

Ultrasound-guided erector spinae plane block for postoperative analgesia after percutaneous nephrolithotomy.

Dr Nirmala Devi Kagalkar ¹ MBBS, MD

Dr Anusha Suntan ² MBBS, MD

Dr Puneeth Kumar S ³ MBBS, MD, DNB

Dr Vidya Patil ⁴ MBBS, MD

1. Associate Professor, Department of Anaesthesiology,
BLDEDU Shri B M Patil Medical College Hospital and Research Centre, Vijayapur,
Karnataka, India. E-mail: nirmaladevi.k@bldedu.ac.in. Tel: (+91) 8217618954

ORCID <https://orcid.org/0000-0002-1773-6984>

2. Assistant Professor, Department of Anaesthesiology,
BLDEDU Shri B M Patil Medical College Hospital and Research Centre, Vijayapur,
Karnataka, India. E-mail: dranushasuntan@gmail.com. Tel: (+91) 7795324301

ORCID <https://orcid.org/0000-0002-0435-5226>

3. Assistant Professor, Department of Anaesthesiology, BGS Medical College Hospital,
Bengaluru. Karnataka, India. E-mail: punianaesth@gmail.com. Tel: (+91) 9036165026

ORCID <https://orcid.org/0000-0003-0557-7071>

4. Professor, Department of Anaesthesiology,
BLDEDU Shri B M Patil Medical College Hospital and Research Centre, Vijayapur,
Karnataka, India. E-mail: vidyapatil@gmail.com. Tel: (+91) 9448131260

ORCID <https://orcid.org/0000-0001-8000-1692>

Name of the corresponding author-

Dr Puneeth Kumar S

Department of Anaesthesiology, BGS Medical College Hospital, Bengaluru.

Karnataka, India. Pin code- 563162

E-mail: punianaesth@gmail.com.

Tel: (+91) 9036165026

ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is a standard procedure to remove and disintegrate large kidney stones. Despite minimal invasiveness, it is associated with significant postoperative pain. Erector spinae plane block (ESPB) is a novel interfascial plane block recently introduced to provide analgesia in acute and chronic pain. The current study was conducted to compare the efficacy of ultrasound (USG) guided ESPB and conventional analgesia (CA) following PCNL.

Methodology: After obtaining the institute's ethical committee approval and informed consent, 50 patients were included in the study and were randomized into two equal groups of 25 to receive ESPB with 20 ml of 0.25% bupivacaine or CA. Patients in both groups were given intravenous paracetamol 8th hourly and intravenous tramadol 2mg/kg as rescue analgesia.

Results: Both study and control groups were similar in demographic profile. Pain assessment by Visual analogue scale (VAS) scores in the postoperative period were significantly lower at hours of 20min,40min, and 1,3,6,12 hrs (P<0.0001) and at 9,18 hrs (P<0.05) in the group E, than the control group. The time to first rescue analgesia was observed longer in the ESPB

group than in the control group (2.28 ± 0.58 hrs Vs 15.48 ± 3.17 hrs) ($P < 0.0001$). The average tramadol consumption was less in the ESPB group compared to the control group (139.28 ± 41.36 mg Vs 337.20 ± 38.66 mg) ($P < 0.0001$).

Conclusion: Ultrasound-guided ESPB provides safe and effective postoperative analgesia following PCNL, with decreased VAS scores. ESPB extends the retrieval analgesia time and lessen the requirement for tramadol.

Keywords: Tramadol consumption; Analgesics; Pain relief; Inter-fascial plane block; Renal calculi; Rescue analgesia; VAS scores; Ultrasonography; Erector spinae muscle :

INTRODUCTION:

Percutaneous nephrolithotomy (PCNL) is the preferred surgical intervention for large and multiple renal stones, according to the guidelines of European Association of Urology [1]. Though it is minimally invasive, it causes significant postoperative pain, the principal source of postoperative pain following PCNL is visceral pain from the kidney and ureter whereas the somatosensory pain is from the site of incision. Renal pain derives from the T10-L1 spinal nerve, whereas ureteric pain derives from T10-L2 spinal nerves. Pain, discomfort, stress, and low back pain associated with nephrostomy tube highlight the significance of postoperative analgesia. The indwelling of the renal fistula, peritubular compression of the renal cortex and dilation of a renal capsule also contribute to the aggravation of postoperative pain. Residual stones (4-5 mm) flushed from the kidney to the ureter due to fluid irrigation intraoperatively or discharged due to changes in the body position into the ureter, can stimulate the mucous membrane of the ureter, which causes long-lasting ureteric spasm and pain. As the gastrointestinal and urinary systems are both innervated by the same autonomic nerve, pain may trigger reflex nausea and vomiting [2].

Effective alleviation of pain following PCNL may result in early mobilisation of the patient, lessen hospital stay and discharge time and prevents the transition of acute pain into chronic pain and improves the quality of life. Unsuccessful management of pain increases the risk of pulmonary complications and may also result in postoperative delirium and agitation [3]. Regional anaesthesia techniques like epidural analgesia, intercostal nerve block and paravertebral block have been attempted but are associated with more complications. Peritubal infiltration block using Ultrasound (US) is used to attain both somatic and visceral analgesia, but the duration of action is short [4].

Erector spinae plane block (ESPB) is a recently established inter-fascial plane block used in various thoracoabdominal surgeries for postoperative analgesia, including PCNL [5]. First description of ESPB was done by Forero [6] as a method of pain relief for thoracic neuropathic pain. ESPB is found to be effective in reducing post-PCNL opioid consumption, decreasing pain scores and greatly reducing the odds of having breakthrough pain [7-10]. Despite being useful, just a few studies have shown its effectiveness. Therefore, this study was designed to establish the efficacy of ESPB in providing postoperative analgesia following PCNL. The primary objective of the study was to evaluate the efficacy of ESPB for postoperative analgesia using the VAS score. The secondary objectives were to evaluate the time of request for first rescue analgesia, the postoperative opioid consumption in the first 24 hours, and to observe complications of ESPB and side effects of the opioid.

METHODS

This prospective double-blinded study was carried out in a tertiary care teaching hospital. Institutes Ethics Committee approval was obtained and the study was registered in the Clinical Trials Registry- India (CTRI/2021/02/031343). After obtaining written informed consent, fifty patients aged 18-65 years with an American Society of Anaesthesiologists (ASA) physical status I and II posted for elective PCNL surgery, under General anaesthesia (GA) were included in the study. Patients known to have drug allergy, spine deformity, coagulopathy, BMI ≥ 30 kg/m², uncontrolled co-morbid illnesses, infection at the site of block, major bleeding during surgery, cases which require more than one access for PCNL were excluded from the study.

Patients were randomised by computer-generated random sequence numbers into two study groups, patients in group C (control group) followed conventional analgesia with no block. Patients in group E (ESPB group) followed the same analgesia plan and also USG-guided ESPB. Block was performed by an anaesthesiologist who was not involved in the data collection and analysis. The patient follow-up in the PACU was done by the anaesthesiologist, who was blinded to the allocation of patients.

Premedication, GA induction, maintenance and reversal were same for all the patients. After completion of the surgery and insertion of nephrostomy catheter, USG-guided ESPB block was performed under aseptic precautions in the ESPB group in the prone position. Block was performed using a linear ultrasound transducer probe of high frequency (5-12MHz) at T9. The linear ultrasound transducer probe was placed in the midline in transverse orientation and spinous process was identified. Probe was moved laterally to trace the T9 transverse process. Then the probe was rotated 90° to identify trapezius, erector spinae muscle and transverse process and 23 gauge 90 mm spinal needle was inserted craniocaudally using an in-plane approach. The needle was aimed at the tip of the T9 transverse process deep to the anterior aspect of the erector spinae muscle. The location of the needle tip was confirmed by hydro dissection by injecting 2ml of saline, and visible fluid spread, lifting the erector spinae muscle off the bony shadow of the transverse process. After taking all appropriate safety precautions like good needle visualisation, and repeated aspiration, a volume of 20ml of 0.25% bupivacaine was injected. After reversal of residual neuromuscular blockade, patients were extubated and shifted to the post anaesthesia care unit.

Half an hour before extubation, all patients received 1g of paracetamol intravenously. During the postoperative period, paracetamol 1g every 8 hours was given to both groups. Inj. tramadol 2mg/kg was administered when VAS score ≥ 4 in both groups as rescue analgesia. Minimum six hours interval was allowed between two tramadol doses. If VAS score still ≥ 4 patient was given inj.diclofenac intravenous infusion. The duration of analgesia in Group E was calculated as the interval between ESPB and the first request for a tramadol injection. Both groups kept track of the total amount of intravenous tramadol they needed within 24 hours of the postoperative period.

The postoperative pain score was evaluated using VAS, which was graded from 0 to 10, where 0 indicates no pain and 10 indicates the worst imaginable pain. Prior to surgery, patients were taught how to use the VAS for pain. VAS pain scores and postoperative tramadol requirement for the first 24 hours was recorded in both groups, complications such

as local anaesthetic toxicity, haematoma, nausea, and vomiting were monitored post-operatively. Intravenous ondansetron 4mg was administered to patients who reported nausea and vomiting.

Sample size was calculated on the basis of a study conducted by Tuglar S et al ^[11], the anticipated Mean± SD of mean VAS score in the recovery room was 1± 1.10 in the ESPB group and 2.95± 1.81 in the control group. The minimum sample size was 23 per group with a 5% level of significance and 95% power. The sample size was rounded off to 25 in view of dropouts. Data were analyzed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office 2007. Numerical variables were presented as Mean± SD, and categorical variables were presented as frequency (%) and diagrams. Comparison of numerical variables between groups was found using unpaired t-test/ Mann whitney U test, and categorical variables by Chi-square or Fisher's Exact test. P value < 0.05 was considered statistically significant.

RESULTS:

Patient allocation and randomization is displayed in the Consort flow diagram (Figure-1). Both the groups were similar with respect to demographic profile and mean duration of surgery (Table -1). VAS score (Table-2) (Figures 2) was observed to be lower in group E than in group C, which was statistically highly significant (P<0.0001) at 20min, 40min, 1, 3, 6 and 12 hours and significant (P<0.05) at 9 and 18 hours. Tramadol consumption and time for rescue analgesia and patients required diclofenac were displayed in table-3. Postoperative Tramadol consumption for 24 hours was less in group E (139.28±41.46 mg) compared to group C (337.20±38.56 mg), The time to first rescue analgesia in group E was longer compared to group C (15.38±2.17hrs Vs 2.28±0.56 hrs), which was clinically and statistically significant (P < 0.0001). No patient in group E required diclofenac, but two patients needed diclofenac in group C. Three patients in group C had nausea and vomiting, compared to one in group E (table 4), for which patients received intravenous ondansetron 4mg. No other complications were observed in both the groups.

Discussion:

Demographic profiles such as age, gender, BMI, ASA grade and duration of surgery were comparable in both groups. The main observation in this study was significantly less VAS score up to 18 hours in the group E compared to group C. Tramadol consumption in group E was less compared to group C (139.28± 41.36 mg Vs 337.20± 38.66 mg). Time for first rescue analgesia in study group was more prolonged compared to control group (15.48± 3.17 hours Vs 2.28± 0.58 hours).

Our study results correlate with several previous study results. Rohan Bhatia et al ^[12] in their study ESPB in PCNL surgeries for postoperative analgesia, found that the mean time for rescue analgesia was 12.62± 6.27 hours, significantly reduced VAS pain scores (P <0.000) and less tramadol (103.12± 47.41 mg Vs 218.75± 82.06 mg) consumption compared to the control group. In a study by Kumar G S S et al ^[13], ESPB was compared with infiltration of LA drug at the incision site for postoperative analgesia in PCNL. They performed block at T10 level , by 20 ml of 0.25% bupivacaine and found significantly less NRS pain scores up to 8 hours (P <000), lower postoperative mean opioid consumption (100 mg Vs 150 mg), and longer time to first rescue analgesia (12 hours Vs 0.5 hours). Glutekin M H et al ^[8] assessed

the ESPB for postoperative analgesia for PCNL surgeries, by performing block at T8 level using 20 ml of 0.5% bupivacaine and observed similar results. Prasad MK et al^[9] conducted fluoroscopic guided ESPB for postoperative analgesia by 20 ml of 0.375% ropivacaine at T8 level in patients posted for PCNL and observed lower VAS pain scores ($P < 0.0001$) for 24 hours, prolonged time for rescue analgesia (17.35 ± 0.92 Vs 2.89 ± 0.66 hours) and significantly reduced tramadol consumption (100.00 mg Vs 350 ± 57.24 mg) in block group compared to the control group. They also observed nausea and vomiting in two patients in the control group but no patients in the block group. The above study results were consistent with our study results.

For large kidney stones, PCNL is thought to be the most successful endourological surgery, but it has disadvantages such a higher risk of blood loss, post-operative pain and other complications. The intensity of postoperative pain may be reduced by several methods, like tubeless procedures or by applying a small-bore nephrostomy tube^[14].

ESPB is a recently introduced interfascial paraspinal plane block used for abdominal and thoracic surgery. Forero et al described two techniques of the block. In the first technique, the authors injected LA into the plane between the rhomboid major and erector spinae, i.e., anterior to the erector spinae muscle, in a patient with chronic thoracic neuropathic pain and in another technique, LA was deposited deep to the erector spinae muscle, for video-assisted thoracoscopic surgery, which apart from producing desired analgesic effect also provided cutaneous sensory block. Today's standard practice is to deposit the LA deep into the erector spinae muscle^[15]. Though the exact mechanism of action of ESPB is not fully understood, according to the cadaveric and in vivo studies, the primary mechanism is the spread of LA to the paravertebral space^[16].

ESPB is an easy and safe technique compared to the other regional techniques performed close to the neuraxis. The visualisation and direction of the needle towards the target by ultrasound are simple, and it is associated with a low incidence of complications like pneumothorax and haematoma, as the site of the block is away from pleura and major blood vessels^[17]. Complications like pneumothorax and motor muscle weakness were reported by Hamilton DL^[18] and Selvi et al,^[19] respectively. No such complications occurred in our study as all blocks were performed under USG guidance and after visualisation of the transverse process.

ESPB with single-shot injections will lead to a limited duration of analgesia. Hence ESPB with catheter insertion for intermittent boluses or continuous infusions of local anaesthetic will prolong the duration of analgesia^[20], hence the use of ESPB with single shot technique over ESPB with catheter insertion is one of the limitations of the current study. The current study took a very small sample size into account. Using a larger sample size, additional research may be conducted.

Conclusion: Ultrasound guided ESPB is a simple, safe and effective interfascial plane block, that provides good postoperative analgesia for PCNL surgery. ESPB decreases the postoperative VAS scores, prolongs the rescue analgesia time and reduces the need for postoperative opioids.

Financial support: Nil

Conflicts of interest: There are no conflicts of interest.

References:

1. Kyriazis I, Panagopoulos V, Kallidonis P, Özsoy M, Vasilas M, Liatsikos E. Complications in percutaneous nephrolithotomy. *World J Urol.* 2015;33(8):1069-77.
2. Wu H, Ding T, Yan S, Huang Z, Zhang H. Risk factors for moderate-to-severe postoperative pain after percutaneous nephrolithotomy: a retrospective cohort study. *Sci Rep.* 2022;12(1):8366.
3. Unal S, Baskan S, Guven Aytac B, Aytac I, Balci M. Should the Erector Spinae Plane Block Be Applied in the Pain Management of Percutaneous Nephrolithotomy? *Cureus.* 2022;14(2):e22554.
4. Ibrahim M, Elnabtity AM. Analgesic efficacy of erector spinae plane block in percutaneous nephrolithotomy: A randomised controlled trial. *Anaesthesist.* 2019;68(11):755-61.
5. Lobate P, Jadhav VR, Yadav A. Comparison of the efficacy of erector spinae plane block and peritubular infiltration of levobupivacaine for postoperative analgesia following percutaneous nephrolithotomy. *J Anaesthesiol Clin Pharmacol.* 2021;37(4):574-79.
6. Sarkar S, Jena SS, Nayak P, Mitra JK. Postoperative Pain Relief Following Lumbar Erector Spinae Plane Block in Patients Undergoing Percutaneous Nephrolithotomy: A Randomized Controlled Trial. *Urology.* 2022;160:69-74.
7. Pehlivan S S, Gergin O O, Baydilli N, Ulgey A, Erkan I, Bayram A. Effectiveness of erector spinae plane block in patients with percutaneous nephrolithotomy. *Nigerian J Clin Pract.* 2022;25(2):192-96.
8. Gultekin MH, Erdogan A, Akyol F. Evaluation of the Efficacy of the Erector Spinae Plane Block for Postoperative Pain in Patients Undergoing Percutaneous Nephrolithotomy: A Randomized Controlled Trial. *J Endourol.* 2020;34(3):267-72.
9. 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 randomised controlled study. *Saudi J Anaesth.* 2020;14(4):480-86.
10. Yang H, Lee H, Chappidi M, Bowman M, Hamouche F, Ahn J, et al. The erector spinae plane block reduces breakthrough pain after percutaneous nephrolithotomy. *J Of Urol.* 2021; 206.
11. Tulgar S, Kapakli MS, Kose HC, Senturk O, Selvi O, Serifsoy TE, et al. Evaluation of Ultrasound-Guided Erector Spinae Plane Block and Oblique Subcostal Transversus Abdominis Plane Block in Laparoscopic Cholecystectomy: Randomized, Controlled, Prospective Study. *Anesth Essays Res.* 2019 Jan-Mar;13(1):50-56
12. Bhatia R, Asthana V, Sarpal R, Bindal K. Role of Erector Spinae Plane Block for Postoperative Analgesia in Patients Undergoing Percutaneous Nephrolithotomy. *J of Med Sciences.* 2021; 7(3): 235-38.
13. Kumar G S S, Balakundi P, Deo A. ESRA19-0663 A new indication of erector spinae plane block for perioperative analgesia in percutaneous nephrolithotomy (PCNL) surgery: case series. *Regio Anesthesia and Pain Med.* 2019; 44: 254-55.

14. Bryniarski P, Bialka S, Kepinski M, Szelka-Urbanczyk A, Paradysz A, Misiolek H. Erector Spinae Plane Block for Perioperative Analgesia after Percutaneous Nephrolithotomy. *Int J Environ Res Public Health*. 202; 18(7): 3625.
15. 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(5):621-27.
16. Chin KJ, El-Boghdadly K. Mechanisms of action of the erector spinae plane (ESP) block: a narrative review. *Can J Anaesth*. 2021;68(3):387–408.
17. Pablo Kot , Rodriguez P, Granell M, Cano B, Rovira L, Morales J, et al. The erector spinae plane block: a narrative review. *Korean J Anesthesiol*. 2019;72(3):209–20.
18. Hamilton DL. Pneumothorax following erector spinae plane block. *J Clin Anesth*. 2019;11:e3815.
19. Selvi O, Tulgar S. Ultrasound-guided erector spinae plane as a cause of the unintended motor block. *Rev Esp Anestesiol Reanim*. 2018;65(10):589-92.
20. 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. *A A Case Rep*. 2017;9(11):319–21.

Table 1: Demographic and baseline characteristics

Variables	Group E	Group C	Test	P value
	Mean±SD	Mean±SD		
Gender (male/female)	18/7	17/8		Not applicable
Age	44.16±12.092	40.72±9.271	1.129	0.265
Height	163.60±11.079	158.44±12.207	1.565	0.124
Weight	64.20±12.000	63.92±9.151	0.093	0.926
BMI	23.92±3.593	25.48±2.988	-1.669	0.102
ASA(grade 1 /grade 2)	12/13	16/9	1.299	0.2595
Duration of surgery	120.38±32.54	118.54±41.62	0.058	0.954
*: Statistically significant				

Table 2: Comparison of VAS Score between two groups

VAS score	Group E			Group C		95% CI	Mann-Whitney U Test	P value
	Mean	±SD	95% CI	Mean	±SD			
20 th min	2.00	1.041	1.57-2.43	3.44	1.530	2.81-4.07	133.000	0.0001*
40 th min	1.80	1.041	2.23-1.37	3.24	1.091	2.79-3.69	114.000	0.0001*
1 st hr	1.68	1.030	1.26-2.10	3.56	1.474	2.95-4.17	100.500	0.0001*
3 rd hr	1.44	1.227	.93-1.95	3.48	1.229	2.97-3.99	70.000	0.0001*
6 th hr	1.64	1.524	1.01-2.27	3.16	0.987	2.75-3.57	134.500	0.0001*
9 th hr	1.96	1.136	1.49-2.43	2.76	0.879	2.40-3.12	200.500	0.020
12 th hr	2.80	1.702	1.79-2.37	2.80	0.577	2.56-3.04	150.500	0.001
18 th hr	2.52	1.653	2.25-2.79	2.84	1.473	2.64-3.04	226.000	0.049
24 th hr	2.72	1.458	2.53-2.91	2.80	1.408	2.63-2.97	287.500	0.512

Table 3: Comparison of postoperative analgesia requirement between two groups

Variables	Group E (n = 25)		Group C (n = 25)		Mann-Whitney U Test	P value
	Mean	±SD	Mean	±SD		
Total Tramadol requirement in first 24 hours (mg)	139.28	41.36	337.20	38.66	152.500	< 0.0001*
Time to first rescue analgesia (hours)	15.48	3.17	2.28	0.58	199.500	< 0.0001*
Number of patients requiring Diclofenac sodium, n%	0(0)		2(8)		p = 0.002*	

*: Statistically significant

Table 4: Comparison of complications between two groups

Complications	Group E(n = 25)	Group C(n = 25)	P value
Nausea	1(4%)	2(8%)	0.973
vomiting	0(0.0%)	1(4%)	0.985
Haematoma	0(0.0%)	0(0.0%)	Not applicable
Local anaesthetic toxicity	0(0.0%)	0(0.0%)	Not applicable

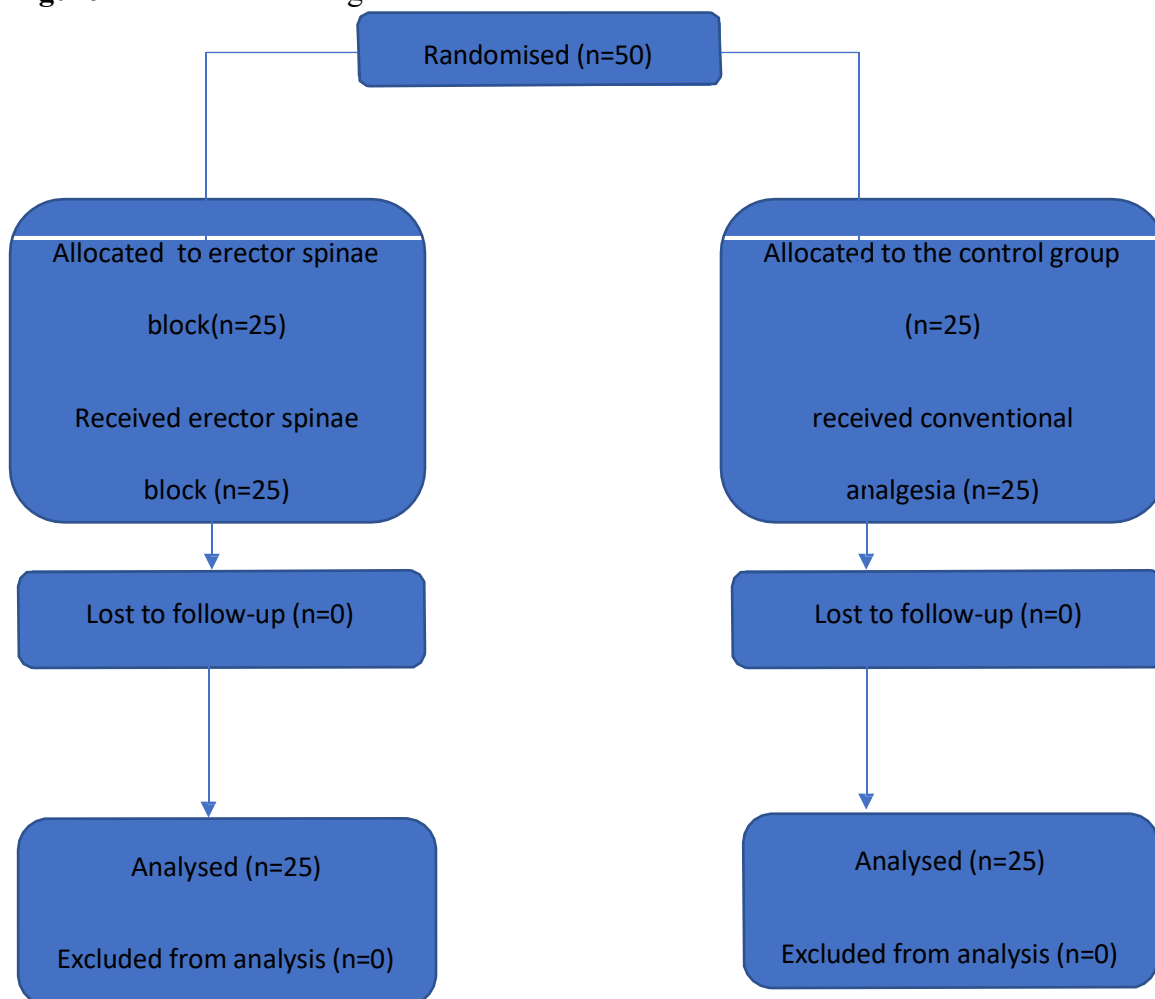
Figure 1 Consort flow diagram.

Figure 2 Comparison of VAS Score between two groups

