

Intravertebral Anaesthesia For cesarean section

Fangjun Wang (✉ wfjlxy006@nsmc.edu.cn)

North Sichuan Medical University <https://orcid.org/0000-0002-0818-7215>

Dan Xie

Affiliated Hospital of North Sichuan Medical College

Chun Hong Xu

Affiliated Hospital of North Sichuan Medical College

Qin Ye

Affiliated Hospital of North Sichuan Medical College

Research article

Keywords: Epidural block; Subarachnoid block; Caudal block; Cesarean section

Posted Date: April 18th, 2019

DOI: <https://doi.org/10.21203/rs.2.9253/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

BACKGROUND: Although epidural and spinal anaesthesia in patients undergoing cesarean section is the general choice recently, both of the two anesthesia methods still have imperfections. Caudal anesthesia has been considered more appropriate for gynecological surgery. However, there is a lack of experiments on the effects of epidural block combined with caudal block anaesthesia for cesarean section. **METHODS:** One hundred and fifty patients undergoing elective cesarean section were recruited to this clinical trial and randomized to receive epidural block, subarachnoid block, and epidural block combined with caudal block. The primary objective was to compare and evaluate the clinical efficacy of three groups. Secondary outcomes included side effects and the quality of intraoperative and postoperative comfort assessment. **RESULTS:** The times to cryanaesthesia at T10 and time to maximum motor block were shorter in group SAB. The maximal sensory blockade spinal segments of group SAB(15.18 ± 0.90) and EAC (14.74 ± 1.16) were much more than group EPB(10.74 ± 1.77). Compared to group EPB(155.40 ± 13.28) and EAC(160.70 ± 12.58), the duration of complete regression of motor block was longer in group SAB(190.00 ± 13.25). The intraoperative quality of anesthesia was judged by the gynecologist was excellent in group EAC and SAB($P=0.005$), and by the parturients was only best in group EAC($P=0.001$). The parturients felt more comfortable after surgery in group EPB and group EAC($P=0.007$). **CONCLUSIONS:** Epidural block combined with caudal block anaesthesia can achieve the same anesthetic effect as spinal anaesthesia which is better than epidural anaesthesia for elective cesarean section, and have the highest level of intraoperative and postoperative comfort for parturient.

Introduction

Epidural or spinal anesthesia is increasingly used in Cesarean deliveries for it's safer for the fetuses and pregnant women than general anesthesia¹. When intravertebral anesthesia is errorlessly administered the vital signs of the mother and neonate aren't changed significantly, adverse reactions are very rare and the contact between the newborn and mother is possible to be established immediately after delivery.

Although spinal anaesthesia is more popular in parturients undergoing abdominal delivery for its shorter anesthetic time and lower postoperative pain scores², it is still imperfect in some aspects. Firstly, spinal anesthesia was associated with a higher risk of postoperative venous thromboembolism, as compared with that associated with epidural anesthesia³. Secondly, the incidence of postdural puncture headache (PDPH) in pregnant women undergoing spinal anesthesia during cesarean section was 10.8 %^{4,5}. Most of the patients developed PDPH 1 or 2 days after surgery^{6,7}. In order to prevent the PDPH, patients had to be supine position for at least 4 hours after surgery. Due to the deficiencies described above in spinal anaesthesia, epidural blockade anesthesia may be the best choice for parturients undergoing abdominal delivery. But the incidence of unsatisfactory anesthesia that requires intervention is relatively high during epidural anesthesia for cesarean section⁸.

The incision of cesarean section is located between T₁₀-T₁₂, and the surgical operation are mainly performed in the pelvic cavity. Therefore a cesarean delivery anesthetic segment requires at least from

the 10th thoracic nerve to sacral nerve. A single point epidural block can't achieve such a wide range of nerve blocking. Caudal anesthesia as a supplementary mode of analgesia has been considered more appropriate for gynecological surgery, and many studies have shown that the application of ultrasound has increased the safety, ease, and consistency of a caudal block analgesia⁹⁻¹². Thus we speculated that the epidural anaesthesia within T₁₁-T₁₂ intervertebral space combined with caudal block anesthesia could achieve satisfactory anesthesia for cesarean section. However, no experiments have yet been conducted with respect to the effects of epidural block combined with caudal block anesthesia for cesarean section. The purpose of the present randomized trial is to determine whether epidural block combined with caudal block anaesthesia is more appropriate for cesarean section than spinal anaesthesia or a single point epidural block anaesthesia.

Methods

Following the approval by the Ethics Committee of the Affiliated Hospital of North Sichuan Medical College, we obtained the written informed consent from all the participants for this randomized prospective clinical trial. This prospective, double-blind, randomized controlled study has been registered prior to patient enrollment at the Chinese Clinical Trial Registry (<http://www.chictr.org.cn/>; Principal investigator: Fangjun Wang, Date of registration: July 28 2016, Registration number: ChiCTR-INR-16008933).

This is a clinical, controlled, and randomized trial. 150 parturients at term, all of the participants were primigravida. American Society of Anesthesiologists (ASA) grade I or II, single birth, and undergoing optional cesarean section, were included in this study. Exclusion criteria included: a history of hypersensitivity to the drugs used, contraindications for regional block (such as infection of the puncture site, anatomic deformities, or coagulation disorders), diagnosis of acute or chronic fetal distress, prior administration of opioids and other central nervous system depressants, Rhesus immunization, pregnancy-induced hypertension syndrome, body mass index (BMI) > 35 kg/m², and intraoperative blood loss >800ml. The patients were randomized into three groups by use of sealed envelopes (50 patients each) to receive epidural block (EPB group), subarachnoid block (SAB group), or epidural block combined with caudal block (EAC group).

All the parturients were assessed preoperatively by history, physical examination, and laboratory evaluations (liver function, renal function tests, and complete blood picture). The day before surgery, the study protocol, including EPB, SAB and EAC procedures were explained to each parturient. All parturients were made familiar with the use of a numeric rating scale (NRS) identifying 1 as unsatisfactory and 5 as the excellent. The parturients were fasted for 8 hours and had not been given any preanesthetic medication. Monitoring in the operating room included electrocardiography (ECG), pulse oxygen saturation (SpO₂), urine volume, and non-invasive blood pressure (NIBP). Baseline NIBP, respiratory rate, ECG and SpO₂ were recorded. After a good IV access secured, all parturients were administered 500 ml of Ringer's lactic acid solution intravenously before anesthesia. The 6 L/min oxygen was provided to all participants by a facemask until the end of the operation. All blocks isolated from gynecologists were

performed by the same group of anesthesiologists who were proficient in intravertebral anaesthesia and had more than 10 years experience in anaesthesia.

Patients in three groups were placed with a left lateral position, and local anesthesia of skin and subcutaneous tissues were performed at puncture site under aseptic technique with 2% lidocaine hydrochloride 2-3mL. The epidural puncture site was at the L2-3 intervertebral space in EPB group and T11-T12 intervertebral space in EAC group. The epidural space was localized and confirmed with the sudden disappearance of resistance and the appearance of negative pressure. Then an epidural catheter was inserted 4.5cm into epidural space in a cephalic direction and gently withdrawing either no cerebrospinal fluid or blood. In EAC group, a 22-gauge needle was inserted into the sacral hiatus using ultrasound to guide accurate placement of the needle, after prior negative blood aspiration, a caudal injection of 0.25% ropivacaine 20ml administered in <30 s was performed, then any untoward effect was observed for 5-10 minutes. In SAB group, the 18G Tuohy needle was used to identify epidural space by loss of resistance to air technique at L2-3 or L3-4 intervertebral space, and a 25G pencil point spinal needle was inserted through the 18G Tuohy needle and once free flow of cerebrospinal fluid was obtained hyperbaric 0.5% ropivacaine 15 mg (3 ml) was injected intrathecally over 30 seconds, then epidural catheter was inserted 4.5 cm into epidural space and fixed without withdrawing CSF or blood through it in SAB group. After the epidural catheter being secured to skin surface, the caudal injection and intrathecal injection, women were repositioned with left uterine displacement by keeping a wedge beneath the right half of lower back and a pillow was placed below the head and shoulders. Thereafter, 3 mL of 2% lidocaine hydrochloride solution was administered as a test dose and any untoward effect was observed for in EPB group and EAC group. After 5–8 minutes of institution of the test dose, EPB group and EAC group were received epidural anesthesia with 15 mL and 10 mL of 0.75% ropivacaine respectively. Surgical procedures were initiated only after the anesthetic level was completely established minimum until T10 or 20 min had passed after completion of spinal or epidural anesthetic. Participants were required to compare the sensation of cool induced by evaporating of alcohol on the cervical skin to the sensation at lower dermatome levels. The alcohol cotton ball was moved from caudad to cephalad direction starting at the L2 dermatome, and the testing of sensory level was performed every two minutes after administration of the spinal or epidural anesthetic until 30 min had passed. Patients were asked to indicate when the sensation of alcohol felt the same as on the forehead. Motor block using a modified Bromage motor scales(MBS) (1=Complete block, unable to move feet or knees; 2 =Almost complete block, able to move feet only; 3 = Partial block, just able to move knees; 4 = Detectable weakness of hip flexion while supine, full flexion of knees; 5 =No detectable weakness of hip flexion while supine)¹³ was also recorded at the same intervals. The following variables were recorded: time to initial onset of cryanaesthesia at T10, maximal sensory block level, time to attain maximum motor blockade, and time for complete regression of motor block. Maternal hemodynamic parameters included NIBP (both systolic and diastolic), ECG, heart rate, SpO₂ and respiratory rate, were monitored continuously. Recordings were made every 1 minute until 30 minutes after the local anesthetic administered and at 5-minute intervals thereafter up to the end of surgery. Hypotension (defined as systolic falling more than 20% before anesthesia or systolic values lower than 80 mmHg) was treated with ephedrine 6 mg intravenous bolus

immediately. Bradycardia (defined as heart < 55 beats/minute) was treated with 0.3 mg of injection atropine.

During the surgical procedure, Intravenous fluids were given as per the body weight and operative loss requirement with none requiring blood transfusion. Intraoperative adverse events like nausea, vomiting, maternal bradycardia or hypotension were recorded. Nausea and/or vomiting were treated with ondansetron 4 mg intravenous. During at the end of surgery, the quality of anesthesia was judged by the parturients and the gynecologist on a numeric rating scale (NRS) from 1 (unsatisfactory: the parturients feel pain and the gynecologist felt tension in the patient's abdominal muscles, general anesthesia required to complete the cesarean section) to 5 (excellent: the parturients feel painless and the gynecologist felt relaxant in the patient's abdominal muscles). All patients returned to the maternity ward and received epidural analgesia after cesarean section. In order to avoid PDPH, patients in group SAB were positioned supine for at least 4 hours after surgery, whereas patients in group EPB and EAC did not need to be so. The quality of postoperative comfort was judged by the parturients 12h after operation on a numeric rating scale (NRS) from 1 (unsatisfactory: with a headache, moveless and numbness legs, be in a uncomfortable position while breastfeeding) to 5 (excellent: no headache, free movement of legs and without numbness, be in a comfortable position while breastfeeding). All the indicators were assessed and recorded by a research assistant who was unaware of the grouping of clinical trials.

Statistical analysis

A comparison of the satisfaction rate of patients was the primary outcome of this study. In the preliminary experiment, we found that the satisfaction rates of patients in the spinal anesthesia group, epidural block group and epidural block combined with caudal block group were 65%, 75% and 85% respectively. We assumed that 10% decrease in satisfaction rate of patients would be clinically relevant and calculated that a sample size of 48 patients would be needed in each group (type I error of 0.05, power of 0.9). Considering a 10% dropout rate, 53 patients in each group were necessary.

The statistic software SPSS (version 19.0) was used for all statistical analysis. One-sample Kolmogorov-Smirnov test was applied to analyze the distribution of the data, and each group of data was taken a homogeneity test for variance in multiplicate samples by the means of Levene. One-way analysis of variance was used to examine the differences of quantitative data between groups. The Kruskal-Wallis H(K) was performed to analyze the ordered variables, such as time to cryanaesthesia at T₁₀, maximal sensory blockade spinal segments, time to maximum motor block, time for complete regression of motor block and apgar scores. The incidences of maternal bradycardia, hypotension, nausea, vomiting, postoperative headache, quality of anesthesia and postoperative comfort among the three groups were compared with Chi-Square test. A *p* value<0.05 was considered statistically significant.

Results

Total 150 women were enrolled in the study between January 2016 and May 2017. Maternal characteristics are shown in table 1. The participants' age, height, weight and gestational weeks were statistically similar among three groups. The duration of surgery of group EPB was significantly longer than that of group SAB ($P=0.001$) and group EAC ($P=0.007$), while no significant difference was found between the group SAB and EAC ($P=0.596$).

The time to cryanaesthesia at T10 and time to maximum motor block were significantly shorter in group SAB ($P<0.01$). The sensory blockade spinal segments were significantly wider in group SAB and EAC ($P<0.01$). At the same time, the scores of MBS in group SAB and EAC were decreased significantly ($P<0.01$). Compared to group EPB and EAC, the time for complete regression of motor block was significantly longer in group SAB ($P<0.01$).

No significant differences among three groups with respect to maternal bradycardia, nausea, vomiting and postoperative headache were found. The incidence of maternal hypotension was significantly higher in group SAB ($P=0.013$). The intraoperative quality of anesthesia was judged by the gynecologist was excellent in group EAC and SAB, and by the parturients was only best in group EAC. The parturients felt more comfortable after surgery in group EPB and group EAC.

Discussion

The present study showed that the onset time of spinal anesthesia was the shortest among the three groups. A wider spinal block segment was observed both during spinal anesthesia and epidural block combined with caudal block. The intraoperative quality of anesthesia was judged by the gynecologist was excellent both in group EAC and SAB, but by the parturients was only best in group EAC. The parturients felt more comfortable after surgery in group EPB and group EAC. However patients in group SAB complained of numbness and immobility of lower limbs during and after surgery, and this result in their depression.

Regional blockade has been shown to be superior to general anaesthesia for cesarean section, and the preferred anesthetic technique for cesarean section delivery is neuraxial anesthesia, including spinal anesthesia and epidural block¹⁴. The local anesthetic was instilled in the vertebral subarachnoid space during spinal anesthesia, and the site of local anesthetic administered was proximity to the site of action. This lead to smaller dosage, faster onset, shorter duration of action, more effective and reliable block, and being more popular in cesarean sections compared to epidural anesthesia^{15,16}. In present study, we found that the time to cryanaesthesia at T₁₀ and time to maximum motor block were shorter in group SAB compared to group EBP and EAC, and a better muscle relaxation was considered by Gynecologist during spinal anaesthesia, which is similar to the results described women receiving spinal anaesthesia for caesarean section showed reduced time from start of the anaesthetic to start of the operation¹⁷.

Despite it has so many advantages and is popular with gynecologists, spinal anesthesia can lead to several clinical complications. Hypotension is the most common problem associated with spinal

anesthesia, and treatment for hypotension is more likely when this method is used^{18, 19}. The incidences of hypotension during spinal anaesthesia for cesarean section reported vary from 53 to 85% worldwide²⁰. The possible mechanism of subarachnoid block-induced hypotension is related to spinal nerve sympathectomy, vasodilation of peripheral arteries, decreased venous reflux, and consequently decreased cardiac output²¹. According to the current study findings, the incidence of hypotension was 44% in group SAB. The incidence of hypotension in our study was lower than those reported, maybe due to the parturients being repositioned with left uterine displacement, Pre-infusion sodium chloride solution 500ml, and the level of the blockade less than T₈ during spinal anaesthesia. But the incidence of hypotension was higher in group SAB than group EPB and EAC (rates of hypotension in group EPB and EAC were 20% and 22% respectively). It seemed that maternal haemodynamic was more stable during epidural anesthesia and epidural block combined with caudal block than spinal anesthesia.

Post-dural puncture headache is another well-known iatrogenic complication of spinal anesthesia. The incidence of PDPH is significantly higher in pregnant women and in puerperal period compared to general population²². The incidence rate of PDPH in pregnant women receiving spinal anesthesia for cesarean delivery was 10.8 %^{4,5}. However, recent studies have reported that the rates of PDPH were 5.6% and 17.2%^{23,24}. The difference was mainly due to the use of different types and sizes of puncture needles^{25, 26}. In our study, we used the pencil-point spinal needles and the rate of PDPH was 8%. The occurrence of PDPH was partly caused by some parturients who sat up too early for breastfeeding without having kept supine position for at least 4 hours postoperatively in group SAB. The incidence rates of PDPH in epidural block and epidural block with caudal block were 2% and 1% respectively, which was consistent with the report that inadvertent puncture of the dura mater occurs at a rate of 1.5% during epidural placement, and 76–85% of these obstetric patients develop PDPH²⁷.

A higher risk of postoperative venous thromboembolism was associated with spinal anesthesia, as compared with that associated with epidural anesthesia³. However, ultrasound examinations of the lower limbs were not performed in all parturients in present study. Therefore, it was not clear that the parturients had a venous thromboembolism in our study. Patients in group SAB complained of numbness and immobility of lower limbs during and after surgery, and this result in their depression.

For the deficiencies described above in spinal anaesthesia, epidural blockade anesthesia may be the best choice for parturients undergoing abdominal delivery. But the incidence of unsatisfactory anesthesia that requires intervention is relatively high during epidural anesthesia for cesarean section⁸. According to previous studies²⁸, L₂-L₃ or L₃-L₄ space was selected for epidural puncture for epidural anesthesia in our study. But the quality of anesthesia was judged by the parturients and the gynecologist in group EPB was the worst. The reason maybe that the incision of cesarean section is located between T₁₀-T₁₂, and the surgical operation are mainly performed in the pelvic cavity. Therefore a cesarean delivery anesthetic segment requires at least from the 10th thoracic nerve to sacral nerve. A single point epidural block can rarely achieve such a wide range of nerve blocking. Caudal anesthesia as a supplementary mode of analgesia has been considered more appropriate for gynecological surgery, and many studies have

shown that the application of ultrasound has increased the safety, ease, and consistency of a caudal block analgesia⁹⁻¹². The blockade level is an important factor to determine adequate intraoperative analgesia during regional blocks in cesarean section²⁹. In our study, we changed the epidural puncture point L₂₋₃ or L₃₋₄ to T₁₁-T₁₂ for epidural anesthesia combined with caudal anesthesia, and 10 mL of 0.75% ropivacaine and 20 ml of 0.25% ropivacaine were administered in epidural and sacral canal respectively. The intraoperative quality of anesthesia was judged by the parturients and the gynecologist was as better as that in spinal anesthesia. Though the time to maximum motor block and time cryanaesthesia at T₁₀ were 7 minutes delayed in group EAC compared with group SAB, the duration of surgery were similar in group SAB and EAC.

Breastfeeding has proven many clinical benefits for the infants, including improvement in the gastrointestinal function, host defense, and intelligence-test scores^{30,31}. Patients undergoing spinal anesthesia for cesarean section has greater number of breastfeeding problems during the postpartum period, and parturients after cesarean section tended to breastfeed less often after the first day postpartum than parturients after vaginal delivery³². Although the effects of spinal anesthesia on breastfeeding during the early postpartum period wasn't investigated in our study, the parturients received subarachnoid block complained about being positioned supine for at least 4 hours after surgery, and unable to sit up for breastfeeding during this time. In the group EBP and EAC, the parturients did not need to be supine for 4 hours and their lower limbs could move freely. This is helpful for delivery women to early postoperative breastfeeding.

There are limitations in our study. Firstly, Previous studies have reported that epidural anesthesia was associated with a lower risk of postoperative venous thromboembolism³, as compared with that associated with spinal anesthesia. The reason is the superior pain relief afforded by epidural analgesia, which facilitates the early postoperative mobilization of patients. Patients received epidural block in present study could move their leg early postoperatively, while patients undergoing spinal anesthesia were unable to do so. All the patients in this study were not performed the ultrasound examinations, and the postoperative thromboembolic events were unclear. Secondly, Infants who initiated breastfeeding within an hour of birth had a 33% lower risk of neonatal mortality compared to infants who initiated breastfeeding between 2–23 hours after birth³³. Some parturients received subarachnoid block complained about being positioned supine for at least 4 hours after surgery, and unable to sit up for breastfeeding during this time. This maybe have a negative effect on the infants whose mother receiving spinal anesthesia. But we didn't demonstrate the effects of both spinal anesthesia and epidural anesthesia on breastfeeding during the early postpartum period.

In conclusion, epidural block combined with caudal block anesthesia can achieve the same anesthetic effect as spinal anesthesia which is better than a single point epidural block anesthesia for elective cesarean section, and have the highest level of intraoperative and postoperative comfort for parturient.

Declarations

Conflicts of Interest: None

IRB Information: This study was approved by the IRB at the Affiliated Hospital of North Sichuan Medical College(IRB 2016ER(R)-002), Contact: IRB specialist; Mingcai Zhao, Phone: 86-0817-2262124 and written informed consent had been obtained from all subjects participating in the trial. This study was registered prior to patient enrollment at the Chinese Clinical Trial Registry(Principal investigator: Fangjun Wang, Date of registration: July 28 2016), Registry URL:<http://www.chictr.org.cn/>; Registration number: ChiCTR-INR- 16008933.

References

1. Maronge L, Bogod D. Complications in obstetric anaesthesia. *Anaesthesia*. 2018; 73 :61-6.
2. Huang CH, Hsieh YJ, Wei KH, Sun WZ, Tsao SL. A comparison of spinal and epidural anesthesia for cesarean section following epidural labor analgesia: A retrospective cohort study. *Acta Anaesthesiol Taiwan*. 2015; 53(1): 7-11.
3. Nakamura M, Kamei M, Bito S, et al. Spinal anesthesia increases the risk of venous thromboembolism in total arthroplasty: Secondary analysis of a J-PSVT cohort study on anesthesia. *Medicine (Baltimore)*.2017; 96(18):e6748.
4. Yousefshahi F, Dahmardeh AR, Khajavi M, Najafi A, Khashayar P, Barkhordari K. Effect of dexamethasone on the frequency of postdural puncture headache after spinal anesthesia for cesarean section: a double-blind randomized clinical trial. *Acta Neurol Belg*. 2012; 112(4):345-50.
5. L'ubuský M, Berta E, Procházka M, Marek O, Kudela M. Development of incidence of post-dural puncture headache in patients undergoing caesarean section in spinal anaesthesia at the Department of Obstetrics and Gynecology in Olomouc during 2003-2004. *Cas Lek Cesk*. 2006; 145(3):204-8.
6. Shaikh JM, Memon A, Memon MA, Khan M. Post dural puncture headache after spinal anaesthesia for caesarean section: a comparison of 25 g Quincke, 27g Quincke and 27g Whitacre spinal needles. *J Ayub Med Coll Abbottabad*. 2008; 20(3):10-3.
7. Krommendijk EJ, Verheijen R, Van Dijk B, Spoelder EM, Gielen MJM, De Lange JJ. The PENCAN 25-gauge needle: a new pencil-point needle for spinal anesthesia tested in 1,193 patients. *Regional Anesthesia and Pain Medicine*. 1999; 24(1):43–50.
8. Portnoy D, Vadhera RB. Mechanisms and management of an incomplete epidural block for cesarean section. *Anesthesiol Clin North America*. 2003; 21(1):39-57.

9. Tsuchiya M, Kyoh Y, Mizutani K, Yamashita J, Hamada T. Ultrasound-guided single shot caudal block anesthesia reduces postoperative urinary catheter-induced discomfort. *Minerva Anesthesiol.* 2013;79(12):1381-8.
10. Jöhr M, Berger TM. Caudal blocks. *Paediatr Anaesth.* 2012; 22(1):44-50.
11. Ahiskalioglu A, Yayik AM, Ahiskalioglu EO, et al. Ultrasound-guided versus conventional injection for caudal block in children: A prospective randomized clinical study. *J Clin Anesth.* 2018; 44: 91-6.
12. Abukawa Y, Hiroki K, Morioka N, et al. Ultrasound versus anatomical landmarks for caudal epidural anesthesia in pediatric patients. *BMC Anesthesiol.* 2015; 15:102.
13. Kuusniemi KS, Pihlajamäki KK, Pitkänen MT, Helenius HY, Kirvelä OA. The use of bupivacaine and fentanyl for spinal anesthesia for urologic surgery. *Anesth Analg* 2000; 91(6): 1452-6.
14. Afolabi BB, Lesi FE. Regional versus general anaesthesia for caesarean section. *Cochrane Database Syst Rev.* 2012; 10:CD004350.
15. Skjellerup N. Successful spinal anaesthesia for caesarean section in a patient with Marfan syndrome complicated by dural ectasia. *Int J Obstet Anesth.* 2018; 35:88-92.
16. Hollis N. Hyperbaric vs. isobaric bupivacaine for spinal anaesthesia for elective caesarean section. *Anaesthesia.* 2018; 73(6):790-1. [PMID: 29747229]
17. Schewe JC, Komusin A, Zinserling J, Nadstawek J, Hoeft A, Hering R. Effects of spinal anaesthesia versus epidural anaesthesia for caesarean section on postoperative analgesic consumption and postoperative pain. *Eur J Anaesthesiol.* 2009; 26(1):52-9.
18. Lee MH, Kim EM, Bae JH, Park SH, Chung MH, Choi YR, et al. Head Elevation in Spinal-Epidural Anesthesia Provides Improved Hemodynamics and Appropriate Sensory Block Height at Caesarean Section. *Yonsei Med J.* 2015;56(4):1122-7.
19. Kinsella SM, Carvalho B, Dyer RA, Fernando R, McDonnell N, Mercier FJ, et al. International consensus statement on the management of hypotension with vasopressors during caesarean section under spinal anaesthesia. *Anaesthesia.* 2018;73(1):71-92.
20. Oofuvong M, Kunapaisal T, Karnjanawanichkul O, Dilokrattanaphijit N, Leeratiwong J. Minimal effective weight-based dosing of ondansetron to reduce hypotension in cesarean section under spinal anesthesia: a randomized controlled superiority trial. *BMC Anesthesiol.* 2018; 18(1):105.
21. Ngan Kee WD. A Random-allocation Graded Dose-Response Study of Norepinephrine and Phenylephrine for Treating Hypotension during Spinal Anesthesia for Cesarean Delivery. *Anesthesiology.* 2017; 127(6):934-41.
22. Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. *British Journal of Anaesthesia.* 2003; 91(5):718–29.
23. Loures V, Savoldelli G, Kern K, Haller G. Atypical headache following dural puncture in obstetrics. *Int J Obstet Anesth.* 2014; 23(3):246-52.
24. Yang CJ, Chen T, Ni X, Yu WY, Wang W. Effect of pre-administration with aminophylline on the occurrence of post-dural puncture headache in women undergoing caesarean section by combined

- spinal-epidural anaesthesia. *J Int Med Res.* 2018;300060518803231. [Epub ahead of print]
25. Schmittner MD, Terboven T, Dluzak M, Janke A, Limmer ME, Weiss C, et al. High incidence of postdural puncture headache in patients with spinal saddle block induced with Quincke needles for anorectal surgery: a randomised clinical trial. *Int J Colorectal Dis.* 2010; 25(6):775-81.
 26. Lee SI, Sandhu S, Djulbegovic B, Mhaskar RS. Impact of spinal needle type on postdural puncture headache among women undergoing Cesarean section surgery under spinal anesthesia: A meta-analysis. *J Evid Based Med.* 2018; 11(3):136-44.
 27. Kwak KH. Postdural puncture headache. *Korean J Anesthesiol.* 2017; 70(2):136-43.
 28. Braga Ade F, Frias JA, Braga FS, Pereira RI, Blumer MF, Ferreira MF. Epidural block for cesarean section: a comparative study between 0.5% racemic Bupivacaine (S50-R50) and 0.5% enantiomeric excess Bupivacaine (S75-R25) associated with Sufentanil. *Rev Bras Anesthesiol.* 2009; 59(3):261-72.
 29. Eley VA, Chin A, Tham I, Poh J, Aujla P, Glasgow E, et al. Epidural extension failure in obese women is comparable to that of non-obese women. *Acta Anaesthesiol Scand.* 2018; 62(6): 839-47.
 30. Belamarich PF, Bochner RE, Racine AD. A Critical Review of the Marketing Claims of Infant Formula Products in the United States. *Clin Pediatr (Phila).* 2016; 55(5): 437-42.
 31. Ajetunmobi OM, Whyte B, Chalmers J, Tappin DM, Wolfson L, Fleming M, et al. Breastfeeding is associated with reduced childhood hospitalization: evidence from a Scottish Birth Cohort (1997-2009). *J Pediatr.* 2015; 166(3):620-5.e4.
 32. İsik Y, Dag ZO, Tulmac OB, Pek E. Early postpartum lactation effects of cesarean and vaginal birth. *Ginekol Pol.* 2016; 87(6):426-30.
 33. Smith ER, Hurt L, Chowdhury R, Sinha B, Fawzi W, Edmond KM. Delayed breastfeeding initiation and infant survival: A systematic review and meta-analysis. *PLoS One.* 2017; 12(7): e0180722.

Tables

Table 1 Characteristics of participants for the three groups

	EPB(<i>n</i> =50)	SAB(<i>n</i> =50)	EAC(<i>n</i> =50)	<i>F</i>	<i>P</i> value
Age(yr)	27.8±5.5	26.5±3.2	27.3±4.0	1.190	0.307
Height(cm)	161.4±6.7	160.2±5.4	159.5±6.3	1.151	0.319
Weight(kg)	67.8±9.5	68.2±9.8	67.1±10.3	0.161	0.852
Gestational age(d)	274.4±8.4	271.6±9.8	272.3±9.8	0.856	0.427
duration of surgery(minutes)	63.2±9.0	56.9±9.6*	57.9±10.2#	6.246	0.002

Values are presented as mean ± SD. EPB: epidural block for cesarean section; SAB: subarachnoid block for cesarean section; EAC: epidural block combined with caudal block for cesarean section; **P*=0.001<0.05 vs EPB, #*P*=0.007<0.05 vs EPB.

Table 2 Initial block characteristics

Group	<i>n</i>	Time to cryanaesthesia at T10(minutes)	Maximal Sensory blockade spinal segments	Maximum motor block	Time to maximum motor block (min)	Time for complete regression of motor block (minutes)
EPB	50	13.66±3.15	10.74±1.77#	1.84±0.93▲	16.04±3.10	155.40±13.28
SAB	50	5.70±1.36*	15.18±0.90	1.22±0.42	7.72±1.37▼	190.00±13.25*
EAC	50	12.20±3.03	14.74±1.16	1.24±0.56	15.06±2.90	160.70±12.58
		100.40	97.03	20.86	100.64	89.96
<i>P</i>		<0.01	<0.01	<0.01	<0.01	<0.01

Values are presented as mean ± SD. EPB: epidural block for cesarean section; SAB: subarachnoid block for cesarean section; EAC: epidural block combined with caudal block for cesarean section. **P*<0.01 vs groups EPB and EAC, #*P*<0.01 vs groups SAB and EAC, ▲*P*<0.01 vs groups SAB and EAC, ▼*P*<0.01 vs groups EPB and EAC, **P*<0.01 vs groups EPB and EAC.

Table 3 Side effects

	EPB[n=50]	SAB[n=50]	EAC[n=50]	<i>P</i>	
maternal bradycardia	1(2)	2(4)	1(2)	0.514	0.773
maternal hypotension	10(20)*	22(44)	11(22)#	8.672	0.013
nausea	5(10)	7(14)	4(8)	0.979	0.613
vomiting	3(6)	4(8)	2(4)	1.515	0.469
Postoperative headache	2(4)	4(8)	1(2)	2.098	0.350

Values are number of patients (%). EPB: epidural block for cesarean section; SAB: subarachnoid block for cesarean section; EAC: epidural block combined with caudal block for cesarean section. * $P=0.01$ vs group SAB, # $P=0.019$ vs group SAB.

Table 4 The quality of anesthesia was judged by the parturients and the gynecologist

Groups	<i>n</i>	parturients					gynecologists				
		1	2	3	4	5	1	2	3	4	5
EPB#	50	3	3	12	20	12	1	3	10	16	20
SAB*▼	50	0	0	14	16	20	0	0	4	12	34
EAC▲	50	0	0	8	12	30	0	0	7	13	30
		13.842					9.880				
<i>p</i>		0.001					0.005				

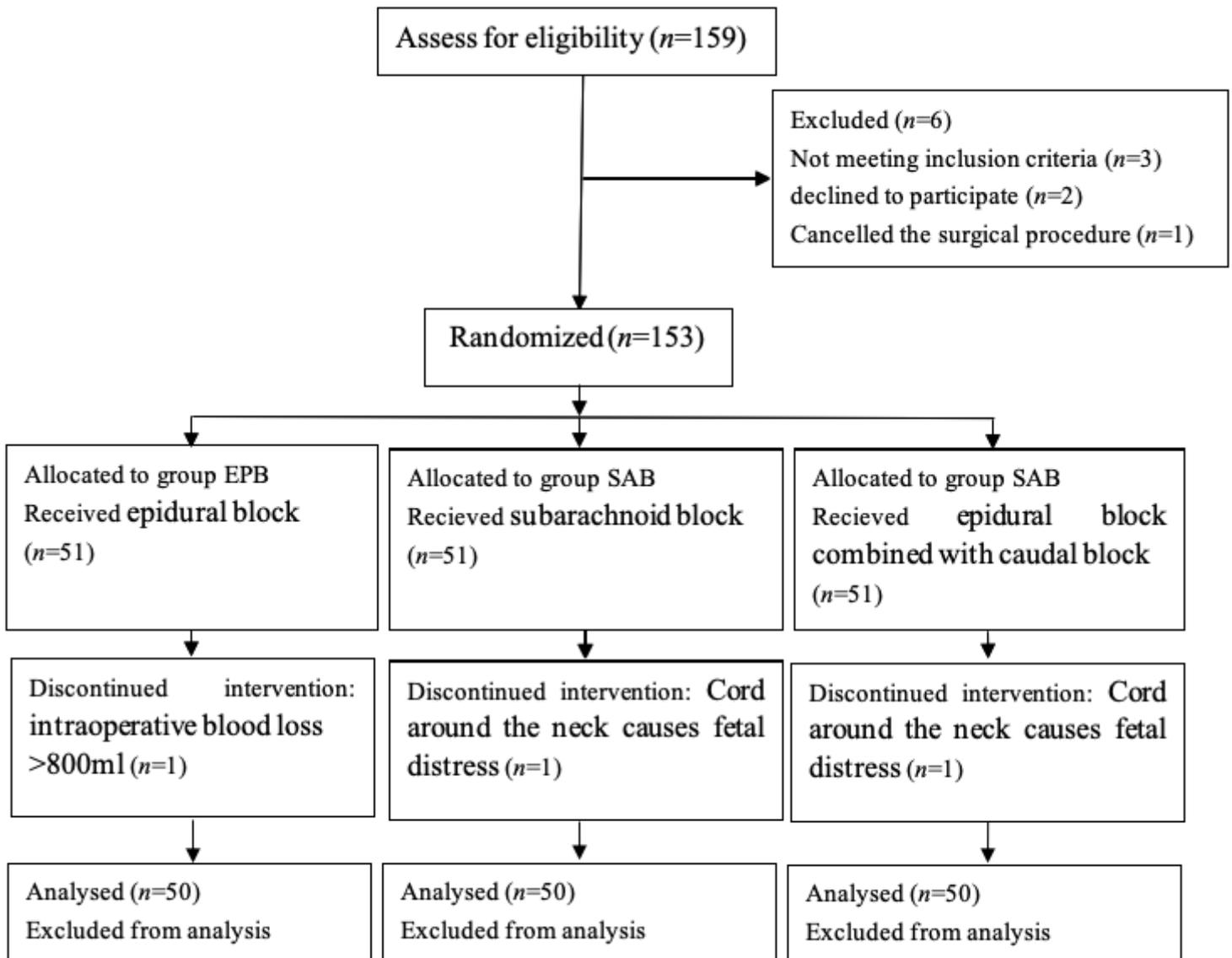
Values are number of patients. EPB: epidural block for cesarean section; SAB: subarachnoid block for cesarean section; EAC: epidural block combined with caudal block for cesarean section. The quality of anesthesia was judged by the parturients, * $P=0.043$ vs group EAC, # $P<0.001$ vs group EAC. The quality of anesthesia was judged by the gynecologist, ▼ $P=0.002$ vs group EPB, ▲ $P=0.025$ vs group EPB.

Table 5 The quality of postoperative comfort

Groups	<i>n</i>	1	2	3	4	5
EPB*	50	0	1	11	10	28
SAB	50	0	3	15	16	16
EAC#	50	0	0	8	12	30
				9.847		
<i>P</i>				0.007		

Values are number of patients. EPB: epidural block for cesarean section; SAB: subarachnoid block for cesarean section; EAC: epidural block combined with caudal block for cesarean section. * $P=0.026$ vs group SAB, # $P=0.003$ vs group SAB.

Figures



Study flow diagram

Figure 1

One hundred and fifty-nine patients were screened for eligibility, three patients whose body mass index (BMI) > 35 kg/m² were excluded, two patients declined to participate and one patients were Cancelled the surgical procedure. 153 patients were subsequently allocated to three groups. During operation, two patients were excluded for cord around the neck causing fetal distress, and one patient was excluded for intraoperative blood loss >800ml. A total of one hundred and fifty patients completed the study (Fig. 1).