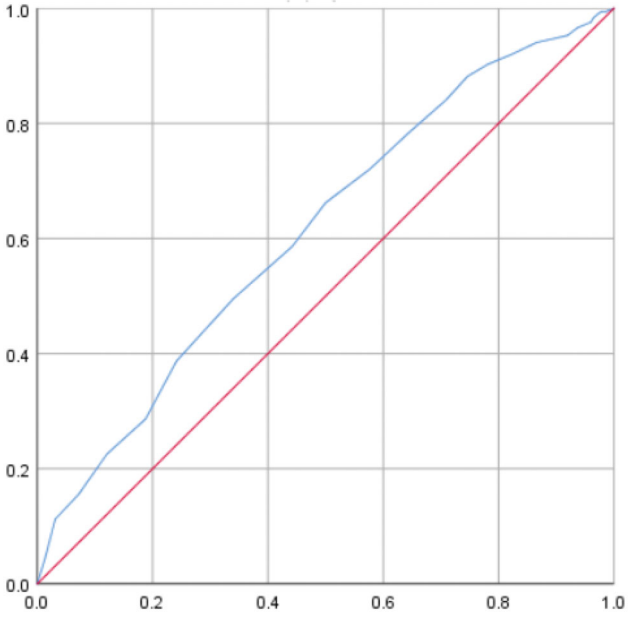

Figure 1. ELA duration ROC.

$p < .01$) promoted the success of conversion. The area under the ROC curve for ELA duration was 0.60, cut-off point was 8 h, specificity was 50.6%, and sensitivity was 60.2% (Figure 1).

The parturients were divided into two groups according to the cut-off point of ELA duration and the relative risk of each group was calculated. Statistical results (Table 5) showed that among 1061 parturients in the non-general anaesthesia group, the proportion of conversion failure in the group with ELA duration ≥8 h (38.2%) was higher than that in the group with ELA duration <8 h (28.5%), and the RR was 1.27 (95% CI, 1.01–1.74; $p < .01$).

4. Discussion

Obstetric GA is an independent risk factor for maternal death [8]; therefore, methods reduce complications due to anaesthesia during conversion and avoid the use of GA are challenges for anaesthesiologists. The incidence of conversion failure of existing ELA to ESA is between 0% and 21% [9]. Currently, it is considered that the position of the epidural catheter and the effect of ELA are the main factors that determine the success of conversion. Although previous studies did not clearly show the relationship between ELA duration and conversion [10,11], our study showed that ELA duration may affect these two main factors simultaneously.

Ensuring the position of the epidural catheter before surgery is critical for conversion success. It is a necessary to ensure the ELA effect and judge whether the catheter still in the epidural space. Furthermore, the effect depends on drug concentration, diffusion, and absorption and on personal, physical, and other factors. We agree that the longer the catheter is in place, the more likely it is to become displaced from the epidural space [12]. Meanwhile, anxiety due to a long waiting period decreases the maternal pain tolerance threshold [13]. Thus, a higher dose of anaesthetic is required during ELA. This leads to a dilution of the preoperative medication by the liquid injected into the epidural space [9], ultimately increasing the probability of conversion failure.

When the cervical orifice expands to 5–6 cm, the progress of labour is significantly accelerated [14]. Breakthrough pain is prone to occur, and increases the requirement of the anaesthetic. Thus, the probability of conversion failure increases [15]. However, the progress of labour varies from person to person. For example, labour in multiparous women is faster than that in primiparous women; therefore, this factor needs to be further studied and explored.

Compared with nonpregnant individuals, parturients with diabetes are more sensitive to local anaesthetics and have a longer block time [16,17]; hence, they need a smaller dose during ELA and less preoperative fluid during ESA. The conversion success rate is higher.

There are two ways to determine the position of the epidural catheter: (1) gently aspirate through the epidural catheter to check for blood or cerebrospinal fluid to quickly and effectively identify a misplaced epidural catheter [18] and (2) supplement the test dose before CS and evaluate the analgesic effect [19]. However, a study found that when SA was performed after getting poor analgesia with a supplementary test

Table 5. Relative risk for ELA duration*.

	Successful Conversion ($n = 704$)	Conversion failure ($n = 357$)	RR	95 CI%	$p < .01$
ELA duration $\geq$ 8 h ($n = 563$)	348 (61.8%)	215 (38.2%)	1.27	1.01–1.47	
ELA duration $<$ 8 h ($n = 498$)	356 (71.5%)	142 (28.5%)	0.82	0.73–0.92	

*ELA: epidural labour analgesia; RR: risk ratio; CI: confidence interval.

dose, the incidence of high block increased [20]. Dadarkar et al [21] did not supplement the test dose before CS; they performed SA directly, and reported no high block. Therefore, we use and recommend the first method. The primary objective is to judge the position of the catheter, rather than to test the effect of a catheter that might have been displaced.

With regards to poor catheter location and insufficient analgesia, our approach is to abandon conversion, remove the catheter, and administer SA. However, in another study [22], the researchers continued the conversion or administered GA, and the final GA rate was 13.1%. In some studies that did not actively implement SA, the GA rate was between 7.8% and 19.8% [23–25], which was higher than the requirement of <5% [26]. Although the SA rate in this study was 24.9%, we administered GA in only 23 cases (2.2%), and could reduce the adverse outcomes of obstetric GA significantly.

This study had some limitations. First, because the three hospitals were in the same city, both the obstetricians and anaesthesiologists had similar medical habits, making it easier to draw consistent conclusions. Second, the conversion rate of ELA to CS (14.3%) was too high, suggesting that the indications for CS are not clearly defined in obstetrics. Thus, there may be deviations from the actual number of cases. Further high-quality studies are needed to evaluate the potential risk factors associated with conversion failure.

5. Conclusion

Prolonged ELA duration increased the possibility of rendering the epidural catheter invalid, resulting in a raised risk of conversion failure from ELA to ESA. Furthermore, this risk was higher when the ELA duration was >8 h. Therefore, conversion should be abandoned in a parturient with a long period of analgesia (especially more than 8 h) requires a CS. In addition, if it is impossible to judge whether the conversion is successful immediately, SA should be given to reduce the high block or GA rate.

These conclusions need to be accepted with caution by other medical institutions, and anaesthesiologists should determine the cut-off point according to the real situation in their hospitals. Nevertheless, it is true that prolonged ELA duration raises the risk of conversion failure; hence, we recommend that anaesthesiologists strengthen the follow-up and treatment during ELA, establish good communication with obstetricians and midwives, and choose an appropriate anaesthetic methods to improve the prognosis of mothers and babies.

Disclosure statement

We declare that we have no financial and/or personal relationships with other people or organisations that can inappropriately influence our work. There is no professional or other personal interest of any nature or kind in any product, service, and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled, "The prolonged duration of epidural labor analgesia decreased the successful rate of cesarean section by epidural anesthesia."

Author contributions

1. Zhang Jian and Gao Yan contributed to the conception of the study;
2. Zhang Jian, Ran Longqing, Wei Dayuan, Jia Fei, Liu Bo, Zhang Gang, and Zhu Siying performed the experiment;
3. Ran Longqing and Wei Dayuan contributed significantly to analysis and manuscript preparation;
4. Wei Dayuan performed the data analyses and wrote the manuscript;
5. Zhang Jian and Ran Longqing helped perform the analysis with constructive discussions.
6. Gao Yan approved the final version to be published.

Funding

This work was supported by the Project of Science and Technology Department of Sichuan Province under grant number 2018SZ0267 and the National Key R&D Program of China under grant number 2017YFC0907300.

Data availability statement

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is private.

References

[1] American College of Obstetricians and Gynecologists' Committee on Practice Bulletins. ACOG practice

bulletin no. 209: obstetric analgesia and anesthesia. Obstetrics Obstet Gynecol. 2019;133(3):e208–e225.
[2] Wu J, Yao S-L. Obstetric anesthesia in China: associated challenges and long-term goals. Chin Med J (Engl). 2020;133(5):505–508.
[3] Neuhaus S, Neuhaus C, Fluhr H, et al. ["why mothers die". learning from the analysis of anaesthesia-related maternal deaths (1985–2013)]. Anaesthesist. 2016; 65(4):281–294.
[4] Hawkins JL, Chang J, Palmer SK, et al. Anesthesia-related maternal mortality in the United States: 1979–2002. Obstet Gynecol. 2011;117(1):69–74.
[5] Herrera-Gómez A, Luna-Bertos E, Ramos-Torrecillas J, et al. The effect of epidural analgesia alone and in association with other variables on the risk of cesarean section. Biol Res Nurs. 2017;19(4):393–398.
[6] Lucas DN, Yentis SM, Kinsella SM, et al. [Urgency of caesarean section: a new classification]. J R Soc Med. 2000;93(7):346–350.
[7] Plante L, Gaiser R. Practice bulletin no.177:Obstetric analgesia and anesthesia. Obstet Gynecol. 2017; 129(4):e73–e89.
[8] Ratnayake G, Patil V. General anaesthesia during caesarean sections: implications for the mother, foetus, anaesthetist and obstetrician. Curr Opin Obstet Gynecol. 2019;31(6):393–402.
[9] Mankowitz SK, Gonzalez Fiol A, Smiley R. Failure to extend epidural labor analgesia for cesarean delivery anesthesia: a focused review. Anesth Analg. 2016; 123(5):1174–1180.
[10] Halpern SH, Soliman A, Yee J, et al. Conversion of epidural labour analgesia to anaesthesia for Caesarean section: a prospective study of the incidence and determinants of failure. Br J Anaesth. 2009;102(2): 240–243.
[11] Kinsella SM. A prospective audit of regional anaesthesia failure in 5080 Caesarean sections. Anaesthesia. 2008;63(8):822–832.
[12] Riley ET, Papasin J. Epidural catheter function during labor predicts anesthetic efficacy for subsequent cesarean delivery. Int J Obstet Anesth. 2002;11(2): 81–84.
[13] Reicherts P, Wiemer J, Gerdes ABM, et al. Anxious anticipation and pain: the influence of instructed vs conditioned threat on pain. Soc Cogn Affect Neurosci. 2017;12(4):544–554.
[14] Caughey AB. Is Zhang the new Friedman: How should we evaluate the first stage of labor? Semin Perinatol. 2020;44(2):151215.
[15] Lee S, Lew E, Lim Y, et al. Failure of augmentation of labor epidural analgesia for intrapartum cesarean delivery: a retrospective review. Anesth Analg. 2009; 108(1):252–254.
[16] Baeriswyl M, Taffé P, Kirkham KR, et al. Comparison of peripheral nerve blockade characteristics between non-diabetic patients and patients suffering from diabetic neuropathy: a prospective cohort study. Anaesthesia. 2018;73(9):1110–1117.
[17] Gebhard RE, Nielsen KC, Pietrobon R, et al. Diabetes mellitus, independent of body mass index, is associated with a "higher success" rate for supraclavicular brachial plexus blocks. Reg Anesth Pain Med. 2009; 34(5):404–407.
[18] Desai N, Carvalho B. Conversion of labour epidural analgesia to surgical anaesthesia for emergency intrapartum Caesarean section. BJA Educ. 2020;20(1): 26–31.
[19] Regan KJ, O'Sullivan G. The extension of epidural blockade for emergency Caesarean section: a survey of current UK practice. Anaesthesia. 2008;63(2): 136–142.
[20] D'Angelo R, Smiley RM, Riley ET, et al. Serious complications related to obstetric anesthesia: the serious complication repository project of the Society for Obstetric Anesthesia and Perinatology. Anesthesiology. 2014;120(6):1505–1512.
[21] Dadarkar P, Philip J, Weidner C, et al. Spinal anesthesia for cesarean section following inadequate labor epidural analgesia: a retrospective audit. Int J Obstet Anesth. 2004;13(4):239–243.
[22] Ismail S, Chugtai S, Hussain A. Incidence of cesarean section and analysis of risk factors for failed conversion of labor epidural to surgical anesthesia: a prospective, observational study in a tertiary care center. J Anaesthesiol Clin Pharmacol. 2015;31(4):535–541.
[23] Rafi MA, Arfeen Z, Misra U. Conversion of regional to general anaesthesia at caesarean section: increasing the use of regional anaesthesia through continuous prospective audit. Int J Obstet Anesth. 2010;19(2):179–82.
[24] Shen C, Chen L, Yue C, et al. Extending epidural analgesia for intrapartum cesarean section following epidural labor analgesia: a retrospective cohort study. J Matern Fetal Neonatal Med. 2022;35(6):1127–1133.
[25] Orbach-Zinger S, Friedman L, Avramovich A, et al. Risk factors for failure to extend labor epidural analgesia to epidural anesthesia for Cesarean section. Acta Anaesthesiol Scand. 2006;50(7):793–797.
[26] Purva M, Russell I, Kinsella M. Conversion from regional to general anaesthesia for caesarean section: are we meeting the standards? Anaesthesia. 2012; 67(11):1278–1279.