

Peripheral nerve stimulator guided erector spinae plane block for post-operative analgesia after total abdominal hysterectomies: A feasibility study

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ABSTRACT

Background and Aims: The pain following total abdominal hysterectomy (TAH), a very commonly performed gynaecological surgery, is usually taken care of by various opioids, non-opioids, regional and peripheral nerve blocks. Erector spinae plane block (ESPB) under ultrasound guidance is a relatively new approach for postoperative analgesia in thoracic and abdominal surgeries. Ultrasound availability and expertise to use it is a limitation at times. The primary aim of this study was to determine the analgesic efficacy of ESPB using peripheral nerve stimulation (PNS) technique in patients undergoing TAH. **Methods:** A total of 60 American Society of Anesthesiologists physical status I and II female patients were posted for abdominal hysterectomy after obtaining ethical committee clearance in a tertiary care centre. Group I (n = 30) received spinal anaesthesia, whereas Group II (n = 30) received ESPB under peripheral nerve stimulator (PNS) guidance with 20 mL of 0.375% ropivacaine before spinal anaesthesia. Post-operative pain intensity reported using the Visual Analogue Scale (VAS) was considered as the primary outcome. The haemodynamic variables, total duration before the first rescue analgesia, total consumption of tramadol, level of satisfaction regarding analgesia and any complications were considered as secondary outcomes. The data were recorded in an excel sheet, and analysis was performed using the Statistical Package for the Social Sciences version 23.0. **Results:** VAS score was significantly lower ($P < 0.001$) in Group II at 0, 1, 2, 3, 4, 6, 12, 18 and 24 h post-operatively. The total dose of rescue analgesia was significantly reduced in the ESPB group. **Conclusion:** PNS-guided ESPB is effective in relieving pain in patients undergoing TAH.

Key words: Analgesia, hysterectomy, pain, post-operative, ropivacaine

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INTRODUCTION

Total abdominal hysterectomy (TAH) is the second commonest surgery after caesarean section performed in females aged 25–50 years.^[1] Postoperative pain following abdominal hysterectomy is being conventionally managed with opioids using patient-controlled analgesia (PCA) pump, or central neuraxial technique such as epidural analgesia. However, using these modalities along with the biological and psychological mechanisms together with the equipment involved, makes the assessment of pain relief more difficult during movement as compared to rest. Increasing the dose of opioids is associated with

adverse effects such as nausea, vomiting, pruritus and sedation.^[2] Neuraxial analgesia has an edge over systemic opioids that it avoids systemic side-effects and postoperative analgesia can be prolonged.^[3]

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Central neuraxial techniques have their own set of complications – hypotension, headache, dislodgement of catheter and nerve damage.^[4] Various methods such as paravertebral block, wound infiltration or intraperitoneal infiltration have been tried with variable pain relief and opioid-sparing effect.^[5-7]

Forero described ultrasonography (USG)-guided paraspinal fascial plane block called erector spinae plane block (ESPB) in 2016 for post-operative analgesia where local anaesthetic is administered in the plane between erector spinae and transverse process of a vertebra. Since then, it has been used in a vast spectrum of thoracic and abdominal surgeries.^[8,9] However, in low-resource settings, a nerve stimulator could be a practical alternative to ultrasound for administering ESPB.

We planned to perform ESPB under peripheral nerve stimulation (PNS) guidance, to test the null hypothesis that no significant analgesic efficacy will be observed after giving ESPB using PNS guidance following TAH.

METHODS

The study was conducted from September 2019 to April 2020 in the Departments of Anaesthesiology and Obstetrics and Gynaecology in a tertiary care centre in India. It was registered in Clinical Trials Registry-India after obtaining institutional ethical committee approval.

The aim of the study was to determine the effectiveness of ESPB after TAH using the PNS technique.

The primary objective was to compare the Visual Analogue Scale (VAS) score postoperatively and to calculate the total time duration before which the first dose of rescue analgesia was given and calculate the total amount of tramadol consumed. The secondary objectives were to compare intraoperative and postoperative haemodynamic parameters and to note if any complications occurred.

Inclusion criteria selected were patients giving written informed consent, American Society of Anesthesiologists (ASA) physical status grade I-II, aged 40–60 years, body mass index (BMI) between 18.5 and 22.9 kg/m². Patients on chronic analgesic therapy, hypersensitive to local anaesthetics, having local site infection, diagnosed coagulation disorder were

excluded from the study. Those cases with surgery duration >120 min were excluded from the analysis. The chit and box method was used for randomisation into two groups.

Group I (N = 30, control)- spinal anaesthesia with 2.5 mL (12.5 mg) of 0.5% hyperbaric bupivacaine.

Group II (N = 30, case)- 20 mL of 0.375% ropivacaine via ESPB bilaterally before spinal anaesthesia with 2.5 mL (12.5 mg) of 0.5% hyperbaric bupivacaine.

The patients were taken into the operation theatre after ensuring proper fasting. They were instructed about the VAS score and verbal rating scale in the preoperative period. All standard monitors were attached, and Ringer's lactate (10 mL/kg) infusion was started. ESPB was performed in the lateral position by an anaesthesiologist who was trained in performing ESPB and paravertebral blocks. After identifying and marking the T10 vertebral spine (using vertebra at Tuffier's line as L4), a vertical line was drawn in the midline and two parallel lines 3 cm apart from the midline on either side. A line transecting all three parallel lines at the level of the T10 spinous process was drawn. The point of intersection of both paravertebral lines was taken as the point of entry [Figure 1]. Under aseptic conditions, a 22-G 10 cm long insulated needle (Stimuplex A, B Braun) was inserted from a marked point of entry till it hit the transverse process (TP) of the T10 vertebrae, and a motor response from adjoining paraspinal muscles was elicited. If muscle twitch was not elicited even after hitting the TP, the needle was redirected to either cephalad or caudad, walking on the TP till the twitch came. The initial current was set to 1.5 mA and reduced to

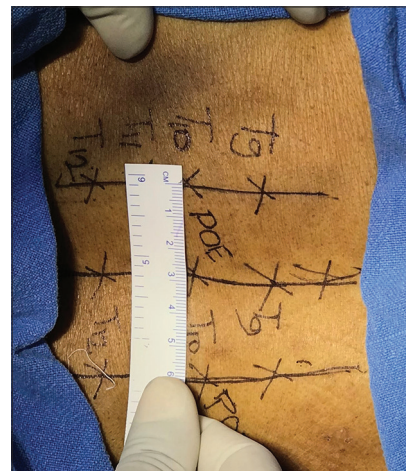


Figure 1: Landmarks showing point of entry (POE)

0.5 mA while assuring that the motor response though decreased in intensity was still present [Figure 2]. After negative aspiration of blood, 20 mL of 0.375% ropivacaine was given in 5 mL aliquots, and loss of twitches was observed. The same procedure was followed on the other side of the midline. If TP was not encountered till 4 cm, then the needle was redirected either cephalad or caudad till the TP was hit.

The onset of sensory blockade after ESPB was defined as the time from the injection of a drug to the absence of pain between T8 and T12 dermatome. It was assessed as loss of pinprick sensation using a blunt 26-G needle (hypodermic) every 1 min after ESPB till 15 min. The failed block was defined as the absence of sensory loss after 15 min on either or both sides. The sensory block was ensured till T8–T12 level bilaterally before proceeding for spinal anaesthesia L2–L3 interspace in lateral position as per group allotted. Surgery was started after obtaining adequate anaesthesia till the T6 level in both groups. In case the T6 level was not achieved in either of the groups, the patient was administered general anaesthesia and excluded from the study.

VAS was used to rate the pain (0 - no pain; 10 - most severe pain). The primary outcome of the VAS score was recorded post-surgery at 0 h followed by 1, 2, 3, 4, 6, 12, 18 and 24 h. The patients received rescue analgesia viz- intravenous (IV) tramadol 2 mg/kg if VAS >4. Total block duration was defined as the interval between completion of the block and the first tramadol administered. 1 gm IV paracetamol was given 8 hourly postoperatively in both groups as per the hospital protocol.



Figure 2: PNS needle *in situ* at point of entry (POE). Drug was administered when PNS current reduced to less than 0.5 mA

Overall level of satisfaction of the patients was recorded by Likert verbal rating scale during post-operative period (graded 1 to 7 where 1 = extremely dissatisfied patient, 2 = dissatisfied, 3 = somewhat dissatisfied, 4 = undecided, 5 = somewhat satisfied, 6 = satisfied, and 7 = extremely satisfied). Patient satisfaction score was recorded in the postoperative period at 1, 2, 3, 4, 6, 12, 18 and 24 hours. The scores were recorded by an observer who was blinded to the study.

The haemodynamic parameters like heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and oxygen saturation (SPO₂) were recorded preoperatively and intraoperatively at 5, 10, 15, 30, 45, 60, 90 and 120 min and at 1, 2, 3, 4, 6, 12, 18 and 24 h in the postoperative period as secondary outcomes in both the groups.

Patients were observed for complications such as hypotension, bradycardia, headache, pneumothorax, allergic reactions, nausea, vomiting and convulsions. Hypotension (fall in SBP <90 mm Hg or decrease in MAP >20% from baseline value) was treated with IV mephentermine 6 mg boluses and fluid bolus of 10 mL/kg, and bradycardia (HR <20% of baseline) was treated with IV atropine 10 µg/kg boluses.

We used online software “G-Power” version 3.1.9.7 to calculate the sample size. For the current study, postoperative VAS distinction during 1st postoperative hour was significant when there was at least a two-point difference between patients receiving ESPB and patients not receiving the ESPB (the variability was estimated from interim analysis; standard deviation [SD]:1.6). The minimum sample required was 56 when one-tailed significance was 5% ($\alpha = 0.05$), the power of the study (1- β) was 0.90, and the effect size was 0.8 in each group of 28 patients. The sample size was increased to 65 to compensate for dropouts.

Statistical package for the Social Sciences (SPSS) version 23.0 (International Business Machines Corporation, USA) was used to evaluate the study data. Mean \pm SD was used to record the quantitative data, and numbers/percentages for the qualitative data. Comparison of parametric variables with a normal distribution was performed using unpaired Student's *t*-test, and those without it were performed using Mann–Whitney U test. Categorical data were expressed using Chi-square test or Fisher's exact test or median \pm (interquartile) range. A *P* value < 0.05 was considered as significant.

RESULTS

In our study, 65 patients were assessed, and 60 patients fulfilling the inclusion criteria were included in the study [Figure 3]. There was no significant difference in mean age (51.1 ± 7.85 vs 47.89 ± 6.37 , $P = 0.09$), BMI (22.43 ± 1.26 vs 21.78 ± 0.74 , $P = 0.86$), and ASA status in both the groups.

The mean duration of the surgery showed no clinically significant difference. The time to achieve the T8 level of ESP sensory block in group II was 16.89 ± 2.18 min. The time duration when group II demanded rescue analgesia was significantly prolonged, and total consumption of tramadol in the postoperative period was significantly reduced. Overall satisfaction level was more in group II [Table 1]. VAS score in Group II was significantly lower. [Table 2] The haemodynamic profile (HR, SBP, DBP and MAP) for both the groups was similar [Figure 4], and no significant complications were observed.

DISCUSSION

ESPB is a truncal block that has been used for many abdominal and thoracic pain conditions.^[10,11]

Ultrasonography (USG) guided ESPB has been used for controlling postoperative pain after TAH as a part of multimodal analgesia.^[12]

The mechanism of ESPB is not completely understood. Anterior diffusion of the local anaesthetic into the paravertebral space or an interfascial spread toward the posterior rami of spinal nerves could be the mechanism. Forero described that dorsal rami, ventral rami and lateral cutaneous branches of intercostal nerves are blocked in ESPB when the drug spreads

Table 1: Duration of surgery, onset of sensory block, rescue analgesia, total analgesic requirement of tramadol and satisfaction score in both groups

Parameter	Group I (n=30)	Group II (n=28)	P
Mean Duration of Surgery (min) ± SD	108.83±8.98	108.39±9.73	0.86
Time of onset of ESPB (min) ± SD	-	16.89±2.18	-
Time for First Rescue Analgesia (hours) Mean±SD	2.64±0.58	16.32±1.33	<0.0001 *
Total tramadol consumption in 24 h (mg)	328±43.12	100.00	<0.0001*
Satisfaction score (Mean±SD)	3.37±0.73	6.46±0.92	<0.0001*

* Significant SD- Standard Deviation

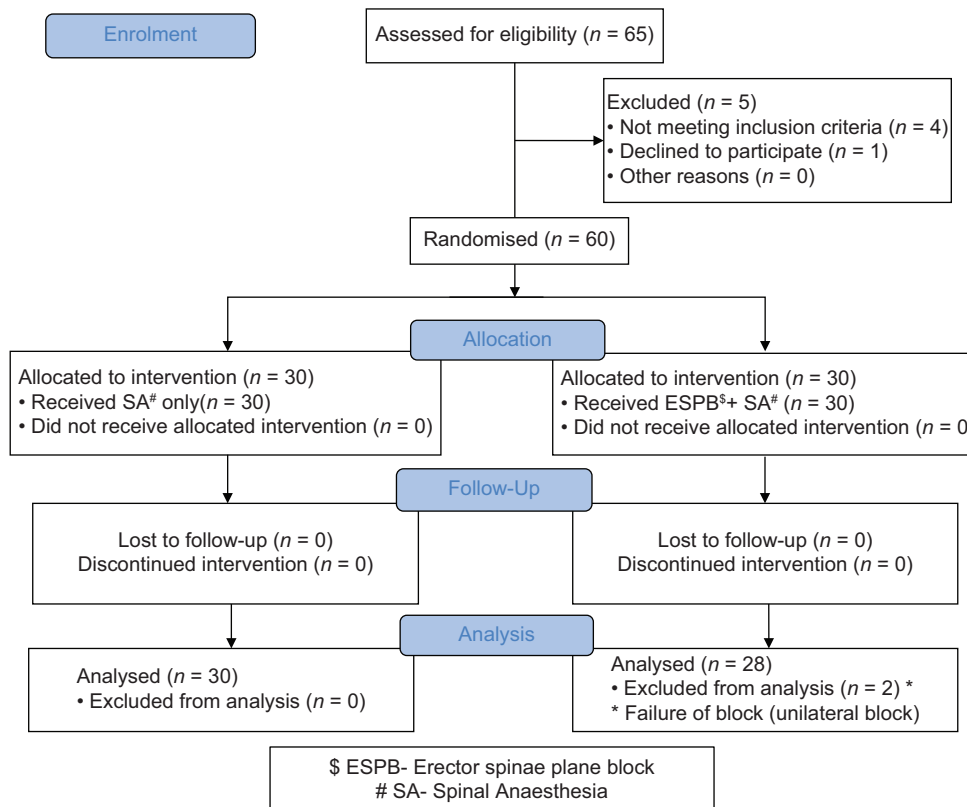


Figure 3: CONSORT flow diagram

Table 2: Comparison of Visual Analogue Scale score (median interquartile range) in both groups in the first 24 h in postoperative period

Time (h)	VAS score, median interquartile range		P
	Group I (n=30)	Group II (n=28)	
0	3 (2-5)	1 (0-1)	<0.0001
1	2 (2-4)	1 (0-1)	<0.0001
2	3 (1-4)	1 (0-1)	<0.0001
3	3 (1-4)	1 (1-2)	<0.0001
4	2 (1-3)	0 (1-1)	<0.0001
6	2 (2-4)	2 (0-2)	<0.0001
12	3 (2-5)	1 (1-2)	<0.0001
18	3 (2-5)	2 (1-2)	<0.001
24	2 (3-5)	1 (2-3)	<0.001

VAS – Visual Analogue Scale; P<0.05 Significant

cephalo-caudally once deposited below erector spinae muscle and TP.^[8] ESPB is mostly performed under ultrasound guidance; however, fluoroscopy-guided and landmark-guided techniques have also been used.^[13,14] In the current study, PNS was used to perform ESPB.

According to the anatomy of the thoracic spinal nerve, the common dorsal ramus passes dorsally and caudally, entering the back through an anatomic foramen bounded by the superior border of the TP, the anterior aspect of the superior articular zygapophyseal joint, and the intertransverse ligament. Approximately 5–10 mm from its origin, the common dorsal ramus divides at about a 30° angle into medial and lateral branches ascending into the erector spinae muscle. These branches contain both sensory and motor fibres.^[8,15] In our study, we targeted the common dorsal nerve/its branches for stimulation, and erector spinae muscle (iliocostalis, longissimus, spinalis thoracis) twitching was observed.

Chin KJ in a study on fresh cadaver models injected 20 mL of fluid at T7 TP and computed tomography discovered a spread of fluid extending cranially till C7–T2 and caudally till L2–L3 levels.^[16] Another cadaveric study by Altinpulluk *et al.*^[17] found that when 20 mL of methylene blue was injected into each side at the T9 level, the spread observed was between T3 and L2 levels. Considering the level of spread in the cadaveric model, we decided to conduct our ESPB at the T10 level.

Most of the studies done earlier on ESPB for postoperative analgesia were performed in patients undergoing surgery under general anaesthesia in contrast to our study where we performed it in

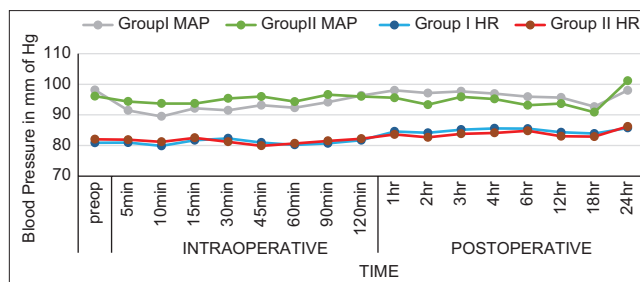


Figure 4: Comparison of heart rate and mean arterial pressure between both groups intraoperative and postoperatively. MAP: Mean arterial pressure; HR: Heart rate

patients undergoing abdominal surgery under spinal anaesthesia. ESPB was given before spinal anaesthesia which helped us in determining the time of onset of the block as well as the failure of the block.

In our study, there was a significant decrease in the requirement of rescue analgesia in patients who were administered PNS-guided ESPB in the initial 24 h after TAH. The patients who underwent ESPB had post-operative analgesia of 16.89 ± 2.18 h in our study. Our findings were further supported by the study conducted by Hamed *et al.*^[12] who concluded that the average duration of postoperative analgesia was more than 12 h in patients who were given USG-guided ESPB in patients undergoing TAH. Tulgar *et al.*^[18] used USG-guided ESPB for three different abdominal procedures in three patients and found postoperative analgesia ranging from 13 h to 17 h which was very close to our results. In a case series by Altinpulluk *et al.*,^[17] patients who underwent open abdominal hysterectomy had mild to moderate pain during first 6 h of postoperative period, especially in the pubic region, and had some urinary catheter discomfort but were quite comfortable in the first 48 h after surgery. These data suggest that PNS-guided ESPB can be used effectively as alternatives to USG, especially in low resource settings.

Overall VAS score in 24 h of postoperative period was found to be statistically significant in the ESPB group as compared to the control group. Our results are supported by Hamed *et al.* who observed that pain scores were significantly reduced for more than 12 h in patients who received ESPB. However, Hamed *et al.*^[12] performed surgeries under general anaesthesia in their study, whereas we administered spinal anaesthesia to our patients.

Rescue analgesic dose was significantly lower in RSPB group during the initial 24 h of post-operative

period in our study which corresponds to the Hamed *et al.*^[12] study where RSPB significantly reduced opioid consumption. A multimodal approach for postoperative analgesia is a key factor in improving postoperative analgesia which holds good in our study too. ESPB is relatively safe as the endpoint is hitting a bony structure i.e., TP. Cadaveric studies had demonstrated the drug spread in paravertebral spaces, and both ventral and dorsal rami in the paravertebral space were dyed.^[17]

There were no significant haemodynamic differences between both the groups during the intraoperative and postoperative periods in our study. No significant adverse effects such as hypotension, bradycardia, pneumothorax, allergic reactions, nausea and vomiting were noted in both groups. This is comparable with Hamed *et al.*^[12] study, whereas Ueshmia reported pneumothorax in a case where ESPB was administered.^[19]

In our study, VAS score was invariably on lower side in ESPB group when compared with group I. This may find an association in decreasing the development of chronic pain.

As per the extensive Medline search, PNS-guided ESPB has not been reported yet in the world literature, and this is the first study to use this technique without previous evidence.

Our study has some limitations. Operator bias was present as it was not a double-blinded study. Patient bias was decreased by using the same position for both procedures. Due to limited resources, the use of USG machines along with PNS as dual guidance could not be done.

Another limitation was that landmark-guided identification of the T10 TP may not actually correspond to T10 TP, and we could not confirm the exact placement of the PNS needle. However, as this was an interfascial plane block, the placement of the needle in one TP above or below did not make much difference. The exact spread of drug in ESPB could not be assessed making this a limitation of our study, however when ESPB was performed using the blind technique, the injected drug spread in the longitudinal axis to both cephalad and caudal direction over several levels.^[14] We limited our study population to normal or healthy weighted (BMI <22.9 kg/m²) in view of easy identification of landmarks.

CONCLUSION

ESPB under PNS guidance provides significant postoperative analgesia with reduced opioid consumption and better satisfaction score in patients undergoing TAH under spinal anaesthesia and can be used as an alternative to USG, especially in limited resources settings.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Singh S, Prasad C. Post-operative analgesic effect of dexmedetomidine administration in wound infiltration for abdominal hysterectomy: A randomised control study. *Indian J Anaesth* 2017;61:494-8.
2. Veiga de Sá A, Cavaleiro C, Campos M. Haemodynamic and analgesic control in a perioperative opioid-free approach to bariatric surgery - A case report. *Indian J Anaesth* 2020;64:141-4.
3. Kjølhed P, Bergdahl O, Borendal Wodlin N, Nilsson L. Effect of intrathecal morphine and epidural analgesia on postoperative recovery after abdominal surgery for gynecologic malignancy: An open-label randomised trial. *BMJ Open* 2019;9:e024484.
4. Cook FAB, Millar E, McLennan F, Janssens M, Stretton C. Non-obstetric safety of epidurals (NOSE). *BMJ Open Qual* 2021;10:e000943.
5. Ilfeld BM. Continuous peripheral nerve blocks: An update of the published evidence and comparison with novel, alternative analgesic modalities. *Anesth Analg* 2017;124:308-35.
6. Thangavel AR, Sethi S, Gupta V. Comparison of continuous wound infusion versus continuous epidural infusion in upper abdominal surgery: Noninferiority randomized controlled trial. *Anesth Essays Res* 2019;13:676-82.
7. Ammianickal PL, Thangaswamy CR, Balachander H, Subbaiah M, Kumar NC. Comparing epidural and wound infiltration analgesia for total abdominal hysterectomy: A randomised controlled study. *Indian J Anaesth* 2018;62:759-64.
8. 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.
9. Luis -Navarro JC, Seda-Guzman M, Luis-Moreno C, Chin KJ. Erector Spinae plane block in abdominal surgery: Case series. *Indian J Anaesth* 2018;62:549-54.
10. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Erector spinae plane (ESP) block in the management of post thoracotomy pain syndrome: A case series. *Scand J Pain* 2017;17:325-9.
11. Yamak Altinpulluk E, García Simón D, Fajardo-Pérez M. Erector spinae plane block for analgesia after lower segment caesarean section: Case report. *Rev Esp Anestesiología Reanim* 2018;65:284-6.
12. Hamed MA, Goda AS, Basiony MM, Fargaly OS, Abdelhady MA.

- Erector spinae plane block for postoperative analgesia in patients undergoing total abdominal hysterectomy: A randomized controlled study original study. *J Pain Res* 2019;12:1393-8.
13. Prasad MK, Varshney RK, Jain P, Choudhary AK, Khare A, Jheetay GS. Postoperative analgesic efficacy of fluoroscopy-guided erector spinae plane block after percutaneous nephrolithotomy (PCNL): A randomized controlled study. *Saudi J Anaesth* 2020;14:480-6.
 14. Vadera HK, Mistry T. Erector spinae plane block: Anatomical landmark-guided technique. *Saudi J Anaesth* 2019;13:268-9.
 15. Zhou L, Schneck CD, Shao Z. The anatomy of dorsal ramus nerves and its implications in lower back pain. *Neuroscience Med* 2012;3:192-201.
 16. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. *Anaesthesia* 2017;72:452-60.
 17. Altinpulluk EY, Ozdilek A, Colakoglu N, Beyoglu CA, Ertas A, Uzel M, *et al.* Bilateral postoperative ultrasound-guided erector spinae plane block in open abdominal hysterectomy: A case series and cadaveric investigation. *Rom J Anaesth Intensive Care* 2019;26:83-8.
 18. Tulgar S, Selvi O, Kapakli MS. Erector spinae plane block for different laparoscopic abdominal surgeries: Case series. *Case Rep Anesthesiol* 2018:3947281.
 19. Ueshima H. Pneumothorax after the erector spinae plane block. *J Clin Anesth* 2018;48:12.