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Analgesic effect of ultrasound-guided erector spinae plane block (espb) in general anesthesia for cesarean section: a randomized controlled trial

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Abstract

Background: The analgesic effects of erector spinae plane block in general anesthesia for cesarean section and recovery from puerperae remain unclear.

Methods: Sixty patients with contraindications for spinal anesthesia who required general anesthesia for cesarean section were enrolled and randomly divided into the erector spinal plane block (ESPB) combined with the general anesthesia group (group E) and general anesthesia group (group G). Group E received bilateral ESPB (20 ml of 0.25% ropivacaine on each side) under ultrasound guidance 30 min before general anesthesia. The primary outcomes were the number of patient-controlled intravenous analgesia (PCIA) boluses, and Bruggemann comfort scale (BCS) scores at 2 h, 6 h, 12 h, and 24 h after operation. The second outcome was intraoperative anesthesia dosage, fetal delivery time, puerperae emergence time, visual analog scale (VAS) at 2 h, 6 h, 12 h, and 24 h after operation, and incidence of nausea and vomiting. Heart rate (HR) and mean arterial pressure (MAP) were recorded 10 min before the start of anesthesia (T0), at the induction of anesthesia (T1), at skin incision (T2), and fetal delivery (T3), and immediately after surgery (T4).

Results: The number of PCIA boluses was lower in group E than in group G ($P < 0.001$). The BCS score increased at 2 h and 6 h after the operation in group E ($P < 0.05$), while the VAS score significantly decreased in group E at the same time ($P < 0.05$). Compared with group G, the doses of propofol and remifentanyl were significantly decreased in group E ($P < 0.001$), the emergence time of puerperae was shortened ($P = 0.003$), and the incidence of nausea and vomiting was significantly decreased ($P = 0.014$).

Conclusion: Ultrasound-guided ESPB applied to general anesthesia for a cesarean section can significantly reduce the required dose of general anesthetic drugs, shorten the recovery time of the puerperae, and improve postoperative analgesia.

Trial registration: www.clinicaltrials.gov under the number ChiCTR2200056337 (04-02-2022).

Keywords: Erector spinae plane block, Ultrasound-guided, General anesthesia, Cesarean section

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Background

Several studies have shown China's cesarean section rate has been high in recent years [1]. Spinal anesthesia is still the preferred anesthesia method for cesarean section, with perfect analgesia, good muscle relaxation,



and no adverse effects on the mother or fetus [2, 3]. General anesthesia is suitable for puerperae that are prohibited from spinal anesthesia, especially for those with coagulation disorders, thrombocytopenia, spinal deformity, and other complications. However, it is necessary to maintain a good depth of anesthesia and sufficient analgesia and to consider the impact of anesthesia drugs on the fetus [4]. Total intravenous anesthesia is widely used; however, multimodal analgesia is required to reduce drug use and side effects [5]. Nerve blocks currently used for multimodal analgesia include ultrasound-guided transversus abdominis plane, quadratus lumborum plane, and erector spinae plane blocks [6, 7].

The erector spinal plane block (ESPB) was initially described by Forero et al. to achieve thoracic analgesia during the T5 transverse process [8]. The block is achieved by injecting an anesthetic into the plane between the erector spinae muscle and the transverse process, which can be achieved by blocking the dorsal and lateral branches of the spinal nerve. Recently, ESPB has been widely used in thoracic and lumbar spinal surgery [9, 10]. Few studies have investigated the analgesic effects of ESPB in obstetrics.

This study aimed to evaluate the clinical effect of ESPB in general anesthesia for cesarean section and to investigate whether it would be a part of a multimodal opioid-sparing analgesia procedure in cesarean section.

Methods

Patient enrollment

Sixty participants in our hospital were contraindicated for spinal anesthesia and required general anesthesia for a cesarean section from March 1, 2022, to April 10, 2022, and were selected. The participants were randomly divided into two groups according to a 1:1 ratio through the central randomization network system: the ESPB combined with the general anesthesia group (Group E) and the general anesthesia group (Group G) (Fig. 1). This study was approved by the Ethics Committee of Women and Children’s Hospital of Chongqing Medical University and registered at www.clinicaltrials.gov under the number ChiCTR2200056337(04–02-2022), following the tenets of the Declaration of Helsinki. Written informed consent was obtained from all the participants.

The inclusion criteria were as follows: (1) singleton pregnancy for elective cesarean section; (2) spinal anesthesia prohibited (due to reasons such as spinal

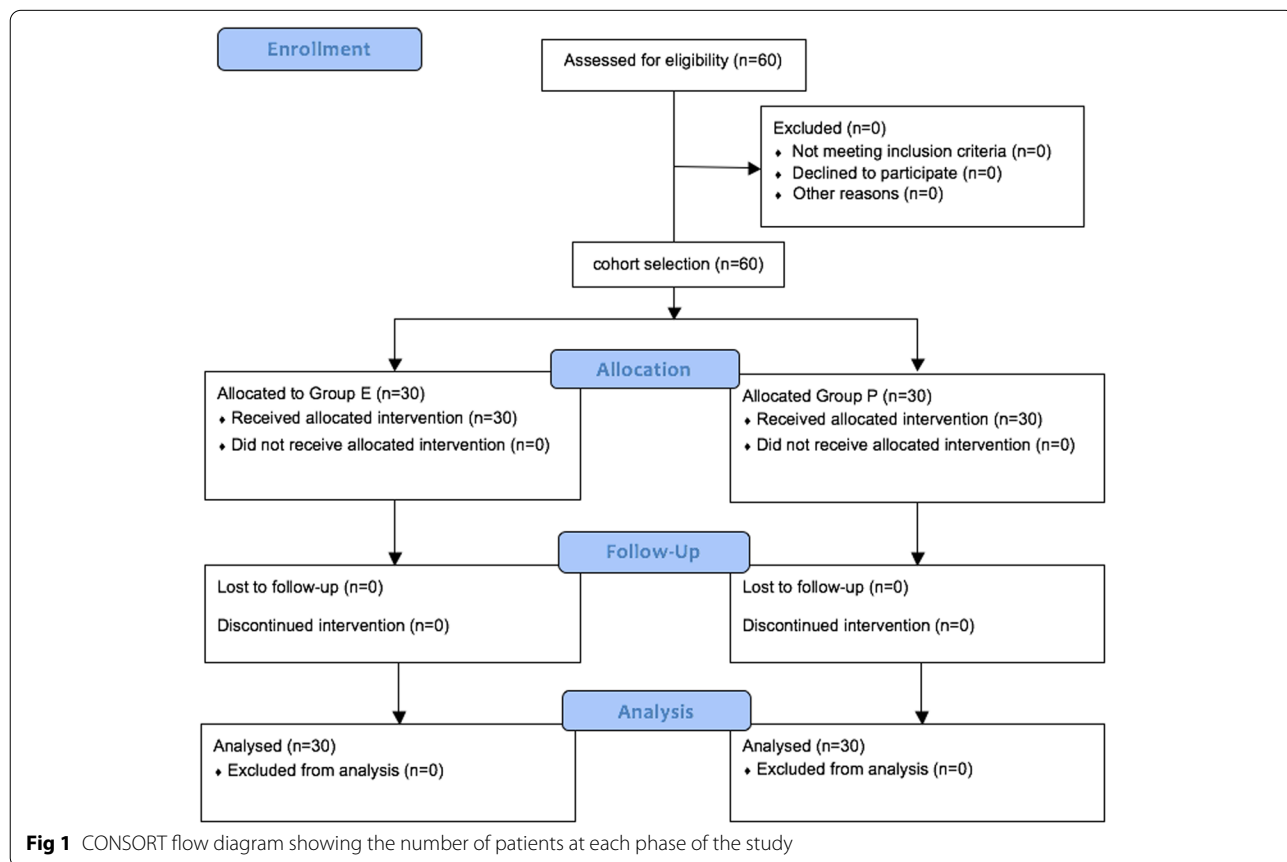


Fig 1 CONSORT flow diagram showing the number of patients at each phase of the study

deformity, spinal trauma, and coagulation dysfunction); (3) American Society of Anesthesiologists grade II; and (4) normal cognitive function.

The exclusion criteria were as follows: (1) allergy to local anesthetics; (2) body mass index (BMI) > 35 kg/m²; and (3) severe heart disease, hypertension, diabetes, etc.

Patient Management

General anesthesia in both groups was performed by total intravenous anesthesia, and anesthesia induction was performed with 4–6 µg/ml propofol and 4–6 ng/ml remifentanyl TCI target-controlled infusion, 0.6 mg/kg rocuronium before endotracheal intubation. Anesthesia was maintained with 2.5–4 µg/ml propofol and 4–6 ng/ml remifentanyl TCI target-controlled infusion. The utility of BIS for sedation management during monitored anesthesia care was maintained within the range of 40–60. After the fetus was delivered, sufentanil 0.2 µg/kg was injected intravenously, and rocuronium was administered during the operation as needed. All patients were transferred to the post-anesthesia care unit after surgery. The patient-controlled intravenous analgesia (PCIA) formula comprised fentanyl 0.2 mg + tramadol 80 mg + dexamethasone 10 mg to 100 mL 0.9% normal saline, with a 2 mL/h background infusion and a 2 mL bolus dose, with a lock time of 15 min.

Group E: Thirty minutes before induction of general anesthesia, bilateral ESPB was performed under ultrasound guidance by the same anesthesiologist in the preparation room for anesthesia. The patients were instructed to remain in the lateral decubitus position. The ultrasound probe was placed on the spinous process of the 9th thoracic vertebra along the short axis. Subsequently, the probe was slid slightly in the lateral direction until the transverse processed image was visible. With subcutaneous infiltration of 3 mL of 2% lidocaine, a 22G blunt needle (Spinocan, B. Braun Melsungen AG, Germany) was introduced from the outside toward the transverse process (T9) using the in-plane method until the needle tip crossed all the muscles. Subsequently, 20 ml of 0.25% ropivacaine was injected between the transverse process and the deep surface of the erector spinae on each side.

Group G: with no ESPB.

Pain measurements and outcomes

Heart rate (HR) and mean arterial pressure (MAP) were recorded 10 min before the start of anesthesia (T0), at the induction of anesthesia (T1), at skin incision (T2), at fetal delivery (T3), and at the end of the operation (T4). The intraoperative propofol and remifentanyl dosages, fetal delivery time, and emergence time were recorded. The VAS and BCS comfort scores of patients were measured at 2 h, 6 h, 12 h, and 24 h after the operation. The VAS

score is ranked on a point system from 0–10; 0 points: no pain; less than 3 points: mild pain, which the patient can tolerate; 4–6 points: pain that affects sleep but can be tolerated; 7–10 points: the patient has increasingly severe pain that is unbearable. The BCS comfort score was ranked as follows: 0, persistent pain; 1, no pain at rest; severe pain when breathing or coughing; 2, no pain at rest; mild pain during breathing or coughing; 3, no pain during deep breathing; 4, no pain during deep breathing and coughing; record the number of PCA boluses within 24 h after surgery; and record the incidence of nausea and vomiting within 24 h after the operation. All data were obtained by the same anesthesiologist, who was blinded to the group assignment and was not involved in implementing the nerve block.

Statistical analysis

The sample size estimation was based on the number of PCA boluses within 24 h of the pilot study by our team. To detect a 20% change in PCA boluses with an error of 0.05 and a power of 80%, the minimum sample size was found to be 23 patients per group. Thirty patients were enrolled in each group to account for dropouts.

SPSS 20.0 statistical software was used for data analysis, normally distributed measurement data were expressed as mean ± standard deviation (intraoperative propofol and remifentanyl dosages, fetal delivery time, and emergence time) or as number (%) (incidence of nausea and vomiting), paired t-test was used for intra-group comparison, group t-test was used for inter-group comparison. A two-way repeated-measures analysis of variance with the Bonferroni post hoc -test was used to compare the VAS, hemodynamic variables, and BCS within and between the two groups. Statistical significance was defined as $P < 0.05$.

Results

There was no significant difference in age, weight, height, or gestational age between the two groups of patients, as shown in Table 1. Compared with T1, T2, and T3 in group G, MAP and HR were significantly increased ($P < 0.05$) and were higher than those in group E at the same time point ($P < 0.05$), and there was no statistically significant difference between the T1, T2, and T3 groups in group E ($P > 0.05$) (Fig. 2).

The dosages of propofol and remifentanyl in group E were significantly lower than those in group G ($P < 0.001$), and the emergence of group E was significantly shorter than that in group G ($P = 0.003$). There was no significant difference in the fetal delivery time between the two groups ($P > 0.05$) (Table 2).

Table 2 also compares PCA use and the incidence of nausea and vomiting between the two groups. Compared

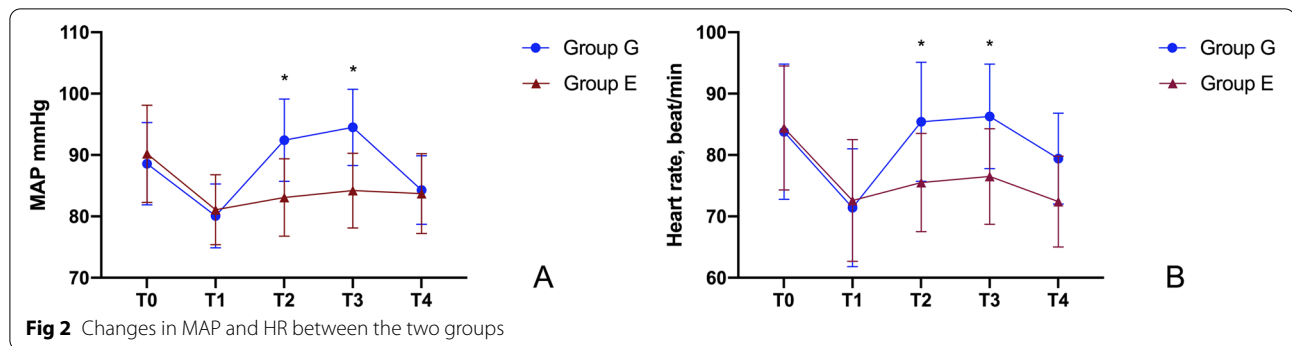


Table 1 Characteristics

Variables	Group G(n=30)	Group E(n=30)	P
Age, yr	28.4 ± 4.7	28.8 ± 4.6	0.336
Height, cm	160.7 ± 4.5	159.4 ± 4.0	0.562
Weight, kg	69.1 ± 9.8	68.3 ± 9.1	0.295
Gestational weeks	38.8 ± 1.3	38.7 ± 1.2	0.671

Table 2 Intraoperative and postoperative related indicators

Variables	Group G(n=30)	Group E(n=30)	P
propofol, mg	478.8 ± 69.0	413.2 ± 52.9 ^a	<0.001
remifentanil, ug	523.7 ± 69.0	446.9 ± 57.1 ^a	<0.001
delivery time, min	5.0 ± 1.5	4.8 ± 1.7	0.307
emergence time, min	12.1 ± 4.6	9.8 ± 3.5 ^{a>}	0.003
bolus of PCIA	11.2 ± 2.1	5.3 ± 1.7	<0.001
PONV	7(23.3%)	3(10%)	0.014

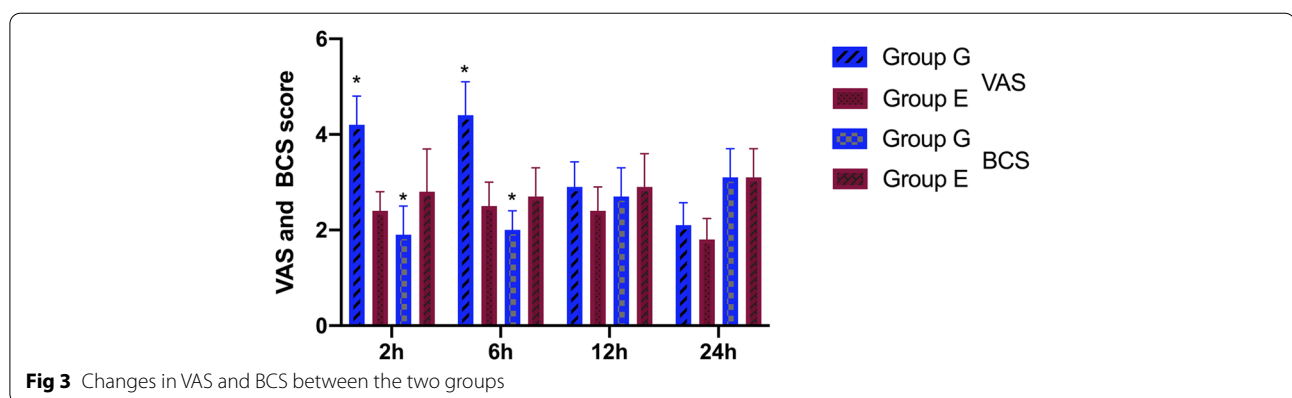
^a statistical difference when compared with group G

with group G, the VAS score of group E was significantly lower at 2 h and 6 h after the operation, while the BCS comfort score was significantly higher ($P < 0.05$).

Discussion

This study evaluated the analgesic effect of ESPB in general anesthesia for cesarean section as part of a multimodal opioid-sparing analgesia procedure. We found that erector spinae plane block combined with general anesthesia could reduce the use of intraoperative and postoperative analgesics and improve postoperative comfort compared with general anesthesia alone. Meanwhile, multimodal analgesia with the addition of erector spinae plane blocks could also obtain more stable intraoperative hemodynamic indicators and reduce the incidence of postoperative nausea and vomiting.

For women who have contraindications to spinal anesthesia and can only choose general anesthesia, the choice of anesthetic drugs and postoperative analgesia is particularly important. It is necessary to meet the appropri-



to group G, group E required fewer bolus doses, and the incidence of nausea and vomiting significantly decreased ($P < 0.014$).

The comparison of the VAS and BCS comfort scores between the two groups is shown in Fig. 3. Compared

ate depth of anesthesia, suppress the stress response of surgery, and avoid maternal awareness during surgery. Considering the potential dangers of general anesthetic drugs to mothers and babies, the safety of neonates in general anesthesia obstetrics has always been a research

hotspot [11]. Anesthetics easily pass through the placenta, and higher doses of general anesthetics may inhibit neonatal breathing [12]. Many studies have been conducted to determine whether general anesthesia affects neonatal neurobehavioral abilities; however, the results are conflicted. Therefore, the anesthetic dosage should be minimized to avoid fetal damage. Local anesthesia is an important component of multimodal analgesia, with limited effects, precise effects, and little impact on the mother and baby [13]. In addition, studies have shown that the neurotoxicity of ropivacaine in TAPB during cesarean section may be related to increased plasma protein binding of ropivacaine during pregnancy [14]. Therefore, in this study, ESPB was selected for the ninth thoracic vertebrae, and 20 ml of ropivacaine at a low concentration of 0.25% was unilaterally administered to ensure the block effect and prevent neurotoxicity.

Currently, the erector spinae plane block is widely used in clinical practice, whether for perioperative analgesia or chronic pain management. Frassanito et al. used ESPB in laparoscopic hysterectomy, which can reduce the dosage of anesthetics, shorten recovery time, and relieve postoperative pain [15]. Postmastectomy pain syndrome (PMPS) is a common complication that occurs in 20%–44% of patients after breast surgery and is often challenging to manage. Hasoon et al. verified that ESPB could be utilized to provide analgesia to patients suffering from this difficulty in managing the condition [16]. Meanwhile, some studies compared ESPB with other nerve blocks in cesarean section, but the results differed. Hamed et al. confirmed that ESPB has a successful postoperative analgesic effect and may limit opioid consumption in parturients compared to intrathecal morphine (ITM) for analgesia after elective cesarean delivery under spinal anesthesia [17]. Boules and Malawat verified that the ESP block provided prolonged analgesia with a significant decrease in analgesic requirement compared with the TAP block [18, 19]. However, a recent Bayesian network meta-analysis showed that erector spinae block could reduce pain scores at 6 and 12 h. Still, TAPB is the most comprehensive local anesthetic technique for postoperative cesarean section analgesia [5].

Our research has some limitations. The sample size was small, and we strive to conduct a larger sample study and a deeper discussion on the mechanism of action in the future.

In conclusion, ESPB used in general anesthesia for cesarean section can significantly reduce the dosage of general anesthesia, shorten the recovery time, improve the postoperative analgesic effect, and improve the perioperative comfort of the puerpera while ensuring the safety of mothers and their babies.

Abbreviations

ESPB: Erector spinae plane block; HR: Heart rate; MAP: Mean arterial pressure; VAS: Visual analog scale; BCS: Bruggemann comfort scale; PCIA: Patient-controlled intravenous analgesia; ESM: Erector spinae muscle; PCIA: Patient-controlled intravenous analgesia; PONV: Postoperative nausea and vomiting.

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None

Authors' contributions

J. H. and Q. C. conceived of and coordinated the study. Q. X. and Y. S. performed the experiments. Q. X. and Y. S. collected and analyzed the data. J. H. and Q. C. prepared the manuscript. K.W and X.F. L edited the manuscript. All authors have read and approved the final manuscript.

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Availability of data and materials

The data analyzed and preserved during the current study are available from the corresponding author upon reasonable request via e-mail.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Chongqing Health Center for Women and Children, affiliated with the Chongqing Medical University. Written informed consent was obtained from all the patients.

Consent for publication

NA

Competing interests

The authors declare that they have no competing interests.

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