Original Article

Erector spinae plane block for postoperative analgesia following percutaneous nephrolithotomy under spinal anaesthesia- A randomised controlled study

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Submitted: 25-Jul-2022
Revised: 06-Dec-2022
Accepted: 07-Dec-2022
Published: 20-Dec-2022

Access this article online

Website: www.ijaweb.org

DOI: 10.4103/ija.ija_692_21

Quick response code

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ABSTRACT

Background and Aims: Postoperative pain is a multitude of various irksome sensory, emotional and mental experiences aggravated by surgical trauma and associated with autonomic, endocrine, metabolic, physiological and behavioural responses. The aim of this study was to evaluate the effect of erector spinae plane block (ESPB) in postoperative analgesia following percutaneous nephrolithotomy (PCNL) under spinal anaesthesia. **Methods:** This prospective randomised study was conducted on sixty American Society of Anesthesiologists physical status I and II patients scheduled for PCNL under spinal anaesthesia. They were randomised into two equal groups of thirty patients. ESPB was given in group A with 20 ml of injection bupivacaine 0.25% and dexamethasone 8 mg and group B received injection tramadol 1.5 mg/kg intravenously immediately after PCNL. The primary outcome was comparison of visual analogue scale (VAS) score in the first 24 h postoperatively, whereas secondary objectives included hemodynamic variables and requirement of rescue analgesia. **Results:** VAS score in group A (ESPB) with mean of 3.15 ± 0.68 was comparatively low when compared to group B with mean of 6.61 ± 0.50 at 6 hours. After 4 h postoperatively, VAS scores continued to be higher and significant number of patients required rescue analgesia in group B. **Conclusion:** ESPB reduced VAS score, provided adequate postoperative analgesia, with similar haemodynamic changes and adverse effects in comparison to the conventional analgesia with tramadol in PCNL.

Key words: Nephrolithotomy, pain, percutaneous, regional anaesthesia, tramadol

INTRODUCTION

Over a period of years, the practice of administering opioids and non-steroidal anti-inflammatory drugs (NSAIDS) constituted most of the postoperative pain management strategies after spinal anaesthesia. However, their unpleasant side effects such as gastritis, diarrhoea, nausea and vomiting have not been favourable from the patient point of view. Recent advances in regional anaesthesia such as using myofascial blocks have been proving their efficacy in reducing the postoperative site pain devoid of the unpleasant side effects especially for abdominal and thoracic surgeries. Percutaneous nephrolithotomy (PCNL) is a minimally invasive surgery performed for renal and ureteric calculi extraction. One of the most common complications of this procedure is acute pain in the postoperative period which is due to cutaneous innervation at the incision site (T8–T11) and renal parenchymal and ureteric pain (T10–L2). Ultrasound-guided erector spinae plane (ESPB) block is a novel procedure in regional

How to cite this article: 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.

anaesthesia, described in 2016, that has been shown to be effective in managing both acute and chronic pain. The hypothesis that ESPB is a differential block mediated by the smaller C fibres rather than the bigger A-delta and A-gamma fibres is one explanation for this significant effect.[1-3]

Dexamethasone, a synthetic glucocorticoid derivative, is favoured due to its powerful anti-inflammatory and immunosuppressive properties. When administered perineurally, it impedes the transfer of nociceptive C fibres and reduces inflammatory and ectopic neuronal firing along with the upregulation of potassium channels. An added advantage is that it decreases postoperative nausea and vomiting. Thus, the current research was undertaken to study the effectiveness of ESPB with 20 ml of 0.25% bupivacaine and 8 mg dexamethasone as opposed to the conventional intravenous (IV) tramadol 1.5 mg/kg for postoperative analgesia and to minimise the haemodynamic changes associated with pain following PCNL procedures.

The primary outcome monitored was comparison of the visual analogue scale (VAS) score in the first 24 h postoperatively, whereas the secondary objectives included haemodynamic variables and requirement of rescue analgesia which were recorded postoperatively.

METHODS

After receiving acceptance from the institutional ethics subcommittee (Research Protocol Number: IESC/FP/2020/32), this prospective randomised, comparative study was carried out in accordance with the principles of the Declaration of Helsinki, and patients had given their written informed consent after receiving a patient information document. We carried out the research for duration of eight months from 15 January 2020 to 15 September 2020, in a tertiary medical hospital and research centre.

Patients were allocated into two groups at random by a computer-generated random sequence number: group A and group B. Our study was limited to American Society of Anesthesiologists (ASA) physical status I–II patients between the ages of 18 and 60 years who were listed for PCNL procedure under spinal anaesthesia. Patients unwilling to participate in the trial, those known to be hypersensitive to any of the study medicines, and patients with known coagulopathy were excluded. Sample size estimation was done using the values of VAS score from a study by S Kumar GS *et al*.[4] Assuming the moderate effect size (0.5), the calculated sample size was 49 using G POWER (Faul, & Buchner, Germany, 1996) software version 3.1.9.4. However, in our study we took a sample size of 60 (30 in each group) to compensate for any attrition. Preoperative assessment was conducted on the day before surgery, during which a thorough history and clinical examination were done and recorded. In the operating room, non-invasive blood pressure, oxygen saturation and electrocardiography were monitored, and the baseline vitals were noted. Peripheral venous access was established with a 20 gauge IV cannula and with proper aseptic measures; spinal anaesthesia (with injection bupivacaine 0.5% 3.5 ml) with a fixed adjuvant (injection fentanyl 25 μg) for all the patients was administered in the sitting position. At the end of the surgery, erector spinae block was performed on the respective operated side with patient lying prone, as per the surgical requirement. The field was prepared with povidone iodine 5%, and two to three ml of 2% lidocaine infiltration was given subcutaneously at the site where the block had to be given. A high-frequency, linear, ultrasound probe was used to identify the ultrasound anatomical landmarks comprising the transverse process at the T8 level and the trapezius and erector spinae muscles, organised from posterior to anterior. Under ultrasound guidance, a 90 mm 22 gauge spinal needle was inserted in a cranial to caudal direction by the in-plane needling technique, aiming at the tip of the transverse process. Bupivacaine 0.25% and dexamethasone 8 mg were injected in a total volume of 20 ml after making mild contact with the transverse process tip in group A.[5] All appropriate safety measures were taken before administering the local anaesthetic (LA) (good needle visualisation, recurrent aspiration and feedback about pressure during injection). VAS score at rest, 2 hours, 4 hours, 12 hours and 24 hours following surgery were recorded. Haemodynamic parameters 15 min after the block, 2 hours, 4 hours, 12 hours and 24 hours following surgery were recorded. During the postoperative period, patients were given IV tramadol 1.5 mg.kg^{-1} stat for rescue analgesia when the VAS pain score was more than 7. Subsequent rescue analgesics were given if the patient had a pain score of 5 or more.

In group B, injection tramadol 1.5 mg/kg IV was given routinely for all the patients. Injection paracetamol

15 mg/kg IV was given for rescue analgesia in group B. Time of administration of the rescue analgesic was noted, and a chart was maintained.

Data was collected, compiled and tabulated. The statistical analysis was executed on the basis of z-test (with a standard normal variant) with 95% level of significance. The G POWER statistical package was used to analyse the data, with the unpaired t-test for quantitative analysis and qualitative data analysis, respectively.

RESULTS

A total 60 patients were analysed [Figure 1]. Age, gender, weight, length of surgery and ASA grading of patients in the two groups were equivalent ($P > 0.05$) [Table 1]. All the patients in both the groups reported VAS of 2-4 at rest and at 2 hours postoperatively, and the difference was statistically insignificant with *P* value of 0.495. At 4 hours, out of 30 patients in group B, seven patients had VAS of 1-2, 21 patients had VAS of 3-4 and two patients had VAS of 5-6 with mean and standard deviation (SD) of 3.15 ± 0.68, whereas the patients in the control group had VAS of 6-7 with mean and SD of 6.61 ± 0.50 and *P* value was <0.001 [Table 2]. The VAS scores were significantly lower in the group A thereafter ($P < 0.001$).

The heart rates (HRs) in the two groups did not differ statistically at baseline, 2 hours, 4 hours, 6 hours, 12 hours and 24 hours following the surgery. However, the HR in the control group was slightly on the higher side postoperatively at 6 h and 24 h, and the difference was statistically significant with a *P* value of less than 0.001 [Figure 2].

Systolic blood pressure (SBP) and diastolic blood pressures (DBPs) recorded were marginally higher at 6 hours and 24 hours in the postoperative period with a statistically significant *P* value of less than 0.001. On an average, the control group essentially required 3-4 doses of rescue analgesia, whereas patients in

Table 1: Distribution of the study subjects in both the groups according to the age

Parameter	Group A (Mean±standard deviation)	Group B (Mean±standard deviation)	P
Age in years	48±16.08	47.92±17.96	0.68
Weight in kg	57.566±9.32	60±8.179	0.287
Height in metres	1.62±0.08	1.62±0.08	0.133

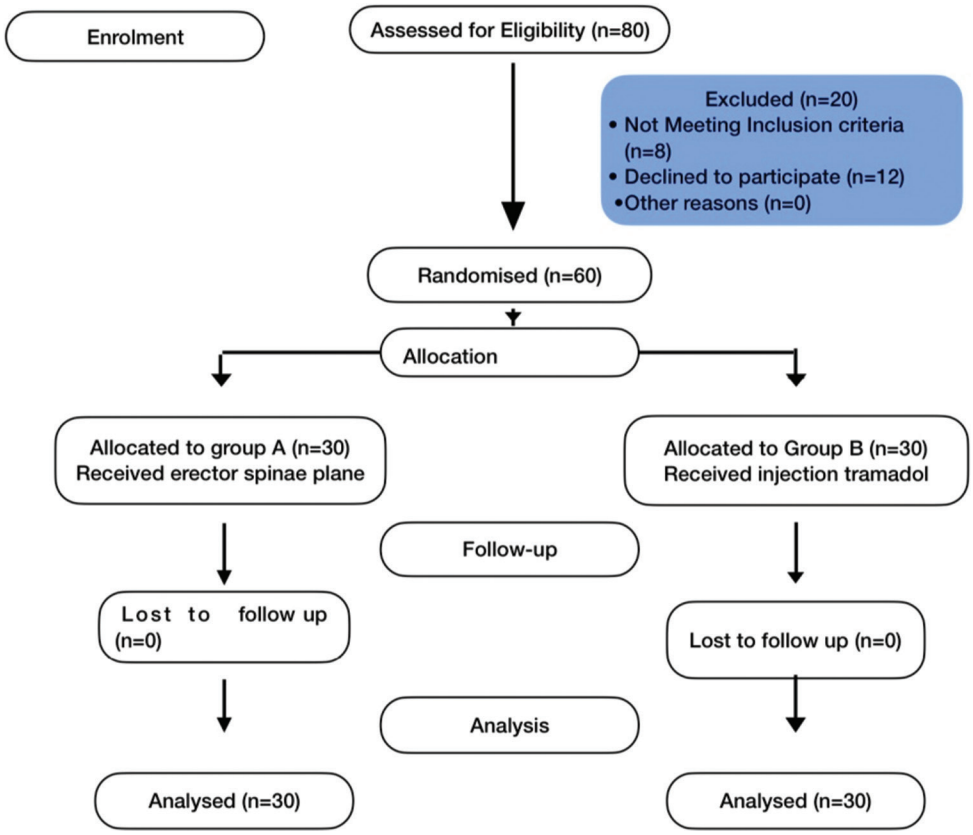

Figure 1: Consolidated standards of reporting trials (CONSORT) diagram

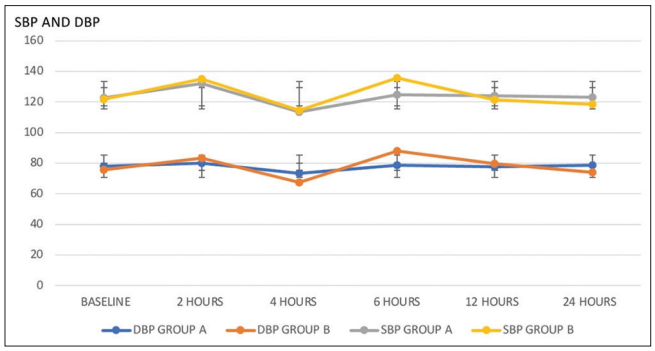

Figure 2: Diastolic and systolic blood pressure in both the groups

Table 2: Comparing the VAS score between both the groups

	Mean±SD		*P*
	Group A	Group B	
VAS			
2 h	2.07±0.75	2.46±0.66	0.495
4 h	3.15±0.68	6.61±0.50	<0.001*
6 h	3.92±0.64	4.46±0.51	<0.001*
12 h	2.21±0.57	5.53±0.50	<0.001*
24 h	2.07±0.64	3.96±0.50	<0.001*

SD=Standard deviation; VAS=Visual analogue scale; *P*<0.001*, significant

ESPB group required 0-1 dose of the same having a statistically significant *P* value of 0.001 [Figure 3].

DISCUSSION

In our study, ESPB was compared with conventional use of tramadol as a mode of postoperative analgesia following PCNL. ESPB showed a significant reduction in the VAS scores and the requirement of rescue analgesia with similar haemodynamic variables.

PCNL is a minimally invasive surgical procedure for treating urolithiasis, which extends the benefits of shorter hospital stay, reduced morbidity and early recovery. Pain following PCNL is due to incision site at the 10th to 11th intercostal space (corresponds to T8–T12 dermatome), renal parenchymal or capsule dilatation (T10–L1), ureteric pain (T10–L2) and the nephrostomy tube.[6]

Multimodal analgesia for PCNL includes conventional use of opioids, NSAIDS, local infiltration, epidural analgesia, blocks such as paravertebral block, intercostal block and peritubal infiltration of ropivacaine or bupivacaine. The ESPB was initially pioneered by Chin KJ *et al.* in 2016 as a successful approach for treating thoracic neuropathic pain.[2]

Ultrasound-sound-guided ESPB blocks the ramus dorsalis of the thoracic and abdominal spinal

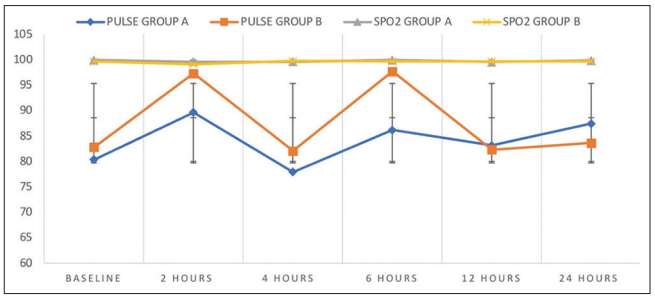

Figure 3: Heart rate, peripheral oxygen saturation (SpO_2) in both the groups

nerves and has a remarkably wide spectrum of application.[7] Studies have shown that ESPB provides adequate postoperative analgesia for thoracotomy, modified radical mastectomy, multiple rib fractures, lumbar spine surgery, caesarean sections, total abdominal hysterectomies, extracorporeal shockwave lithotripsy, hemiarthroplasty, hernia repairs and laparoscopic procedures.[8-12]

Bovincini D *et al.*, in their recent investigation, used 20 ml volume of dye in the erector spinae plane at the tip of the T7 transverse process and demonstrated the histotopographic spread cranially and caudally from T2/3 to L2–L3 with a lateral extension of up to 10 cm when injected in a cadaver.[13] It spread anteriorly into and along the costotransverse foramen and into the surrounding area of the origin of dorsal and ventral rami. Based on this data, we calculated the volume and injected 20 ml LA in the thoracic area to cover the dermatomal area of the operating field.

In our study, VAS scores were in the range of 3–4 for 21 patients and significantly reduced after 4 hours postoperatively in the ESPB group, whereas in the control group, the VAS scores were higher.

Several authors debate that ESPB is a promising approach that produces excellent postoperative analgesia with reduced requirement of opioids and other analgesics. In the research by Swati S *et al.* and S Kumar GS *et al.*, the duration of analgesia was 6–8 hours, maximum patients were free of pain for 24 hours postoperatively with a VAS of less than 3, and no postoperative rescue analgesia was necessary.[4,13,14]

The mean time to first rescue analgesia was 12 h, and the total tramadol requirement was less in our study. The control group essentially required an average of 3–4 doses of rescue analgesic while the ESPB group required 0–1 doses of the same [Table 3]. Since the incision site is from T10–T11, the extent of pain ranges

Table 3: Rescue analgesia used in both the groups

Rescue analgesia used	Group A (Mean±SD)	Group B (Mean±SD)	*P*
Number of doses per patient	0.51±0.62	3.86±0.47	<0.001

SD=Standard deviation

from T8 to T12. Thus, we could determine from our study that sufficient analgesia can be achieved if the block is given at T8.[15,16]

HR, SBP and DBP values in our study were comparable between the groups. VAS differed significantly between both the groups after 4 hours of ESBP postoperatively. The VAS score was significantly higher in the control group B than the ESPB group ($P < 0.001$).

Our study was associated with some limitations such as smaller sample size, limited variables and absence of blinding.

CONCLUSION

ESPB reduced VAS score and provided adequate postoperative analgesia, with similar haemodynamic changes and adverse effects in comparison to the conventional use of analgesia with tramadol in PCNL.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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