Efficacy of Ultrasonography Guided Erector Spinae Plane Block for Perioperative Analgesia in Percutaneous Nephrolithotomy

Srinivas Kalabhavi[1], Revanasiddappa A. Kanagali[2], Bhuvanesa Nanjappa[3], Ravi Bhat[4], Promod Makanavar[5]

[1, 2, 3, 5] Department of Urology, SDM College of Medical Science and Hospital, Dharwad, Karnataka, India.
[4]Department of Anaesthesia, SDM College of Medical Science and Hospital, Dharwad, Karnataka, India.

ABSTRACT

BACKGROUND

Erector spinae block is a paraspinal, fascial block that targets the ventral, dorsal rami and rami communications of spinal nerves. The present study was conducted to know the efficacy of ultrasound guided erector spinae block (ESP) block in preoperative analgesia among patients with percutaneous nephrolithotomy (PCNL) attending a tertiary care hospital.

METHODS

The study was carried out on 596 patients from Jan 2015 to Jan 2020 who were indicated for PCNL. They were divided into two groups, group A (ESP = 373) and group B (intravenous-IV analgesia = 273). In the group A (N = 373), after induction of general anaesthesia, ESP block with 0.5 % bupivacaine and 1 / 200,000 epinephrine (single shot) was given at lower thoracic level (T10 - 12) and IV analgesia was given in group B. All patients were monitored for supplemental opioid requirement intraoperatively as assessed by their haemodynamic status (baseline change in heart rate-HR & mean arterial blood pressure-MAP). The primary outcome of the study was consumption of tramadol in 24 hrs. Pain assessment every 2-hour pre- and post-operatively using numerical rating (NR) scale was considered as the secondary outcome. Categorical outcomes were compared between study groups using chi-square test / Fisher's exact test; P-value of < 0.05 was considered statistically significant using IBM SPSS.

RESULTS

Most of them in group A were free of pain for 24 hours postoperatively with numerical rating scale score of < 3 and did not require any postop rescue analgesics. Only 1 patient showed numerical rating scale score of 4 around 16 hrs. after the surgery and was given tramadol. Supplemental opioid analgesic was not required by any of the patients during the entire intraoperative period.

CONCLUSIONS

ESP block is a favourable technique that results in very good analgesic effect preoperatively and also lessens the use of intravenous opioids and other analgesics.

KEYWORDS

ESP Block, PCNL Surgery, Tramadol, Kidney Stones

Corresponding Author:
Dr. Revanasiddappa A. Kanagali,
SDM Staff Quarters,
H. No. 403, Ratnashree Vihar,
Sattur, Dharwad – 580001,
Karnataka, India.
E-mail: siddukanagali@gmail.com

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BACKGROUND

Renal calculi are very often treated by a minimally invasive surgical procedure known as percutaneous nephrolithotomy. It is favourable treatment for refractory renal calculi and can be administered safely under both general and neuraxial anaesthesia. General and neuraxial anaesthesia results in complications and hence is contraindicated in special cases where managing these patients is a real challenge.

A nephrostomy tube is usually inserted after PCNL to provide adequate urinary drainage, haemostasis, and access for possible complications. However, nephrostomy tubes can cause significant postoperative pain and prolonged hospitalisation which can lead to patient dissatisfaction.[1] The most common type of pain is visceral pain arising from kidney and ureter. Somatic pain arise from incisional site. These are the common post-operative complications seen after PCNL.

Current modalities used to manage pain for patients undergoing PCNL include oral and parenteral opioid administration, local anaesthetic infiltration, and certain neuraxial and regional anaesthesia procedures including thoracic epidurals and paravertebral blocks.[2,3] These techniques have proven to provide appropriate analgesic coverage but are not without risks and potential side effects.[4]

In the last few years, the erector spinae plane block is being used tremendously for ultrasound guided injection of general anaesthetic into the paraspinal interfacial plane, to minimise regional acute pain. The sonographic landmarks are identified easily, and catheter is easily inserted into the plane after distention is induced by the injection in ESPB technique which is simple to administer. The ESPB has an additional advantage of providing both somatic and visceral sensory blockade.

The injectate is placed deep to the erector spinae muscle causing it to separate from the posterior surface of the transverse process.[5] It was first described by Forero et al. in 2016 for the treatment of chronic thoracic neuropathic pain and postoperative pain in thoracic surgery. Since then, many articles have been published describing the application of the technique for a wide variety of clinical scenarios.[6]

ESPB can be performed as a single shot injection or via catheter placement. Pain after single shot ESPB injections has been reported to recur after 2 to 3 h despite using long-acting local anesthetics.[7] In 2018, Kim et al. published a single-patient case report of a patient who underwent placement of an erector spinae plane catheter (ESPC) for postoperative pain management after PCNL.[8]

Postoperative pain after breast cancer surgery is reduced using various procedures that are widely used like epidural, paravertebral, and intercostal blocks. Though the best approach with less complications has not yet formulated. The epidural block causes haematoma, abscess and dural puncture and involves multiple punctures. The paravertebral block achieves a perfect analgesic effect but causes pneumothorax and hence, becomes difficult to implement. The intercostal nerve block is easy to administer but it requires multiple segments.

Subsequently, this technique was applied for pain management following many surgeries and the analgesic effect was encouraging.

With this background the present study is undertaken to determine the efficacy of ESPB used for intraoperative and postoperative pain management among PCNL patients attending a tertiary care hospital in Dharwad, Karnataka.

METHODS

This is an analytical prospective observational study conducted over a period of five years from Jan 2015 to Jan 2020. Patients attending tertiary care hospital, Dharwad, Karnataka indicated for PCNL were selected for study. A total of 1000 subjects were screened and 596 were selected according to inclusion criteria using convenience sampling.

Ethical and Informed Consent

Permission was obtained from research and ethical committee board of the concerned hospital. Written informed consent was obtained from subjects before the procedure. Confidentiality of the subjects was maintained.

Inclusion Criteria

- Both male and female patients between 18 and 60 years of age,
- Patients weight, 40 - 80 kg.
- Patients scheduled for PCNL with single subcostal nephrostomy tract and
- Patients requiring 18 / 20 French nephrostomy tube at the end of procedure.

Exclusion Criteria

- Patients with renal stones requiring more than a single puncture or supracostal puncture,
- Patients with body mass index of > 30 kg / m 2,
- Patients with uncontrolled diabetes and hypertension.
- Patients with excessive intraoperative bleeding,
- Patients with surgery lasting for > 3 hrs.
- Patients with delayed recovery
- Patients requiring postoperative ventilation.

Data Collection

The subjects were separated in two groups. Group A (ESP) and group B (IV analgesia). The subjects who participated in data collection were not aware of the group assignments. The patients were preoperatively instructed on the use of the numerical rating scale (NRS) with scores ranging from 0 (no pain) to 10 (worst pain imaginable). Baseline measurements of heart rate, mean arterial blood pressure, temperature (° C), respiratory rate (RR), and room air oxygen saturation (SpO2) were obtained using a patient monitoring system.

Intervention

US-guided ESPB was administered using 0.5 % bupivacaine and 1 / 200,000 epinephrine at the 11th and 12th intercostal spaces after premedication in group A. Group B was given IV analgesia. The postop rescue analgesic regimen included regular administration of tramadol IV drip (1 mg / 8 h). Postoperative nausea and vomiting were recorded and treated if they occurred. Postoperative pain and tramadol consumption were recorded. Postoperative patient was followed for 24 hrs. for pain. Rescue analgesia was injection tramadol 1 mg / kg, IV. Time to first rescue analgesia, number of doses and patient satisfaction were noted in all patients. The NRS scale was used to determine pain score. Before discharge, patient satisfaction with postoperative pain control was assessed using NRS scale.[9] The primary outcome of the study was consumption of tramadol in 24 hrs. and pain assessment every 2-hour using NR scale was considered as the secondary outcomes.

Statistical Analysis

Descriptive statistics were presented as mean standard deviations, frequencies and proportions. Inferential statistics: Independent sample t-test was used to compare mean values between study groups (2 groups). Medians and interquartile range (IQR) were compared between study groups using Mann Whitney u test (2 groups). Categorical outcomes were compared between study groups using chi square test / Fisher's exact test. P-value of < 0.05 was considered statistically significant. IBM SPSS version 22[10] was used for statistical analysis.

RESULTS

A total of 596 patients were enrolled. Table 1 shows the mean age which was > 45 in both the groups and majority of them were males in both the groups. Statistically significant difference was not seen between the two groups with respect to baseline characteristics (age, gender, side of the calculus, comorbidity and procedure done). Pre and postoperative tramadol consumption were high in group B compared to ESPB group.

	Parameter	Study Group: (IV analgesia) Group B (N = 223, 37.4 %)	Study Group: (ESP block) Group A (N = 373, 62.6 %)	P Value
	Age (Mean ± SD)	46.56 ± 14.51	45.06 ± 14.31	0.220
Gender	Male	127 (56.95 %)	230 (61.66 %)	0.256
	Female	96 (43.05 %)	143 (38.34 %)	
Side	Bilateral renal calculus	22 (9.87 %)	34 (9.12 %)	
	Lift renal calculus	92 (41.26 %)	138 (37 %)	0.494
	Right renal calculus	109 (48.88 %)	201 (53.89 %)	
	Comorbidity	37 (16.59 %)	74 (19.84 %)	0.324
Procedure done	Bilateral PCNL + DJS	0 (0 %)	2 (0.54 %)	
	Left PCNL	1 (0.45 %)	0 (0 %)	
	Left PCNL + DJS	102 (45.74 %)	151 (40.48 %)	*< 0.001
	Right PCNL + DJS	120 (53.81 %)	220 (58.98 %)	
	Tubeless	24 (10.76 %)	142 (38.07 %)	

Table 1. Baseline Parameters of Both the Study Groups N = 596

A statistical significance was seen with respect to dosage. The dosage was 50 mg in ESPB group and 300 mg in IV group. (P-value 0.001) (Table 2). Pre and postoperative NRS score were compared in both the groups which was statistically significant, P-value was 0.001. It was moderate preoperatively which reduced to mild in both the groups (Table 3).

Variable	Group A	Group B	P-Value
Analgesia tramadol 100 mg	34 (9.2 %)	223 (100 %)	0.001
Analgesia post op	42 (1.26 %)	223 (100 %)	0.001
Tramadol dosage (mg)	50 mg	300 mg	0.001

Table 2. Comparison of Post-Operative Tramadol Requirement in Both the Groups

Type	Group A (ESP Block) N = 373	Group B (IV Analgesia) N = 223	P-Value
Preoperative NRS 2 hr.	5 (4 - 6)	6 (5 - 7)	0.001
6 hr.	4 (3 - 5)	5	0.001
12 hr.	3 (2 - 4)	4 (3 - 5)	0.001
24 hr.	2 (1 - 3)	4 (3 - 5)	0.001
Highest NRS	3 (2 - 4)	4 (3 - 5)	0.001
Postoperative NRS 2 hr.	3 (2 - 4)	4 (3 - 5)	0.001
6 hr.	2 (1 - 3)	4 (3 - 5)	0.001
12 hr.	2 (1 - 3)	3 (2 - 4)	0.001
24 hr.	2 (1 - 3)	3 (2 - 4)	0.001
Highest NRS	2 (1 - 3)	3 (2 - 4)	0.001

Table 3. Comparison of NRS Scores (0 - 11) Pre- and Post-Operative in Both the Groups Expressed as Median Interquartile Range

DISCUSSION

Both somatic and visceral nerves that innervate kidney and the ureters are to be blocked to achieve adequate analgesia during PCNL. According to our knowledge this observational study is first of its kind to be conducted in India. The results of the present study showed that there is decrease in intra and post-operative tramadol consumption in patients who underwent ultrasound guided ESPB for PCNL, which was statistically significant. Patient satisfaction measured through NRS numeric pain rating scale (0 - 11) score reduced from mild to moderate in both the groups which was statistically significant.

Similar results have been found by Eungdon Kim et al.[9] Kumar et al.[11] in their clinical trial reported that ESPB is a safe technique that provides effective postoperative analgesia in patients undergoing PCNL. The ESP block is a fascial plane block, which is performed between the transverse processes and erector spinae muscles, with a moderate level of difficulty, and can provide adequate analgesia through multiple dermatomes by cephalocaudal spread, as reported by Ivanusic et al.[12]

As there are not much studies related to ESP block in patients undergoing PCNL we have compared our findings with other studies where ESP was used in other surgeries. According to findings of our study post-operative tramadol consumption was reduced with ESPB. This finding is in contrast to a study done by Yong Liu et al.[13] where they used paravertebral block for PCNL. ESP block lessens major potential complications during the procedure that includes hypotension and vascular puncture that results from epidural analgesia and paravertebral block. As an added benefit it also reduces the risk of pneumothorax associated with

intercostal and interpleural nerve block.[14] In our study we have used ESPB (0.5 % bupivacaine and 1 / 200,000 epinephrine) single shot. This finding is in contrast to study by Resenick et al.[15] where ESPB was used with catheter though results achieved were same in both the studies. The findings of our study on postoperative tramadol reduction and patient satisfaction on NRS using US guided ESPB in PCNL were similar to other studies done by Swati Sing et al.[16] on radical mastectomy and Bang et al.[17] on lung lobectomy.

The finding of present study on analgesic effect of ESP block was in comparison to randomised control trial on single shot US-guided ESP for breast surgery done by Gürkan et al.[18] They observed a decrease in postoperative morphine consumption by 65 % which was statistically significant, thus establishing its role for analgesia and postoperative opioid sparing effect. Nair et al. published efficacy of this block in a similar surgery on a case series of five patients.[19] They also had a very encouraging result of no requirement of opioid in any of their patient for rescue postoperative analgesia. Most of case reports / series has used this block for perioperative analgesia but Kimachi et al. used US-guided ESP for complete surgical anaesthesia for a right-sided mastectomy and axillary dissection in patients with high cardiovascular risk.[20] They not only accomplished complete surgical anaesthesia but also requirement of postoperative analgesia was minimal.

Damjanovska et al.[21] performed a retrolaminar injection to discover that the spread of the injectate to the ipsilateral paravertebral space was only observed in his high-volume group (30 ml) as opposed to his low-volume group (10 ml). As the retrolaminar block, the clinical effects of the ESPB rely on the spread of the local anaesthetic. Therefore, it is legitimate to deduce the injectate volume of the ESPB. This finding could not be considered in the present study as we have not recorded the volume of local anaesthetic being used.

Jain et al. reported excellent sensory blockade using this regional technique for breast, abdominal, and thoracic procedures, as well as for patients suffering from chronic neuropathic pain.[22] ESP block is superior to many other current first line analgesia as it is continuous in nature, has extensive craniocaudal spread and excellent sensory blockade. For patients undergoing PCNL procedures, much of the pain produced is visceral in nature secondary to the large size of the renal calculus with subsequent stretching of capsular fibers involving the T 10 to L 2 dermatomes. The local anaesthetic administered during the ESPC has a wide area of distribution and likely spreads via action on the ventral and dorsal roots affecting various levels from T 1 to T 11, based on various studies.[23-25] Hence, this type of peripheral nerve block has the potential to benefit patients undergoing PCNL.

Postoperative analgesia is always a major problem that contributes to increased complications postoperative that affects quality of life after surgery. The ESP block studied in the present study emerged as a new fascial block technique that can engender sensory blockade of multiple segments. Our findings showed that ultrasound-guided ESP block exhibited a significant analgesic effect for PCNL. The ESP-block is clear and simple, easy to perform, less time-consuming, and generally well tolerated by the patients. Hence, according to the study findings we can suggest a combination of multimodal pain control along with ESPB is always a better option to manage patients being treated with percutaneous nephrolithotomy.

CONCLUSIONS

Our study findings show that US-guided ESP block exhibits a significant analgesic effect in patients undergoing PCNL surgery. Patients in ESPB group had lower tramadol consumption, longer time to first use, lower rescue drug consumption over 24 hrs, and higher patient satisfaction. Hence, we conclude that ESP block is a favourable technique that results in very good analgesic effect preoperatively and also lessens the use of intravenous opioids and other analgesics and is recommended in PCNL surgery. It is a better option for postoperative analgesia and control of haemodynamics intraoperatively.

Limitations

The major limitation of the present study was responder bias as the study groups knew about the intervention they received to limit pain. Also, in our study we face an inter observer bias as the block was administered by several surgeons in several patients. However, the person who participated in data collection was not aware of the group assignments. Generalisability of the study findings is not possible as we have not examined post-operative nausea and vomiting (PONV) and post-operative care unit (PACU). Though our results confirm satisfactory analgesic effects of ESP block, measuring the exact plane of sensory block and flow and spread of local anaesthetic through imaging evidence in the ESP group was not evaluated in the present study. Further randomised clinical trials with long-term follow-up can be designed to focus on the effects of ESP block on PCNL covering major tertiary care centres for generalisability. Anatomical and clinical investigation is necessary to elucidate the detailed mechanism and clinical applications of ESPB.

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