

# Postoperative analgesic efficacy of fluoroscopy-guided erector spinae plane block after percutaneous nephrolithotomy (PCNL): A randomized controlled study

## ABSTRACT

**Background:** Percutaneous nephrolithotomy (PCNL) a minimally invasive method for the removal of renal calculi and is associated with significant pain in postoperative period. Conventionally, intravenous opioids, local anesthetic infiltration, and regional blocks (intercostal/paravertebral blocks) have been tried with less efficacy to control postoperative pain. The present study is conducted to assess the effectiveness of erector spinae plane block (ESPB) performed under fluoroscopy guidance for postoperative analgesia during PCNL.

**Subjects and Methods:** After obtaining ethical clearance, the study was conducted on 61 American Society of Anaesthesiologists (ASA) I and II patients aged between 18–65 years admitted for PCNL. Group I ( $n = 30$ ) did not receive ESPB while Group II ( $n = 31$ ) received ESPB under fluoroscopy guidance and 20 ml of 0.375% ropivacaine was administered after PCNL. Patient-reported pain intensity using visual analogue scale (VAS) was considered as a primary outcome. The hemodynamic variables (heart rate, systolic, diastolic, and mean blood pressure) was considered as a secondary outcome. Statistical analysis was performed using Student's *t*-test and Mann–Whitney U test. Data analysis was performed using the Statistical Package for the Social Sciences version 23.0.

**Results:** Postoperatively VAS score was significantly lower in Group II at 0, 1, 2, 3, 4, 6, 12, 18, and 24 hours after PCNL ( $P < 0.001$ ). Dose of rescue analgesia significantly decreased in Group II compared to Group I.

**Conclusion:** ESPB performed under fluoroscopic guidance is a simple and effective technique and it provides significantly better postoperative pain relief.

**Key words:** Erector spinae plane block; postoperative analgesia; ropivacaine

## Introduction


Percutaneous nephrolithotomy (PCNL) is considered as a very common surgical technique used for the treatment of renal stones.<sup>[1]</sup> During PCNL, postoperative pain is a

complex condition that needs a multimodal approach and good pain management can decrease hospital stay, rate of complications, and decrease overall health

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** reprints@medknow.com

**How to cite this article:** 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.

Access this article online	
<b>Website:</b> www.saudija.org	<b>Quick Response Code</b> 
<b>DOI:</b> 10.4103/sja.SJA_26_20	

**MUKESH K. PRASAD, ROHIT K. VARSHNEY, PAYAL JAIN, AMIT K. CHOUDHARY<sup>1</sup>, ADITI KHARE, GURDEEP S. JHEETAY**

Department of Anaesthesia and Pain, Teerthankar Mahaveer Medical College, Moradbad, Uttar Pradesh,

<sup>1</sup>Consultant Anaesthesiologist, Indra Memorial Hospital, Patna, Bihar, India

**Address for correspondence:** Dr. Rohit K. Varshney, Department of Anaesthesia, Teerthankar Mahaveer Medical College, Bagdpur, Moradabad, Uttar Pradesh - 244 001, India. E-mail: rohitmaxy@gmail.com

**Submitted:** 08-Jan-2020, **Accepted:** 15-Feb-2020, **Published:** 24-Sep-2020

cost.<sup>[2-4]</sup> Conventional postoperative pain management with opioids compromise early recovery and discharge due to their side effects. Thus, the multimodal postoperative pain management approach helps in reducing opioid-related side effects.

Most of these patients undergoing PCNL have compromised renal function. Nonsteroidal anti-inflammatory drugs (NSAIDs), which provide excellent opioid-free analgesia is relatively contraindicated in such conditions, hence any technique or drug that can avoid side effects of opioids and complications of NSAIDs is desirable.

Erector spinae plane block (ESPB), a relatively newer approach of paraspinal fascial plane block described in 2016 for acute and chronic thoracic pain by Forero is used to administer effective pain relief in abdominal and thoracic surgeries.<sup>[5-7]</sup> ESPB is administered by injecting local anesthesia (LA) in a plane between the transverse process and erector spinae muscle. The LA diffuses into the paravertebral space and spreads on both rami (dorsal and ventral) of spinal nerves through spaces between adjoining vertebrae. This is considered as proposed mechanism of ESPB.<sup>[5,8]</sup> It gives considerable analgesia with a single puncture and can be performed at level relatively far off from the surgical site, thereby averting any local issues that could otherwise contraindicate the puncture at that specific point.

Most of the work and publications done so far had focused on its use for thoracic surgery,<sup>[9-12]</sup> with a few references for the abdominal surgery and total hip arthroplasty.<sup>[13-15]</sup>

We planned to perform ESPB under fluoroscopy guidance. It is convenient to share fluoroscope, which is a surgical armamentarium in PCNL surgery. Moreover, the prone position of the patient during PCNL is an added advantage for performing the block. Under fluoroscopy guidance, it is easy to identify the transverse process and confirm the needle placement as well as to locate the spread of the drugs.

We hypothesized ( $H_0$ ) that ESPB conducted under fluoroscopy guidance, which is used as an alternate to ultrasound would provide a comparable postoperative analgesia in patients without ESPB in PCNL patients.

## Subjects and Methods

This was a prospective double-blind study, which was performed in Department of Anaesthesia in a tertiary care center in Northern part of India between September 2019 and December 2019. The trial was registered in Indian Clinical

Trials Registry (ICMR-NIMS) trial ID: CTRI/2019/08/020877, after approval from institutional ethical committee was obtained. Written informed consent was taken from each patient before enrolling in the study. Sixty-one patients of American Society of Anaesthesiologists (ASA) grade I–II, aged between 18–65 years, with serum creatinine value of less than 1.5 and elective unilateral PCNL surgeries were randomly assigned into two groups using the chit and box method.

Group I (n = 30): Control group did not receive ESPB.

Group II (n = 31): They received a 20 ml injection of 0.375% ropivacaine in ESPB under fluoroscopic guidance.

Patients having a history of allergy, creatinine level more than 1.5, and any drug abuse were excluded from the study.

Appropriate preoperative fasting was ensured. All standard monitors such as electrocardiogram (ECG), blood pressure, pulse oximeter, End-tidal CO<sub>2</sub> (ETCO<sub>2</sub>) were attached after securing the intravenous line. Patients were pre-medicated with Inj. midazolam 1 mg IV, Inj. ondansetron 4 mg IV, and Inj. fentanyl 2 µg/kg IV. Following pre-oxygenation, all patient induction was done with intravenous propofol 2 mg/kg and tracheal intubation was facilitated using IV vecuronium bromide (0.1 mg/kg). Anesthesia maintenance continued with nitrous oxide (60%) and isoflurane (0.5–1%) in oxygen and vecuronium bromide (0.05 mg/kg). After proper padding of eyes, the patients were kept in prone position and all pressure points were secured.

Patients in Group II received fluoroscopy-guided ESPB after PCNL finished under general anesthesia by an expert anesthesiologist who was adequately experienced in giving ESPB and who was also capable of giving paravertebral as well as nerve root blocks under fluoroscopy.

T8 spine was identified under fluoroscopic guidance and marked. A vertical line was drawn in the midline over the spinous process. A parallel line was drawn 2.5 cm lateral to the midline and line joining both lines at T8 level marks the point of entry (POE) [Figure 1].

The skin over the ipsilateral T8 area was decontaminated with betadine solution, which was followed by sterile draping. Tuohy needle (18 G, 8 cm) was inserted at POE under fluoroscopic guidance to hit the transverse process of the T8 vertebrae on the side to be operated [Figure 2a and b]. After hitting the transverse process, needle was slightly retracted and the correct position was confirmed with 1 ml of iohexol (Omnipaque-350®) mixed with 1 ml saline using

both anteroposterior and lateral view under fluoroscopic guidance [Figures 3 and 4].

After obtaining a proper spread of dye in the desirable plane, i.e., in the interfascial plane in paraspinous gutter under C ARM, 20 ml of the prepared mixture of 0.375% ropivacaine [10 ml of 0.75% Ropivacaine (Neon® laboratories limited, India) and 10 ml of normal saline] was injected.

Isoflurane was discontinued after ESPB and all patients were positioned supine. Simultaneously, intravenous paracetamol (1 g/100 ml) was given. Intravenous neostigmine (0.05 mg/kg) with glycopyrrolate (0.01 mg/kg) was used for neuromuscular blockade reversal.

Postoperative pain was assessed using visual analogue scale (VAS), which was graded from 0 to 10 where 0 signified no pain whereas 10 signified most severe pain. In the preoperative period, patients were instructed on how to use VAS for pain. In postoperative period, intravenous paracetamol (1 g) was given every 8 hours by nursing staff in both groups as per hospital protocol. Rescue analgesic in

the form of injection tramadol (2 mg/kg) was administered in both groups when VAS was more than 4. The staff nurse who administered rescue analgesics was blinded to the study. A total of four doses were allowed within 24 hours of postoperative period. The time difference between the administration of the ESPB and the first request of tramadol injection in postoperative period was considered as the total duration of analgesia in Group II. Consumption of total intravenous tramadol within 24 hours of the postoperative period was recorded in both the groups.

The overall level of satisfaction of the patients after 24 hours was determined by means of Likert-like verbal rating scale. It is graded from 1 to 7 where 1 signifies extremely dissatisfied patient, 2 = dissatisfied, 3 = somewhat dissatisfied, 4 = undecided, 5 = somewhat satisfied, 6 = satisfied, and 7 = extremely satisfied.

Patient reported pain intensity as VAS score was considered as the primary outcome. VAS score was recorded after extubation as 0 hour followed by 1, 2, 3, 4, 6, 12, 18, and 24 hours in postoperative period. The hemodynamic parameters, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean blood pressure (MBP) were considered as a secondary outcome and were recorded at

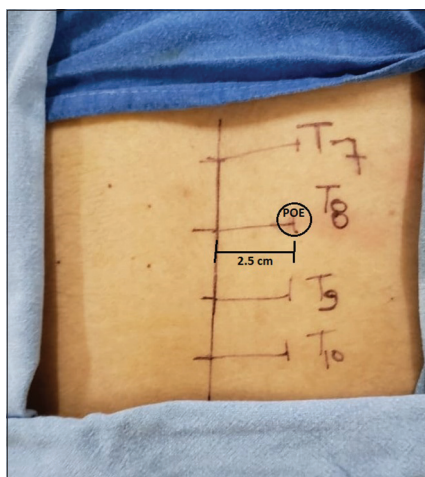


Figure 1: Landmarks showing point of entry (POE)

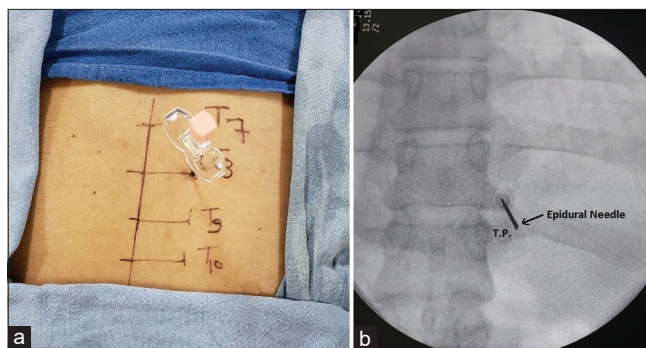


Figure 2: (a) Epidural needle in situ at POE. (b) Needle is touching transverse process (T.P.) of eighth thoracic level (Fluoroscopic anterior-posterior view)

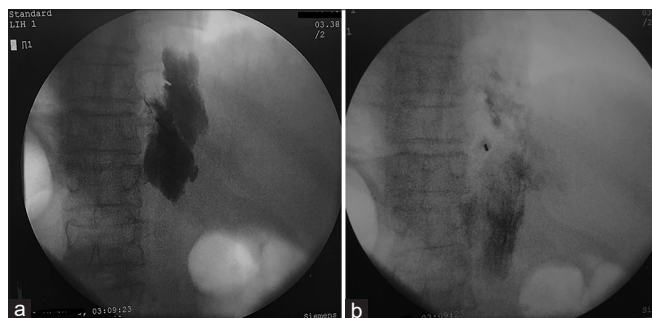


Figure 3: (a) Linear spread of contrast between erector spinae muscle and transverse process (Fluoroscopic anterior-posterior view). (b) Increasing spread of contrast after injection of drug (Fluoroscopic anterior-posterior view)

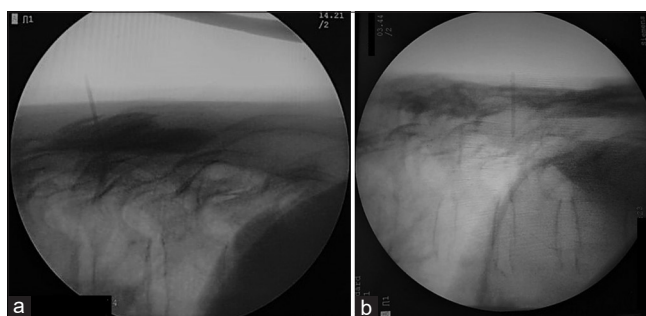


Figure 4: (a) Caudal and cephalic spread of contrast near transverse processes (Fluoroscopic lateral view). (b) Increasing spread of contrast after injection of drug (Fluoroscopic lateral view)

0, 1, 2, 3, 4, 6, 12, 18, and 24 hours. The total postoperative rescue analgesic requirement (tramadol consumption), overall patient satisfaction and any adverse events like hypotension, bradycardia, LA toxicity, postoperative nausea, and vomiting were noted during postoperative period.

In our study, the difference in VAS scores was taken as significant when there was a difference of at least 2 points between Group I and Group II patients during the first hour of postoperative period. This variability was estimated from an interim analysis having standard deviation of 1.7.

Sample sizes were calculated using G Power for Windows (Dusseldorf, Germany). The minimum estimated sample size was 24 in each group considering  $\alpha$  value of 0.05 and power of the study at 0.85. This number was increased to 30 in each group considering any case being canceled or any failure of block. Statistical Package for the Social Sciences (SPSS) for Windows version 23.0 (IBM Corp, NY, USA) was used to perform all statistical analyses. All statistical analyses were considered statistically significant between the groups when the *P* value was less than 0.05.

The mean and standard deviation (SD) of duration of surgery, duration of analgesia due to ESPB, and hemodynamic parameters were performed using student *t*-test. Mann–Whitney U test was used to compare non-parametric data (VAS scores). Categorical data were expressed using Fisher's exact test or Chisquare test or median  $\pm$  (interquartile) range.

## Results

Seventy-one patients were assessed for eligibility to be included in our study and assessment to analysis of study patients is represented in the consort flow diagram [Figure 5]. Sixty-one patients were recruited in this study who underwent PCNL. The groups were comparable with respect to demographics and mean duration of surgery are shown in Tables 1 and 2. There was a significant increase in the time required for the first rescue analgesia when compared with Group I during the first 24 hours of postoperative period [Table 2]. Only eight patients in Group II required rescue analgesia while the remaining 23 patients did not require rescue analgesics in the first 24 hours postoperatively [Table 2]. In Group II patients, VAS score was decreased significantly as compared to Group I in postoperative period [Table 3]. Overall satisfaction score in postoperative period was significantly high in Group II. Heart rate was constantly lower in Group II patients when compared with Group I patients in postoperative

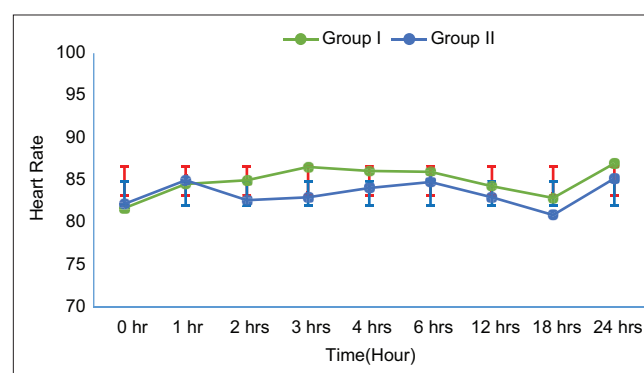
period and it was significantly lower during 2<sup>nd</sup> and 3<sup>rd</sup> postoperative hours [Graph 1]. Rest of the hemodynamic variables (SBP, DBP, and MBP) were comparable in both the groups [Graph 2]. In Group I, two patients had one episode of nausea and vomiting, whereas there was no incidence of any side effects in Group II.

## Discussion

There is a global increase in the incidence of renal calculi in all age groups owing to changed dietary habits and global warming.<sup>[16]</sup> Renal calculi are usually taken care of by PCNL and considered the procedure of choice as this advanced technique results in less morbidity, early mobilization, and reduction in cost compared to open surgery.<sup>[1]</sup> Although PCNL is a less invasive method, still peritubal distressing of the nephrostomy tube, the parenchymal tract, and dilatation of the renal capsule causes severe postoperative pain.<sup>[1,3]</sup>

ESPB is a recently used truncal block for many abdominal and chest pain conditions<sup>[17-19]</sup> In ESPB, the lateral cutaneous branches of intercostal nerves are also blocked in addition to dorsal rami and ventral rami when drug spreads cephalocaudally once deposited between the transverse process and erector spinae muscle.<sup>[20]</sup> ESPB is primarily being performed under ultrasound guidance. In our study, we used fluoroscopic guidance to identify the transverse process which sometimes is confused with ribs under ultrasound guidance. The linear spread of local anesthetic drugs along with contrast could be easily made and a good block efficacy was anticipated accordingly. Moreover, accessibility and availability of fluoroscope for ESPB was an added advantage for us since PCNL was conducted under fluoroscopic guidance.

Postoperative pain after PCNL has been traditionally taken care of by local anesthetic infiltration, combined spinal epidural block, and systemic analgesics such as NSAIDs and opioids.<sup>[21-24]</sup> There was a significant reduction in



Graph 1: Comparison of postoperative mean pulse rate in both groups



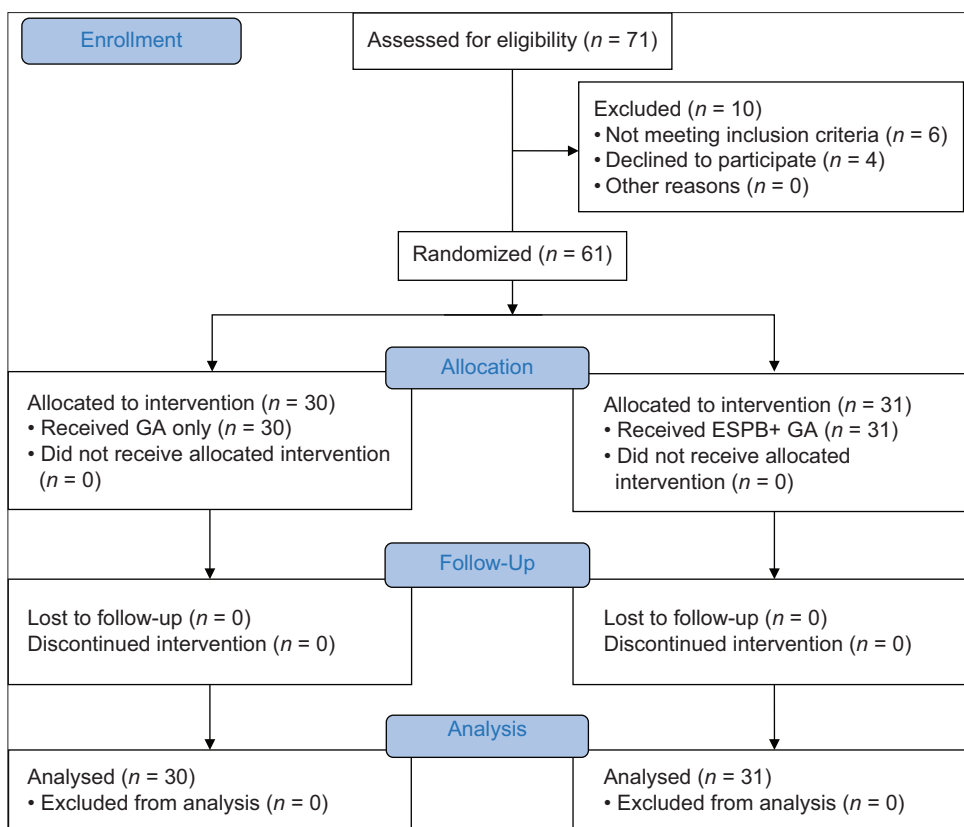


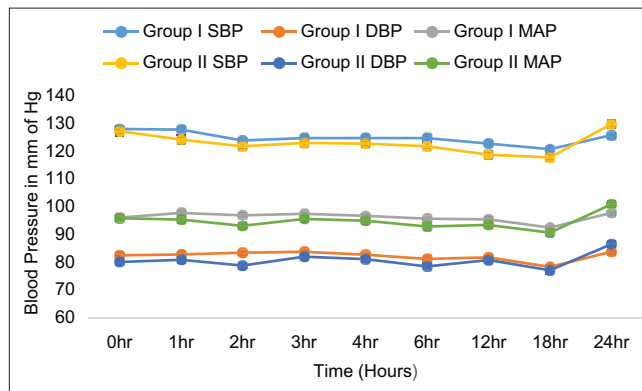
Figure 5: CONSORT 2010 Flow Diagram

Table 1: Distribution of patients according to their demographic data and ASA grading

Parameter	Group I	Group II	P
No of patients	30	31	-
Mean age (years) ±SD	37.37 ± 16.81	41.03 ± 12.58	0.06#
Mean BMI ±SD	22.43 ± 1.26	22.41 ± 1.54	0.783#
ASA I/II	19/11	17/12	0.46#

BMI – Body mass index; ASA – American Society of Anesthesiologists. #Not significant

postoperative pain after PCNL in patients who received ESPB in our study and only eight patients out of 31 patients required rescue analgesia. The time duration for the administration of first rescue analgesia was significantly higher in Group II. Available database suggests no study comparing ESPB with other modalities of postoperative pain relief in PCNL patients. However, in a study comparing paravertebral block with intravenous morphine for postoperative pain relief in PCNL patients, a significant decrease in morphine consumption in paravertebral block patients was observed and the time for first rescue patient controlled analgesia (PCA) use ( $94.28 \pm 24.1$  minutes) in paravertebral block patient was significantly increased.<sup>[25]</sup> Paravertebral block though increased the duration of analgesia but was less when compared to ESPB ( $17.22 \pm 0.97$  hours) in our study. We used a multimodal approach in the form of intravenous paracetamol at regular intervals in both groups, which



Graph 2: Comparison of systolic blood pressure, diastolic blood pressure and mean arterial pressure (mmHg) in both groups postoperatively

probably gave better postoperative pain relief in Group II. Postoperative analgesia can be enhanced by adding different drugs with different mechanisms of action and administering them through different routes. The mean consumption of tramadol 24 hours postoperatively was significantly lower in Group II. Ahmed DG *et al.* conducted a study on second look PCNL where conscious sedation using dexmedetomidine and paravertebral block was used for anesthesia and postoperative analgesia.<sup>[26]</sup> The average time for first rescue analgesia in the postoperative period was  $15 \pm 3.9$  hours compared to  $17.22 \pm 0.97$  hours in ESPB patients in our study. Lönnqvist

**Table 2: Duration of surgery, Rescue analgesia, total analgesic requirement of tramadol and satisfaction score in the both groups**

Parameter	GROUP I	GROUP II	P
Mean Duration of Surgery (minutes) ± SD	110.8±10.83	115.66±13.25	0.096
Time For First Rescue Analgesia (in hrs) Mean±SD	2.89±0.66	17.35±0.92 (Only For 8 Patients)	<0.0001*
Total tramadol consumption in 24 h (mg)	350±57.24	100.00	<0.0001*
Satisfaction score (Mean±SD)	3.1±0.87	5.90±0.82	<0.0001*

\*Significant

**Table 3: Comparison of Visual Analogue Scale score (median interquartile range) in both groups in the first 24 h**

Time (h)	VAS score, median (IQR)		P
	Group I (n=30)	Group II (n=31)	
0	3 (1-5)	1 (1-2)	<0.0001
1	2 (1-3)	1 (0-2)	<0.0001
2	3 (1-4)	1 (0-2)	<0.0001
3	3 (1-4)	1 (0-2)	<0.0001
4	2 (1-4)	1 (0-2)	<0.0001
6	2 (2-5)	1 (0-3)	<0.0001
12	4 (1-5)	2 (1-3)	<0.0001
18	4 (1-5)	2 (0-4)	<0.0001
24	3 (1-5)	2 (1-3)	<0.0001

IQR – Interquartile range; VAS – Visual Analogue Scale

*et al.* compared continuous thoracic paravertebral block (PVB) than classical lumbar epidural block for postoperative analgesia during renal surgeries and found PVB to be better.<sup>[27]</sup> In a letter to the editor by Kim E *et al.* also found that ESPB is an effective approach to counter postoperative pain in PCNL patients. They put a catheter under ultrasound guidance for continuous ESPB.<sup>[28]</sup> In our study, statistical data suggested that pain score was significantly low in Group II patients at all times in postoperative period. However, no comparative study had been done between ESPB and other techniques to compare postoperative analgesia in PCNL and further studies are needed to establish the superiority of ESPB over other techniques.

Other techniques such as spinal epidural anesthesia not only provides analgesia but also has some unwanted effects that would not occur with ESPB, such as prolonged motor blockade, bowel movement impairment, and nausea and vomiting. These additional advantages of ESPB may make it a better analgesic technique in due course of time.

In our study, there was no significant difference in overall SBP, DBP, and MAP between two groups in the postoperative period and that the trend was also somewhat similar if PCNL was conducted under spinal anaesthesia (SA), PVB, and general anaesthesia (GA).<sup>[25,29]</sup> Heart rate (HR) too was comparable in both our groups except at 2<sup>nd</sup> and 3<sup>rd</sup> hours of postoperative period where HR was significantly low in Group II.

The overall satisfaction scores were significantly higher in Group II patients in the present study. In the studies by K. Ak *et al.*, thoracic paravertebral block group patients were more satisfied in postoperative period.<sup>[25]</sup> Ahmed DG *et al.* in their case series found that patients with PVB to be satisfied in postoperative period.<sup>[26]</sup> However, since no data comparing ESPB with PVB are available, we cannot edge ESPB over PVB but is definitely providing better postoperative pain relief than conventional opioid-based or opioid-free analgesia.

None of the patients in our study suffered adverse effects such as pruritus and LA toxicity in any group. In Group I patients, only two patients had nausea and vomiting, whereas in Group II none suffered any nausea or vomiting. No significant side effects like hypotension, bradycardia, respiratory depression, and urinary retention were observed.

Despite the fact that our study resulted in excellent postoperative analgesia with a relatively safe and simple technique, there were few limitations in this study. There were chances of patient and observer bias since our study is nondoubleblinded. Moreover, Group I patients could not be given Sham block because of the ethical concern of unnecessary needling without giving any therapeutic drug. The patients were exposed to fluoroscopic radiation whereas ultrasound guidance is devoid of any radiation. Since the patients were administered ESPB once PCNL was finished, we could not assess the onset of analgesia in these patients. In our study since we are using contrast medium to locate fascial plane it may obscure or partially obstruct surgeon's view while placing fluroscopy guided PCNL needle if we have performed ESPB in begining of surgery. So, we decided to administer ESPB after completion of surgery.

#### Limitation

Larger sample size may be advocated to further emphasize the findings of our study. Institutional financial constraints limited our use of ultrasound for performing the block, which can be a better modality for ESPB.

#### Conclusions

ESPB is a simpler technique under fluoroscopic guidance and it provides better postoperative analgesia in patients

admitted for PCNL. In addition to this, it also provides better hemodynamic stability and overall patient satisfaction with a low complication rate.

### Acknowledgements

The authors deeply acknowledge Dr. Aditya Garg, Dr. Ravi Kumar Kesri, Dr. Gurpartap Singh for organizing and arranging patient document and photographs.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### References

1. Fernstrom I, Johnson B. Percutaneous pyelolithotomy. A new extraction technique. *Scand J Urol Nephrol* 1976;10:257-9.
2. McHugh GA. The management of pain following day-case surgery. *Anesthesiology* 2002;57:270-5.
3. Dalela D, Goel A, Singh P, Shankhwar SN. Renal capsular block: A novel method for performing percutaneous nephrolithotomy under local anesthesia. *J Endourol* 2004;18:544-6.
4. Parikh GP, Shah VR, Modi MP, Chauhan NC. The analgesic efficacy of peritubal infiltration of 0.25% bupivacaine in percutaneous nephrolithotomy --- A prospective randomized study. *J Anaesthesiol Clin Pharmacol* 2011;27:481-4.
5. 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.
6. Restrepo-Garces CE, Chin KJ, Suarez P, Diaz A. Bilateral continuous erector spinae plane block contributes to effective postoperative analgesia after major open abdominal surgery: A case report. *AA Case Rep* 2017;9:319-21.
7. Hamilton DL, Manickam B. Erector spinae plane block for pain relief in rib fractures. *Br J Anaesth* 2017;118:474-5.
8. Ueshima H, Otake H. Similarities between the retrolaminar and erector spinae plane blocks. *Reg Anesth Pain Med* 2017;42:123-4.
9. Scimia P, Basso Ricci E, Droghetti A, Fusco P. The ultrasound-guided continuous erector spinae plane block for postoperative analgesia in video-assisted thoracoscopic lobectomy. *Reg Anesth Pain Med* 2017;42:537.
10. El-Boghdady K, Pawa A. The erector spinae plane block: Plane and simple. *Anaesthesia* 2017;72:434-8.
11. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Continuous erector spinae plane block for rescue analgesia in thoracotomy after epidural failure: A Case report. *AA Case Rep* 2017;8:254-6.
12. Muñoz F, Cubillos J, Bonilla AJ, Chin KJ. Erector spinae plane block for postoperative analgesia in pediatric oncological thoracic surgery. *Can J Anaesth* 2017;64:880-2.
13. 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.
14. Chin KJ, Malhas L, Perlas A. The erector spinae plane block provides visceral abdominal analgesia in bariatric surgery: A report of 3 cases. *Reg Anesth Pain Med* 2017;42:372-6.
15. Tulgar S, Ermis MN, Ozer Z. Combination of lumbar erector spinae plane block and transmuscular quadratus lumborum block for surgical anaesthesia in hemiarthroplasty for femoral neck fracture. *Indian J Anaesth* 2018;62:802-5.
16. Romero V, Akpınar H, Assimos DG. Kidney stones: A global picture of prevalence, incidence and associated risk factors. *Rev Urol* 2010;12:e86-96.
17. 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.
18. Veiga M, Costa D, Brazão I. Erector spinae plane block for radical mastectomy: A new indication? *Rev Esp Anesthesiol Reanim* 2018;65:112-5.
19. Yamak Altınpulluk E, García Simón D, Fajardo-Pérez M. Erector spinae plane block for analgesia after lower segment caesarean section: Case report. *Rev Esp Anesthesiol Reanim* 2018;65:284-6.
20. Ivanusic J, Konishi Y, Barrington MJ. A cadaveric study investigating the mechanism of action of erector spinae blockade. *Reg Anesth Pain Med* 2018;43:567-71.
21. Aravantinos E, Kalogeras N, Stamatou G, Theodorou E, Moutzouris G, Karatzas A, *et al.* Percutaneous nephrolithotomy under a multimodal analgesia regime. *J Endourol* 2009;23:853-6.
22. Chen Y, Zhou Z, Sun W, Zhao T, Wang H. Minimally invasive percutaneous nephrolithotomy under peritubal local infiltration anesthesia. *World J Urol* 2011;29:773-7.
23. Karacalar S, Bilen CY, Sarihasan B, Sarikaya S. Spinal-epidural anesthesia versus general anesthesia in the management of percutaneous nephrolithotripsy. *J Endourol* 2009;23:1591-7.
24. Singh V, Sinha RJ, Sankhwar SN, Malik A. A prospective randomized study comparing percutaneous nephrolithotomy under combined spinal-epidural anesthesia with percutaneous nephrolithotomy under general anesthesia. *Urol Int* 2011;87:293-8.
25. Ak K, Gursoy S, Duger C, Isbir AC, Kaygusuz K, Ozdemir Kol I, *et al.* Thoracic paravertebral block for postoperative pain management in percutaneous nephrolithotomy patients: A randomized controlled clinical trial. *Med Princ Pract* 2013;22:229-33.
26. Ahmed DG, Hetta DF, Abdelraouf AMS. Percutaneous nephrolithotomy under thoracic paravertebral block: A preliminary report. *J Anesth Clin Res* 2017;8:720.
27. Lönnqvist PA. Paravertebral vs epidural block in children. Effects on postoperative morphine requirement after renal surgery. *Acta Anaesthesiol Scand* 1994;38:346-9.
28. Kim E, Kwon W, Oh S, Bang S. The erector spinae plane block for postoperative analgesia after percutaneous nephrolithotomy. *Chin Med J* 2018;131:1877-8.
29. Movasseggi G, Hassani V, Mohaghegh MR, Safaeian R, Safari S, Zamani MM, *et al.* Comparison between spinal and general anesthesia in percutaneous nephrolithotomy. *Anesth Pain Med* 2014;4:1-5.