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ORIGINAL RESEARCH PERIOPERATIVE MEDICINE

Erector spinae plane block vs. single shot epidural block for postoperative analgesia in lumbar spine surgery: a randomized controlled trial

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Abstract

Background: Epidural block is an effective route for analgesia in spine surgeries. Erector spinae plane block (ESPB) is a field block that showed promising results in various surgeries. We compared both procedures in spine surgery, regarding postoperative pain, the time to first analgesic request, postoperative total morphine consumption, perioperative hemodynamics, and any adverse events.

Methodology: Sixty-seven patients were enrolled in this double-blinded randomized controlled study. Patients were allocated into two groups. The epidural group received an ultrasound-guided single-shot epidural block with 20 mL of 0.25% bupivacaine. The ESPB group received an ultrasound-guided bilateral single-shot ESPB with 20 mL of 0.25% bupivacaine for each side. Postoperative pain, the time to first analgesic request, postoperative total morphine consumption, perioperative hemodynamics, and any adverse events were recorded.

Results: The time to the first analgesic requirement was longer in the ESPB group (11.5 [9-14] h, vs. 7 [5-8] h, $P < 0.001$). The mean morphine consumption was lower in the ESPB group (3.88 ± 0.54 vs. 7.12 ± 1.94 mg; $P < 0.001$). The numeric rating scale was lower in the epidural group. Less patients experienced intraoperative hypotension and tachycardia in ESPB group.

Conclusion: ESPB provides longer postoperative analgesia, less opioid consumption, and more intraoperative hemodynamic stability when compared with a single-shot epidural block in lumbar spine surgery.

Trial registration: The ethical approval was obtained from the Research Ethics Committee of Cairo University (M D-82-2019), and the trial was registered on www.clinicaltrials.gov with registration number (NCT04320212). https://clinicaltrials.gov/ct2/show/NCT04320212

Abbreviations: ESPB - Erector spinae plane block; LA - Local anesthetics

Key words: Erector spinae plane block; Pain, Postoperative; Spine surgery; Analgesia, Epidural; Fascial plane blocks; Neuraxial analgesia

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1. Introduction

Spine and spinal cord surgeries are common and are performed for a wide variety of diseases. [1] One of the major problems that the patients face when undergoing spine surgeries is severe postoperative pain. Studies have shown that the incidence of moderate to severe acute postoperative pain varies from 30% to 64%. [2] About 57% of spine surgery patients experienced poor postoperative pain control. [3] Postoperative pain leads to increased morbidity. Additionally, it represents a risk factor for the development of chronic pain syndromes. [4] The standard pain management in such cases is usually a combination of intravenous opioids and non-steroidal anti-inflammatory drugs. However, their pain control is sometimes insufficient and side effects may occur. [5]

Epidural analgesia is considered effective for pain control in lumbar spine surgery. However, it may be associated with hemodynamic instability. Migration of the epidural catheter with unpredictable absorption of the local anesthetics (LA) remains a challenge for anesthetists. [5]

One of the simplest and safest analgesic techniques is the erector spinae plane block (ESPB). This technique blocks the dorsal and ventral rami of the thoracic and lumbar spinal nerves and offers effective analgesia in patients undergoing lumbar spine surgery. [6]

Regional anesthesia is one of the main pillars of the multimodal approach for postoperative pain control. Epidural block carries its own specific hazards. Finding an effective alternative with a satisfactory analgesia and fewer side effects is a golden aim for anesthetists.[7] Till the time of the conduction of this trial, there were no similar studies comparing the analgesic characteristics of both techniques in lumbar spine surgeries.

We hypothesized that the ESPB will prolong the duration of post-operative analgesia more than the lumbar epidural analgesia in patients undergoing lumbar spine surgery.

We compared the postoperative analgesic properties of erector spinae plane block vs. single shot epidural block in lumbar spine surgery under general anesthesia.

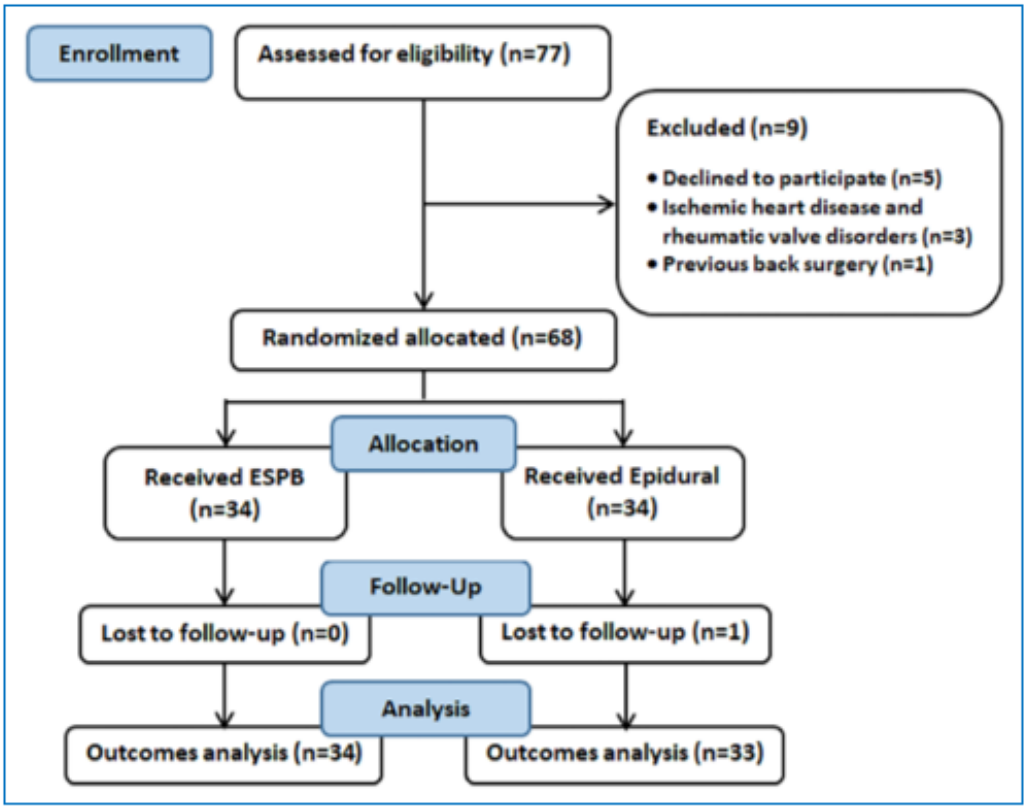

Figure 1: CONSORT flow diagram for patient enrollment.

2. Methodology

This randomized controlled trial was conducted in the orthopedic surgical theatre at Cairo University Hospital from April 2020 to November 2020. Written informed consent was obtained from all patients before enrollment.

We included adult patients (18–60 y), ASA I–II, scheduled for elective single-level lumbosacral spine decompression and fixation surgery, using the posterior approach, under general anesthesia. In a previous study, 8 the time to first analgesic requirement after lumbar spine surgery with epidural analgesia using a bupivacaine injection was found to be 440 ± 185 min. We calculated a sample size that could detect a 30% (132 min) increase in this time with the ESPB, which was 572 ± 185 min. Using G power (version 3.1) software, a minimum number of 32 patients per group was needed to have a study power of 80% and an alpha error of 0.05. The number of envelopes was increased to 34 patients per group to compensate for possible drop-outs.

Our primary outcome was the time to first analgesic requirement, defined as the first recognized time point of NRS over 4 assessed during the first 24 h (calculated from the time of the performance of either the neuraxial or the ESPB). Other outcomes included postoperative total morphine requirements during the first 24 h, postoperative pain assessment, intraoperative and postoperative blood pressure, HR, and any adverse events.

Patients with severe cardiac diseases such as severe ischemic heart disease, tight valve disorders, cardiomyopathy, patient refusal, contraindication to neuraxial anesthesia, hypersensitivity to the LA used, presence of neurologic deficits, preexisting pain symptoms due to neurologic diseases apart from back pain associated with the planned operation, and patients with previous back surgeries were excluded.

Patients were randomly allocated at a 1:1 ratio to either the ESPB group or the epidural group, using a computer-generated random sequence and concealed envelopes that contained group assignments and drug preparation instructions. An experienced anesthetist opened the envelopes, prepared the local anesthetics, and performed the assigned technique with no further involvement in the study. A blinded investigator (an anesthesia and pain therapy specialist) was responsible for perioperative data collection, pain assessment during the first 24 postoperative hours, and providing analgesia. All patients were blinded to the assigned technique.

For all patients who completed the study, the patients arrived at the pre-anesthesia room 1 h before the procedure. The pain was assessed on a Numeric Rate Scale (NRS), and it was explained to all of the patients preoperatively. Preoperative NRS was recorded.

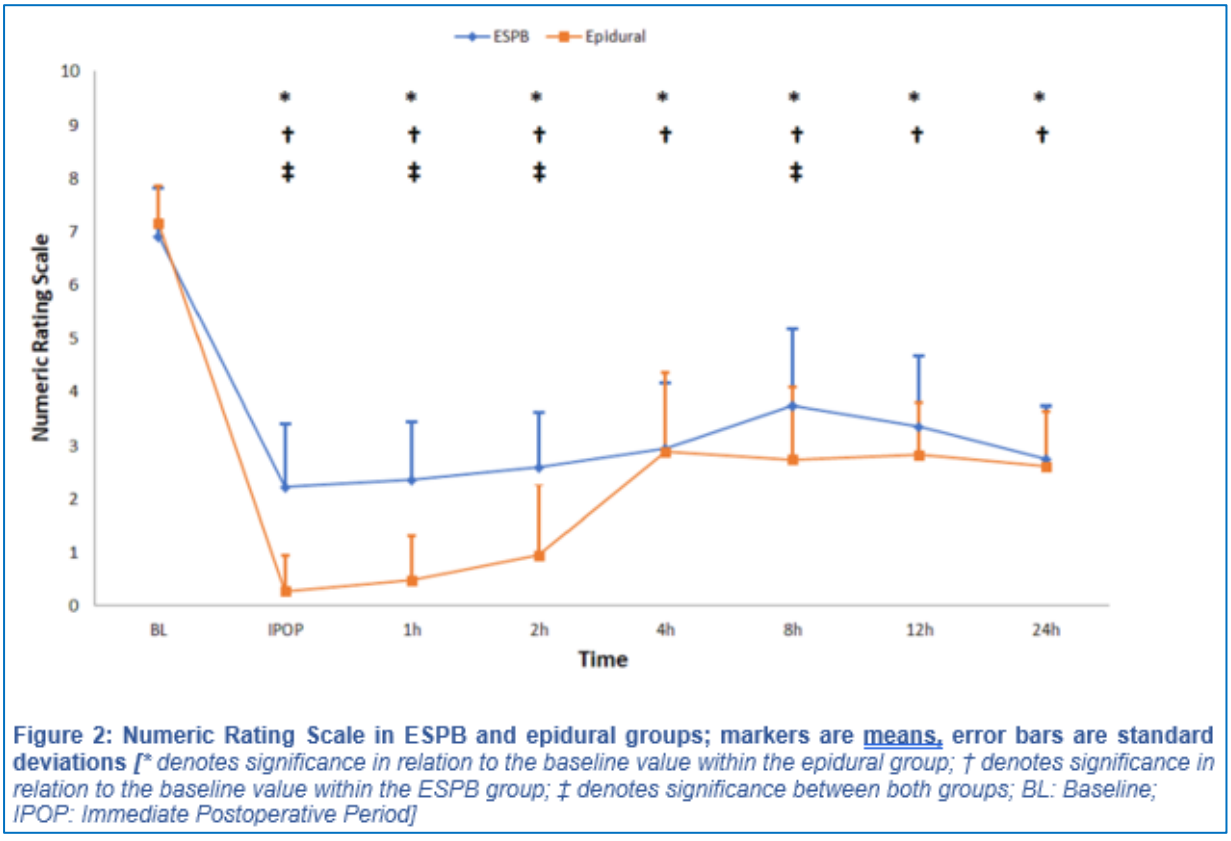

Figure 2: Numeric Rating Scale in ESPB and epidural groups; markers are means, error bars are standard deviations *[* denotes significance in relation to the baseline value within the epidural group; † denotes significance in relation to the baseline value within the ESPB group; ‡ denotes significance between both groups; BL: Baseline; IPOP: Immediate Postoperative Period]*

Baseline vital signs including noninvasive measurement of systolic, mean, and diastolic arterial blood pressures, HR, and SpO_2 were recorded. After inserting an 18G intravenous cannula, the patient was premedicated with midazolam 0.05 mg/kg and metoclopramide at a dose of 0.1–0.2 mg/kg.

Upon arrival in the operating room, standard monitoring (pulse oximetry, electrocardiography, and noninvasive

blood pressure) were applied. General anesthesia was induced by 1.5 µg/kg fentanyl and 2 mg/kg propofol. Tracheal intubation was facilitated with 0.5 mg/kg atracurium, and then, the capnography was connected after intubation. Anesthesia was maintained using isoflurane in 50% oxygen. Additional doses of 0.1 mg/kg atracurium were administrated every 30 min. A urinary catheter was placed.

In the epidural group, each patient was placed in a lateral position, an echogenic 18G Tuohy needle (Perifix® epidural needle) was introduced in the epidural space, using ultrasound, under strict aseptic precautions. A curved array ultrasound probe (1.4–5 MHz frequency) was placed 90° into a transverse orientation and slid cephalad or caudad to obtain the transverse interspinous view two levels above the operation level. The patient received 20 mL of 0.25% plain bupivacaine after negative aspiration for blood or cerebrospinal fluid. The single-shot technique, despite being unfamiliar, avoided the complication of catheter insertion near the surgical wound and field and sped up the recovery of motor power.

In the ESPB group, the ESPB was performed in a prone position two levels above the operation level, a curved array ultrasound probe (1.4–5 MHz frequency) covered with a sterile cover was placed vertically in the midline at the target vertebral level, the spinous processes were identified, and then moved approximately 4–5 cm lateral to the spinous process. The erector spinae muscle and transverse process were identified, an echogenic needle (The Portex® EchoGlo® Peripheral Nerve Block Needle, 22G x 100 mm, 30° bevel, Luer) was advanced after standard skin disinfection in a cephalad-to-caudal direction using the in-plane approach until the tip was between the deep fascia of the erector spinae muscle and the transverse process, and 5 mL of normal saline was injected to confirm the correct needle tip position. The block was performed bilaterally by injecting 40 mL of 0.25% bupivacaine (20 mL into each side).

The ultrasound machine used in all techniques was a Siemens ACUSON X300 Ultrasound System (Siemens Medical Solutions USA, Inc Mountain View, CA 94043 USA, made in Korea, model KT-LM150XD).

The surgical intervention was allowed 20 min after the block. We defined failed block as an increase in the HR and/or the systolic blood pressure (SBP) more than 20% from the baseline on the skin incision. It was treated by a top-up dose of 1 µg/kg of fentanyl, and increasing the isoflurane concentration in case of inadequate response to fentanyl.

At the end of the surgery, patients were extubated after meeting the extubation criteria and were transferred to the post-anesthesia care unit (PACU) for monitoring.

When patients experienced breakthrough pain (NRS more than 4) a pain nurse informed the investigator and rescue analgesia (intravenous morphine 0.05 mg/kg) was given, with a time interval of 30 min at least between the additional doses until NRS became less than or equal to 4.

The pain was assessed using the NRS at rest immediately postoperatively and at 1, 2, 4, 8, 12, and 24 h postoperatively. The total amount of morphine given in the first 24 h was calculated and recorded. All hemodynamic parameters were recorded every 10 min from the skin incision to skin closure and then immediately postoperatively and after 2 and 4 h. Hypotension was defined as a decrease by 20% of the baseline SBP or SBP < 90 mmHg. Tachycardia was defined as a HR ≥ 100 beats per min, and bradycardia was defined as a HR < 60 beats per min. Other

Table 1: Demographic data and baseline characteristics; Data are presented as mean ± SD or numbers (%)

Variable	ESPB Group (n=34)	Epidural Group (n=33)	P value
Age (y)	36.59 ± 11.92	37.06 ± 11.59	0.870
Male Gender	12 (35.3%)	15 (45.45%)	0.460
BMI	28.21 ± 2.85	27.29 ± 2.67	0.179
Baseline vital signs:			
SBP	121.76 ± 10.53	126.76 ± 12.63	0.083
HR	92.94 ± 11.18	91.03 ± 8.32	0.431
Duration of surgery (min)	124.56 ± 12.57	120.00 ± 12.93	0.148

SD - standard deviation; ESPB - Erector Spinae Plane Block; BMI - body mass index; SBP - systolic blood pressure; HR - heart rate.

Table 2: Block characteristics; data presented as mean ± SD, median (quartiles), or numbers (%)

	ESPB group (n = 34)	Epidural group (n = 33)	P-value
First time to rescue analgesia (h)	11.5 (9,14)	7 (5,8)	< 0.001*
Postop morphine consumption (mg)	3.88 ± 0.54	7.12 ± 1.94	< 0.001*
Number of morphine boluses	1 (1,1)	2 (2,2)	< 0.001*
One bolus	34 (100%)	5 (15.15%)	
Two boluses	0 (0%)	27 (81.82%)	
Three boluses	0 (0%)	1 (3.03%)	

*ESPB: Erector Spinae Plane Block; * = statistically significant*

complications such as nausea and vomiting, urinary retention, nerve injury, hematoma formation, local anesthetic toxicity, and intravascular injection were monitored and recorded.

2.1. Statistical analysis

IBM Statistical Package for the Social Sciences (SPSS) software package version 21.0 was used for data analysis. Categorical data were presented as frequency

(%) and analyzed using the Chi-square test. Continuous data were tested for normality using the Shapiro-Wilk test. Normally distributed data were presented as mean and standard deviation and analyzed using the unpaired t-test for single measures. Skewed data were presented and median [quartiles] and analyzed using the Mann-Whitney test. Two-way repeated measures ANOVA was used to evaluate the type of block (between-groups factor) and time (repeated measures). Bonferroni test was used to adjust for multiple comparisons (SBP and HR). To compare the NRS score between the two groups, a generalized estimating equation (GEE) model was established including the NRS as the dependent variable and the group and time as the independent variables. To evaluate the change in relation to the preoperative NRS in each group the time variable was treated as a categorical variable using the preoperative value as the reference. To compare NRS at each time point between the two groups univariate ANOVA test was used. A P-value of 0.05 was considered statistically significant. All figures were performed by Microsoft Office Professional Plus 2010 version 14.0.4760.1000 © 2010 Microsoft Corporation.

3. Results

Seventy-seven patients were screened for eligibility; nine patients were excluded because they did not satisfy the study's inclusion criteria and one patient was lost to follow-up in the epidural group. Sixty-seven patients were available for final analysis and randomized to receive one of the two interventions (Figure 1). We did not observe any case of failed block in either group. Demographic data, baseline hemodynamic characteristics, and the duration of surgery were comparable between the two groups (Table 1).

The time to first analgesic requirement (NRS over four) during the first 24 h, was significantly longer in the ESPB group than in the epidural group (median [quartiles]: 11.5 [9, 14] h and 7 [5, 8] h, respectively; P < 0.001). The longest time to first analgesic requirement (NRS over 4) was 23 h in ESPB group. The morphine consumption in the first 24 h was lower in the ESPB group than in the epidural group (mean [SD]: 3.88 [0.54] mg and 7.12 [1.94] mg, respectively; P < 0.001) (Table 2).

The NRS pain score decreased postoperatively in both groups when compared to the baseline throughout all assessment time points. The NRS scores were lower in the epidural group than the ESPB group by -0.88 (-1.2 to -0.6) points, P < 0.001, it was lower in the epidural group immediately postoperative and at 1, 2, and 8 h. However, at 4, 12, and 24 h, both groups were comparable (Figure 2). The rescue analgesia was required for both groups at points between the predestined time of assessment and by the time of the next assessment the morphine administered has already decreased the pain. That is why the graph shows NRS of lower than 4 all through.

The incidence of intraoperative hypotension and tachycardia was higher in the epidural group compared to the ESPB group, e.g., 81.8% vs. 52.9% (P = 0.019) and 30.3% vs. 5.9% 9P = 011) respectively. However, there were no differences between both groups regarding the incidence of intraoperative bradycardia and postoperative hypotension, bradycardia, and tachycardia.

No postoperative complications, such as PONV, hematoma, sensory and motor deficits, were recorded.

4. Discussion

In the present study, we found that bilateral ESPB provided longer postoperative analgesia and less

morphine consumption during the first 24 h when compared with an epidural block. Further, ESPB offered a more stable hemodynamic profile with a lower incidence of hypotension and tachycardia when compared with the epidural block.

ESPB is a new para-spinal block technique, first introduced in 2016 for the management of chronic neuropathic chest pain. [7] It was proved to be effective in controlling postoperative pain in various breast, abdominal, thoracic, and hip surgeries. [9] It is performed by injecting LA between the deep fascia of the erector spinae muscle and the transverse processes of the vertebrae.

In our study, the quality of analgesia was better in the epidural group than the ESPB group as indicated by the lower NRS in the epidural group during the early postoperative (time points: IPOP, after 1 and 2 h). This difference could be explained as the ESPB being an interfacial plane block, might spread slow targeting the dorsal and ventral rami of the spinal nerves, when compared to the epidural block. The ensuing nerve blockade with the fascial plane blocks may not always be dense or complete. This can be due to the variability inherent in LA spread to the different tissue planes and para-spinal compartments blocking the branches of the dorsal rami at proximal and distal locations. [10]

The epidural analgesia is a well-established and highly effective block in which the LA spreads from the epidural space to the spinal cord, nerve roots, and the cerebrospinal fluid. [11]

Our results are in line with previous reports on the ESBP in lumbar spine surgery in which the block was compared with various analgesic regimens, such as intravenous opioid analgesia [12] and a mid-transverse process to pleura block. [13] Only one study showed no difference in pain scores between patients who received an ESPB and those who did not, and the authors attributed this result to the small volume of local anesthetic that was injected. [14]

The two blocks have previously been compared for other surgeries, such as cardiac and thoracic surgeries, in which the recorded VAS scores were comparable in both groups during the early postoperative period. [15,16] This difference from our results could be explained by the anatomical differences between thoracic and lumbar paravertebral spaces. [17] In the thoracic region, the clear anatomical boundaries cause even a small amount of LA to spread cranially and caudally causing multilevel analgesia. [18] Conversely, in the lumbar region, the paravertebral space does not have such clear boundaries; thus, the LA spreads to the anterior of the paravertebral space surrounding the psoas muscle and lumbar plexus. This could make the ESPB less dense in the lumbar region.

Epidural analgesia has been studied in patients undergoing spine surgery. [19] However, epidural analgesia may be associated with possible complications; such as dural puncture and epidural hematoma ([20]). Moreover, the postoperative motor blockade that may accompany epidural analgesia could interfere with postoperative neurological assessment. This may delay the diagnosis and management of postoperative surgical complications. [21] Thus, other alternative techniques that obviate these complications are warranted.

The blockade of the rami communicantes in the ESPB causing sympathetic fibers to be blocked could produce systemic hypotension, but to a lesser extent than the epidural block. [22] This is consistent with our results. The higher incidence of hypotension with epidural and paravertebral blocks had been previously reported when compared with ESPB. [16, 23] This supports the safety of the ESPB in vulnerable, high-risk, and elderly groups of patients, [24] with a low cardiovascular reserve in whom a sympathetic blockade could result in extensive hypotension and hypo-perfusion.

The ESPB could be considered an effective alternative to epidural analgesia in lumbar spine surgery with satisfactory analgesia and fewer side effects. It is an easy technique to perform, since the transverse process is an obvious sonographic landmark, acting as a backstop for the needle, and it is not difficult to direct the needle toward it. The risk of complications in this technique is low as the target site of the block is far from the important structures (such as the main vessels, pleura, or the medulla). Furthermore, the prolonged analgesia provided by ESPB makes the single-shot LA administration dispensable and the problems associated with catheter use could be avoided, e.g., catheter dislodgment and leakage. [9]

Spine surgery is among the most painful surgical procedures, with median pain scores (using the 0–10 NRS) on the first postoperative day ranging from 5 (spinal decompression) to 7 (spinal fusion). [25] Systemic analgesia is commonly used during and after spine surgery; however, systemic analgesics alone are usually not sufficient to produce complete postoperative pain control, probably because of the concerns of safety and complications that restrict their dosage.

5. Limitations

We were unable to test the extent of the sensory block as the patients were under general anesthesia. Additionally, the dynamic NRS could not be measured as some

surgeons were against the early mobilization of the patients.

6. Conclusion

The ESPB provided longer analgesia and less opioid consumption during the first 24 postoperative hours when compared with a single-shot epidural block in lumbar spine surgery, with a lower incidence of intraoperative hypotension and tachycardia.

6. Future direction

The result of our study warrants further investigation with the inclusion of a wider spectrum of spine surgery operations.

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8. Conflict of interest

The authors report no conflict of interest

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10. Data availability

The numerical data related to this study is available with the authors.

11. Authors' contribution

HS, HA, and SA were responsible for the conception of the idea. AK, HS, and SA shared in the design of the study. HA and AK were responsible for data collection, analysis and interpretation, and writing the manuscript. All authors have read, revised, and approved the final manuscript. The corresponding author agreed to be accountable for all aspects of the work.

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