Original Article

Erector spinae plane block for post-operative analgesia in thoracolumbar spine surgery: A randomised controlled trial

Address for correspondence:
Dr. Jasveer Singh,
Department of Anaesthesia and Intensive Care, Government Medical College and Hospital, Sector- 32, Chandigarh - 160 030, India.
E-mail: drjassy18@gmail.com

Submitted: 21-Apr-2023
Revised: 04-Sep-2023
Accepted: 05-Sep-2023
Published: 07-Nov-2023

Access this article online

Website: https://journals.lww.com/ijaweb

DOI: 10.4103/ija.ija_357_23

Quick response code

Seerat Chiraya, Jasveer Singh[1], Sukanya Mitra[1], Arvind Malhotra[2], Mohit Kishore Srivastava[3], Samra Fatima[1]

Departments of Anaesthesiology, [3]Physical Medical Rehabilitation, AIIMS Rishikesh, Uttarakhand, Departments of [1]Anaesthesia and Intensive Care, [2]Neurosurgery and Government Medical College and Hospital, Chandigarh, India

ABSTRACT

Background and Aims: Thoracolumbar spine surgery is one of the most painful surgical procedures. This study's primary objective was to evaluate the effect of erector spinae plane (ESP) block on post-operative cumulative morphine consumption at 24 h in patients undergoing thoracolumbar spine surgery. **Methods:** Seventy adults posted for thoracolumbar spine surgery were randomised into the control group [Number of patients (n)=35], who received general anaesthesia without any nerve block, and the intervention group (n = 35), who received bilateral ultrasound (US)-guided ESP block at the level of spine surgery with 0.25% bupivacaine 20 mL after standard general anaesthesia. Along with intravenous patient-controlled analgesia morphine, post-operative analgesia was standardised for both groups. Total morphine consumption, visual analogue scale (VAS) score to evaluate pain, overall patient satisfaction, and any side effects were compared at 24 h. The statistical analysis was done using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL). **Results:** Post-operative total morphine consumption at 24 h was significantly decreased in the intervention group compared to the control group [5.69 (1.549) versus 9.51 (1.634) mg; $P < 0.001$]. Post-operative VAS scores were also significantly decreased in the intervention group at rest ($P < 0.001$) and on movement ($P < 0.001$). Patient satisfaction scores were more favourable in the intervention group [3.8 (0.4) versus 3.2 (0.6); $P < 0.001$]. Post-operative nausea and vomiting were found more in the control group but were not significant (n = 14 versus 8; $P = 0.127$). **Conclusion:** US-guided ESP block significantly reduces post-operative morphine consumption and improves analgesia and patient satisfaction without adverse effects in patients undergoing thoracolumbar spine surgery.

Keywords: Analgesia, bupivacaine, erector spinae plane block, intravenous, patient-controlled analgesia, morphine, thoracolumbar, spine surgery

INTRODUCTION

Spine surgeries demand extensive surgical dissection of the ligaments, bones, and subcutaneous tissues, thus resulting in appreciable post-operative pain. Inadequate analgesia may lead to poor post-operative recovery, delayed ambulation, poor surgical outcomes, increased lengths of hospital stay, and higher healthcare costs.[1-4] Post-operative pain had been traditionally managed by opioids. Still, evidence suggests that sometimes pain control is inadequate, and higher doses of opioids have adverse effects such as sedation, pruritus, impaired cognition, risk of respiratory depression and long-term habituation and addiction, nausea, vomiting, ileus, and poor wound healing.[1,5]

How to cite this article: Chiraya S, Singh J, Mitra S, Malhotra A, Srivastava MK, Fatima S. Erector spinae plane block for post-operative analgesia in thoracolumbar spine surgery: A randomised controlled trial. Indian J Anaesth 2023;67:985-90.

Various pain generators of the back, such as intervertebral discs, vertebral body, dura, ligaments, fascia, muscles, nerve root sleeves, and post-operative pain, are elicited via various inflammatory, nociceptive, and neuropathic mechanisms.[6] These tissues are innervated via the dorsal rami of the spinal nerves. The dorsal ramus of the spinal nerve enters the erector spinae muscle, dividing into lateral and medial branches, and the ventral ramus continues laterally as the intercostal nerve. Deposition of local anaesthetic deeper to the erector spinae muscle closer to the origin of dorsal and the ventral rami blocks these nerves in not only the paravertebral space but also the lateral cutaneous branches of the intercostal nerve, providing effective analgesia in the thoracolumbar region.[7,8]

Ultrasound (US)-guided erector spinae plane (ESP) block is a novel, safe analgesic technique with its probable site of action at the spinal nerves' ventral and dorsal rami, which innervate the paraspinal muscles and the vertebra.[7] Simplified sonoanatomy without risk of needle puncture to any vital structures in the immediate vicinity makes ESP block a safe and productive analgesic technique.[9]

The study's primary outcome was to compare the total morphine consumption at 24 h post-operatively in patients receiving the US-guided ESP block to the control group who did not receive the block. Secondary outcomes included pain scores at rest and on movement, patient satisfaction, time to the first bolus of morphine requirement by the patient, and side effects of the procedure/drug.

METHODS

This double-blind, randomised controlled study was conducted from April 2019 to August 2020 after approval from the institutional ethics committee (vide approval number GMCH/IEC/2018 dated 31/12/2018) and registered with the Clinical Trial Registry of India (vide registration number CTRI/2019/04/018395, https://www.ctri.nic.in). Written and informed consent was obtained for participation in the study and use of patient data for research and educational purposes. Seventy patients of the American Society of Anesthesiologists (ASA) physical status I/II aged between 18 and 65 years with a body mass index (BMI) of 18-35 kg/m^2 scheduled to undergo thoracolumbar spine surgery requiring laminectomy or laminotomy and pedicle screw rod fixation for decompression at a single level were included in the study. Patients with coagulopathies, a history of drug allergies, drug abuse, and psychological illness inhibiting the use of an intravenous patient control analgesia (IV-PCA) pump or understanding visual analogue scale (VAS) were excluded from the study. The study was carried out as per the principles of the Declaration of Helsinki, 2013.

All patients underwent a pre-anaesthesia check a day prior to the surgery and received oral ranitidine 150 mg and alprazolam 0.25 mg as premedication at night and on the morning of surgery. Randomisation was done using a computer-generated random number table into two groups: (a) control group - patients received general anaesthesia without any nerve block, and (b) intervention group - patients received US-guided ESP block along with general anaesthesia. The details of the group allotment were concealed (to the data observer) by placing it in a sequentially numbered opaque sealed envelope.

In the operating room, multi-channel monitoring (Aspire View, GE Healthcare, Madison, USA), including continuous monitoring of electrocardiography (ECG), heart rate (HR), oxygen saturation (SpO_2), respiratory rate (RR), non-invasive blood pressure (NIBP), and end-tidal carbon dioxide ($EtCO_2$), was done. Anaesthesia was induced using intravenous (IV) propofol 2 mg/kg and morphine 0.1 mg/kg; tracheal intubation was facilitated by IV vecuronium 0.1 mg/kg. Anaesthesia was maintained using nitrous oxide/oxygen in a ratio of 60:40 with sevoflurane to maintain a minimum alveolar concentration of 1. Subsequently, the same anaesthesiologist performed US-guided ESP block in all cases; they were not involved in the study.

After induction of anaesthesia, the patient was placed prone, and the operative level was identified with C arm and marked. After ensuring complete asepsis, a linear high-frequency US probe (SonoSite Edge, Bothell, WA, USA) in a sterile sheath was placed approximately 3 cm lateral to the midline of the spinous process in a longitudinal parasagittal orientation. The erector spinae muscle was identified at the tip of the transverse process of the vertebra, and a 10-cm 22-G US needle (Pajunk, Geisingen, Germany) was inserted at the level of surgery via the in-plane technique in the cephalic-caudal direction until bone contact with the tip of the transverse process was reached. The correct needle placement was confirmed by hydro-dissection with saline, and 20 mL of 0.25% bupivacaine with adrenaline was administered after negative aspiration.

A linear craniocaudal spread of local anaesthetic separated the erector spinae muscle from the transverse processes was observed using the US. The same procedure was also performed on the contralateral side, and surgery was allowed to proceed. The surgeon gave no local infiltration. Intra-operatively, IV fentanyl 0.5 μg/kg was administered if there was a rise in the mean arterial blood pressure (20% above baseline) for two sequential readings at a gap of 5 min. At the end of the surgery, the residual neuromuscular blockade was reversed using IV neostigmine 50 μg/kg and glycopyrrolate 10 μg/kg. The trachea was extubated, and the patient was shifted to the post-anaesthesia care unit (PACU), where patients from both groups were given an IV-PCA pump (Medima S-PCA, ICU Medical, Inc, San Clemente, CA) with morphine in the strength of 1 mg/mL (bolus only) with a lockout interval of 5 min and the maximum dose of morphine being 0.2 mg/kg body weight over 4 h. A bolus was taken by the patient when the VAS score >3. Standard analgesia with IV paracetamol 1 g 6 hourly and IV diclofenac 75 mg 12 hourly was given in both groups.

An anaesthesiologist blinded to the group allocation recorded the observations. Patient vitals such as HR, RR, NIBP, and VAS for pain (0- no pain to 10- worst imaginable pain) both at rest and on movement were noted at 1, 2, 4, 6, 12, and 24 h in the post-operative period. Total morphine consumption, time to first bolus (TFB) of morphine, and patient satisfaction score by using a 4-point verbal score (1- very dissatisfied; 2- dissatisfied; 3- satisfied; 4- very satisfied) were noted at 24 h. Intra-operative IV fentanyl consumption and any procedural or drug-related adverse drug-related records were also noted.

Sample size calculation was done using software (https://www.stat.ubc.ca). It was calculated that 29 participants in both groups would have 90% power to detect a 30% reduction in mean [standard deviation (SD)] morphine consumption from 9.5 (3.3) mg (observed in 10 pilot cases without ESP block) at $P < 0.05$. Hence, it was decided to recruit 35 participants to both groups, assuming a 20% attrition rate.

Decoding of the result was done after the study, and the data analysis was done using appropriate statistical tests. The statistical analysis was done using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 25.0 for Windows). The quantitative variables were estimated using measures of central tendency (i.e. mean and median) and measures of dispersion (i.e. SD and standard error). The Kolmogorov–Smirnov tests of normality and the measures of skewness were used to check the normality of data. The Student's *t*-test was used to compare the normally distributed data (age, weight, height, post-operative morphine consumption, and time to first bolus of morphine); for time-dependent changes, repeated measure analysis of variance (blood pressure, heart rate) was applied. Proportion comparison was done using Chi-square (post-operative nausea vomiting) or Fisher's exact test, whichever was applicable. The Bonferroni method was used to correct comparing opioid consumption at different intervals. The patient satisfaction score was analysed using the Cochran–Armitage test. All statistical tests were two-sided and were performed at a significance level of $\alpha = 0.05$.

RESULTS

Eighty patients were assessed for eligibility, and 70 patients were randomised into the two groups [Figure 1].

The groups were comparable regarding age, weight, height, body mass index (BMI), and surgical duration [Table 1]. The mean (SD) morphine consumption 24 h post-operatively was significantly lower in the intervention group as compared to the control group [5.69 (1.549) versus (vs) 9.51 (1.634) mg, mean difference [95% confidence interval (CI)]: 3.820 (3.063, 4.576); $P < 0.001$]. The mean (SD) time (in h) to first IV-PCA morphine bolus was also prolonged in the intervention group vs the control group [5.74 (1.52) vs 2.03 (0.587)], mean difference (95% CI): −3.710 (−4.297, −3.122) h; $P < 0.001$]. The group receiving the block had an overall higher satisfaction score in comparison to the control group (3.80 (0.406) vs 3.20 (0.584), mean difference (95% CI): −0.600 (−0.837, −0.362); $P < 0.001$]. A substantial reduction in the intra-operative fentanyl requirement was seen in the intervention group compared to the control group. More nausea and vomiting were

Table 1: Demographic characteristics of the study participants

Characteristics	Intervention group *n*=35	Control group *n*=35
Age (years)	41.4 (11.0)	39.8 (12.2)
Weight (kg)	70.6 (9.3)	68.8 (9.5)
Height (cm)	166.74 (9.80)	165.80 (9.30)
Body mass index (kg/m^2)	25.44 (3.07)	25.020 (2.68)
Duration of surgery (min)	144 (59.1)	138 (42.4)

Data expressed as mean (standard deviation) or number. n=Number of patients

found in the control group [Table 2]. Lower pain scores (VAS) were observed in the intervention group as compared to the control group, and the reduction was significant post-operatively at rest and on movement up to 12 h ($P < 0.001$) and 24 h ($P < 0.001$), respectively [Figures 2 and 3]. No intervention-related adverse effects such as pneumothorax, nerve injury, vascular injury, local anaesthetic toxicity, or haematoma were seen in this study.

DISCUSSION

In this study, we found that US-guided bilateral ESP block reduced post-operative opioid utilisation in thoracolumbar spine surgery compared to standard analgesics alone. The cumulative morphine consumption at 24 h post-operatively was significantly reduced in the patients receiving the ESP block compared to patients who did not receive the block. The time to the first post-operative morphine bolus was also prolonged in the interventional group compared to the control group, suggesting a sustained analgesic effect of the block post-operatively.

Few studies with a large sample size have been conducted regarding spine surgeries. In a study by Singh *et al*.,[10] pre-operative single-shot bilateral ESP block reduced post-operative morphine consumption [1.4 (1.5) vs 7.2 (2.0) mg in the control group; $P < 0.001$], and time to first rescue bolus was prolonged [5.8 (0.75) vs 2.42 (0.59) h; $P = 0.003$).

Table 2: Comparison of outcome measures

Parameters	Intervention Group *n*=35	Control Group *n*=35	Mean Difference (95% CI)	*P*
Total IV morphine in 24 h (mg)	5.69 (1.549)	9.51 (1.634)	3.820 (3.063, 4.576)	<0.001
Time to first bolus of IV morphine (h)	5.74 (1.521)	2.03 (0.857)	−3.710 (−4.294, −3.122)	<0.001
Intra-operative IV fentanyl consumption (μg)	25.60 (15.75)	37.71 (30.08)	12.110 (0.657, 23.562)	0.038
Patient satisfaction score	3.80 (0.406)	3.20 (0.584)	−0.600 (−0.837, −0.362)	<0.001
Post-operative nausea, vomiting, *n*	8	14		0.127

Data expressed as mean (standard deviation) or number. n=Number of patients, CI=Confidence interval, IV=Intravenous

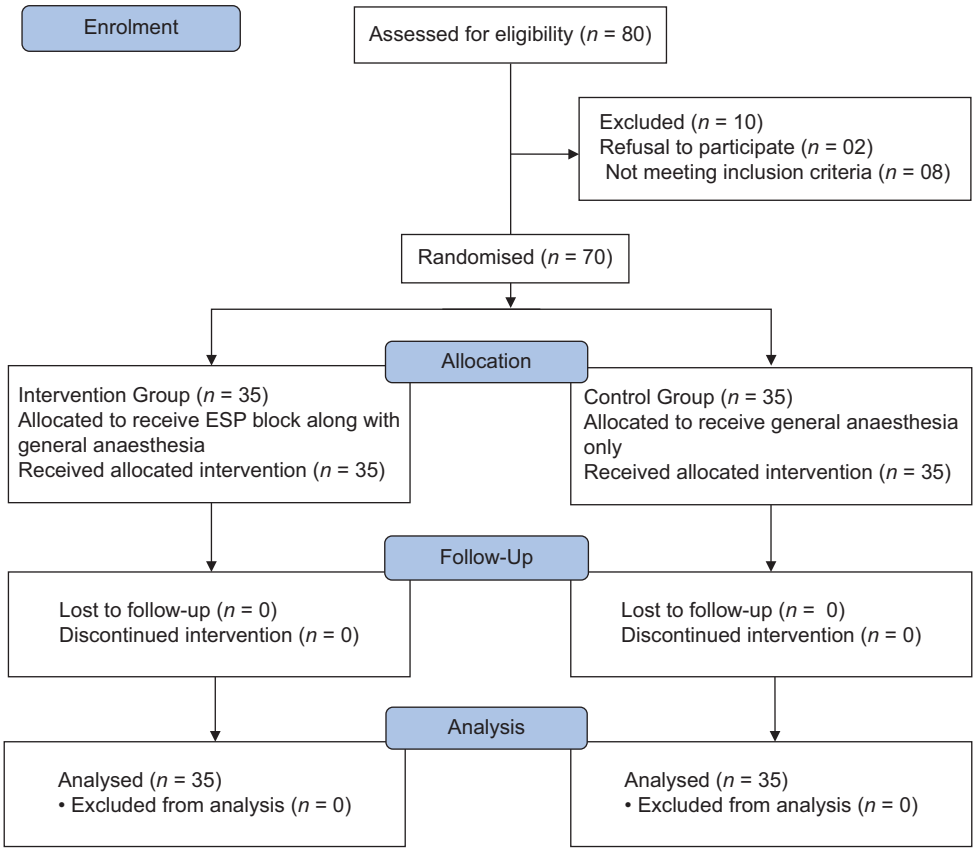

Figure 1: Consolidated standards of reporting trials (CONSORT) flow chart. n: Number of patients

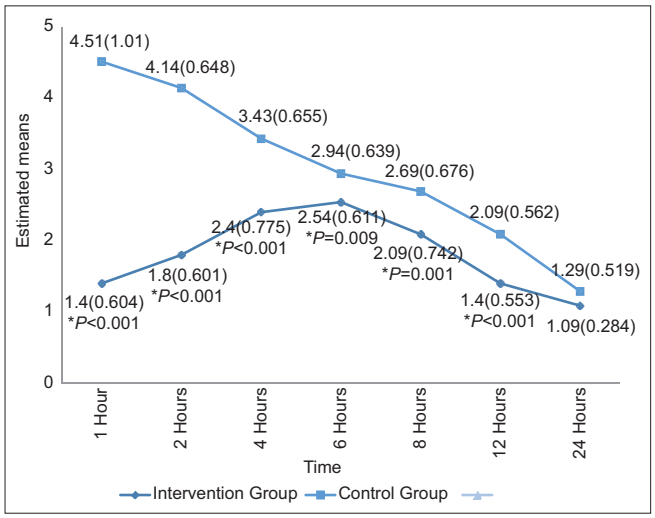

Figure 2: Post-operative visual analogue scale (VAS) score at rest

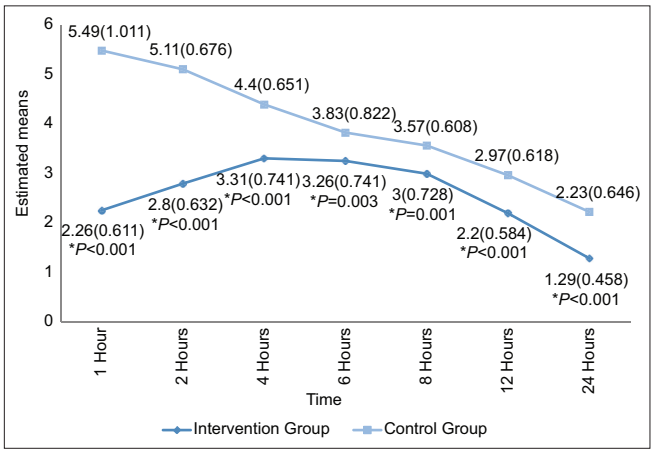

Figure 3: Post-operative visual analogue scale (VAS) score at movement

Zhang TJ *et al*.,[11] in their study of patients undergoing open lumbar spine surgery, found that pre-operative bilateral ESP blocks decreased post-operative cumulative morphine consumption at 24 h, which was 9.1 [2.1vs 21.8 (3.4) mg in the control group; $P = 0.003$]. Lack of use of paracetamol and diclofenac post-operatively might be a reason for the increased morphine requirement in comparison to our study. In a recent study, Bellantonio D *et al*. found that ESP block is a safe and efficient opioid-sparing technique for post-operative pain control after spinal fusion surgery. They noted total post-operative morphine consumption at 48 h [8.5 (5.5) vs 20 (14) mg in the control group; $P < 0.0001$].[12]

In our study, there were substantially reduced pain scores immediately, up to 12 h at rest, and 24 h on movement in the interventional group compared to the control group. A study by Yayik *et al*., Singh *et al*., Ueshima *et al*., and Tulgar *et al*. also suggested reduced post-operative pain scores in patients receiving ESP block in lumbar spine surgeries. However, these studies did not separately assess pain scores at rest and on movement.[6,10,13,14]

Along with the ESP block's beneficial effects, such as its lower pain scores and opioid-sparing effect, the patients receiving the block had a higher satisfaction score than the control group. As a result of prolonged pain relief, the patients receiving the block had a better overall quality of recovery and low post-operative nausea and vomiting, leading to higher satisfaction. Studies conducted by Bellantonio D *et al*. and Tuglar *et al*. also support the evidence that ESP block has an important effect on peri-operative wellness in terms of better patient satisfaction due to reduced pain scores and decreased incidence of nausea and vomiting compared to general anaesthesia alone.[12,14]

The major limitation in this study was that being a single shot pre-operative block, the volume of the drug injected was limited, but an in-situ catheter may also be placed in the ESP, through which continuous local anaesthetic infusion may be administered to prolong the analgesic efficacy of the block. Another limitation was that the dermatomal block area could not be assessed because the block was performed after administration of general anaesthesia.

CONCLUSION

Bilateral US-guided ESP block is an effective, safe, and reliable adjunct to multimodal analgesia to decrease post-operative opioid consumption in thoracolumbar spine surgery.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' Institution policy.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Melvin JP, Schrot RJ, Chu GM, Chin KJ. Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: A case series. Can J Anesth 2018; 65:1057-65.

2. Hassan ME, Wadod MAF. Serratus anterior plane block and erector spinae plane block in postoperative analgesia in thoracotomy: A randomised controlled study. Indian J Anaesth 2022;66:119-25.
3. Baheti S, Kaushik C, Biswas S, Novel use of erector spinae plane block in laparoscopic surgery. Indian J Anaesth 2022;66:573-8.
4. Shah B, Cherukuri K, Tudimilla S, Shah KS. Erector spinae plane block for postoperative analgesia following percutaneous nephrolithotomy under spinal anaesthesia- A randomised controlled study. Indian J Anaesth 2022;66:837-41.
5. Dolin SJ, Cashman JN. Tolerability of acute postoperative pain management: Nausea, vomiting, sedation, pruritus, and urinary retention. Evidence from published data. Br J Anaesth 2005;95:584-91.
6. Yayik AM, Cesur S, Ozturk F, Ahiskalioglu A, Ay AN, Celik EC, *et al*. Postoperative analgesic efficacy of the ultrasound-guided erector spinae plane block in patients undergoing lumbar spinal decompression surgery: A randomized controlled study. World Neurosurg 2019;126:e779-85.
7. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: A novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 2016;41:621-7.
8. Shim JG, Ryu KH, Kim PO, Cho EA, Ahn JH, Yeon JE, *et al*. Evaluation of ultrasound-guided erector spinae plane block for postoperative management of video-assisted thoracoscopic surgery: A prospective, randomized, controlled clinical trial. J Thorac Dis 2020;12:4174-82.
9. Jinn CK, Kariem EB. Mechanisms of action of the erector spinae plane (ESP) block: A narrative review. Can J Anesth 2021;68:387-408.
10. Singh S, Choudhary NK, Lalin D, Verma VK. Bilateral ultrasound-guided erector spinae plane block for postoperative analgesia in lumbar spine surgery: A randomized control trial. J Neurosurg Anesthesiol 2020;32:330-4.
11. Zhang TJ, Zhang JJ, Qu ZY, Zhang HY, Qiu Y, Hua Z. Bilateral erector Spinae plane blocks for open posterior lumbar surgery. J Pain Res 2020;13:709-17.
12. Bellantonio D, Bolondi G, Cultrera F, Lofrese G, Mongardi L, Gobbi L, *et al*. Erector spinae plane block for perioperative pain management in neurosurgical lower-thoracic and lumbar spinal fusion: A single-centre prospective randomised controlled trial. BMC Anesthesiol 2023;23:187.
13. Ueshima H, Inagaki M, Toyone T, Otake H. Efficacy of the erector spinae plane block for lumbar spinal surgery: A retrospective study. Asian Spine J 2019;13:254-7.
14. Tulgar S, Ahiskalioglu A, De Cassai A, Gurkan Y. Efficacy of bilateral erector spinae plane block in the management of pain: Current insights. J Pain Res 2019;12:2597-2613.