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***ORIGINAL RESEARCH***

# The Role of Erector Spinae Plane Block in Percutaneous Nephrolithotomy Pain Management

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## ABSTRACT

**Background**: The erector spine plane block (ESPB) is a novel peripheral nerve block approach between the erector spinal muscle and the thoracic transverse processes. It blocks multiple dermatomal sensory nerves in the thoracic and abdominal walls. ESPB is widely used in thoracoabdominal surgery, including percutaneous nephrolithotomy (PCNL). This review aims to assess the role of ESPB in PCNL.

**Methods:** A Literature search was performed systematically with the medical terms "erector spinae plane block" and "nephrolithotomy" in PubMed, ScienceDirect, Cochrane Library, and Google Scholar until April 30, 2022. Two independent reviewers screened the articles for inclusion based on relevancy to the subject and outcomes. Data extraction was conducted for the included studies. The result from these studies demonstrates the efficacy of ESPB in PCNL.

**Results:** A total of 267 literatures according to the search strategy. Nineteen studies were included in this review after excluding the duplicated, non-English, and irrelevant studies based on the title or abstract. From the full article review, 11 studies were with 644 patients. ESPB group had a significantly superior outcome of decreasing pain score compared to the conventional analgesia, tramadol intravenously, and placebo. ESPB had no significant-differences with intrathecal morphine on the pain scale and first analgesic request. The timing of the first rescue analgesia in the ESPB group was longer and the procedure also reduced opioid requirement in PCNL patients.

**Conclusion:** ESPB is a potentially effective technique to provide post-PCNL analgesia. ESPB provides pain relief after surgery, prolongs time to take additional analgesic drugs including postoperative opioid consumption.

**Keywords**: Analgesic; Erector spinae block; Opioid; Pain; Percutaneous nephrolithotomy.



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## INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a minimally invasive urology procedure that gradually evolved since the first time it was invented in 1976. Recently, this procedure is indicated in patient with ureteral and calyceal diverticular stones with the size of larger than 20 mm, and it is also suggested in patient with shock wave lithotripsy (SWL) failure.[1] Nephrostomy tube is placed in the end of procedure for kidney drainage and bleeding prevention. This placement itself often cause post-operative pain and discomfort which required analgesic treatment.[2,3]

Inadequate post-operative pain management may results in increased morbidity, quality of life impairment, higher risk of chronic pain, and prolonged recovery time and hospitalization.[4] There are different approaches to reduce post-operative pain management of PCNL, such as the use of nephrostomy tube modification, peripheral nerve block, local anesthetic infiltration, opioid, and non-steroidal anti-inflammatory drugs (NSAIDs) administration.[3,5]

Forero invented erector spinae plane block (ESPB) is a novel peripheral nerve block technique that first introduced in 2016.[6] This technique is done by injecting or placing the catheter with anesthetic agent in a plane between erector spinae muscle and the thoracic transverse processes to block multiple sensory dermatomes in thoracic and abdominal walls.[7] It is widely used in thoracoabdominal surgery such as cholecystectomy, herniorrhaphy, breast surgery, abdominal hysterectomy, and caesarean section delivery. There are few clinical trials of ESPB in PCNL, however there has been no systematic review regarding this research yet.[8] Therefore, we collected the available data and conduct a systematic review to assess the role of ESPB for pain management after PCNL.

## METHODS

A Literature search was performed systematically with medical terms of “erector spinae plane block” and “nephrolithotomy” in PubMed, ScienceDirect, Cochrane Library, and Google Scholar until April 30, 2022. The inclusion criteria were clinical trial including randomized controlled trials (RCTs) and cohort studies.

Two independent reviewers used Mendeley to screen the articles. The duplicate, irrelevant articles, and texts with the unclear outcome will be excluded. The result was reported in Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) shown in Figure 1.

The tools to assess included RCTs is Revised Cochrane risk-of-bias for randomized trials (RoB 2) (Table 1) and to assess non-RCT is The Risk Of Bias In Non-randomized Studies-of Interventions (ROBINS-I) (Table 2).

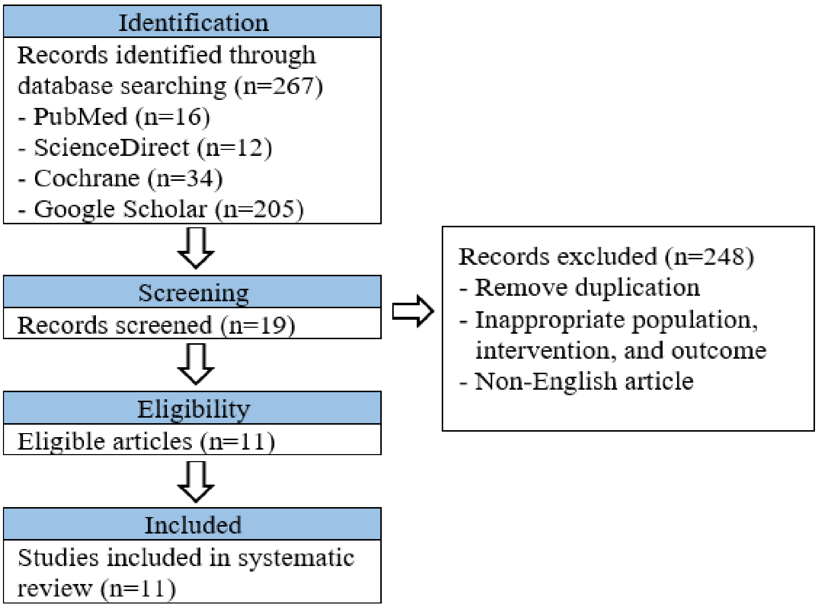


**Figure 1. PRISMA Diagram**

## RESULTS

A total of 267 literatures according to search strategy. 19 studies were included in this review after excluding the duplicated, non-English, and irrelevant studies based on the title or abstract. Finally, 11 studies were included in this review, with a total of 644 patients. The characteristics of final articles analyzed in this study are presented in Table 3.

## DISCUSSION

Percutaneous nephrolithotomy (PCNL) is a minimally invasive urology procedure for treating kidney stone. It has high efficacy and proved to shorten the length of stay. Incidence of post-operative pain following PCNL was 66.7%. Pain in PCNL occurred from visceral pain involving kidney, incision-induced due to the surgery, renal pain from T10-L1, and ureteral pain from T10-L2.[1,3] Adequate analgesia is necessary to enhance recovery, thus decrease morbidity, improve quality of life, reduce risk of chronic pain, abbreviate recovery time and duration of hospitalization.[4,9]

Various nerve block methods are proposed to manage post-operative pain in PCNL, such as intercostal nerve block, quadratus lumborum block, paravertebral block, transversus abdominis plane block, and ESPB.[7,10–12] ESPB is the latest technique used in several PCNL trials. This technique blocked multiple sensory dermatomes in thoracic and abdominal walls through their ventral and dorsal rami.[7]

**Table. 1 Assessment Risk of Bias with RoB 2**

| Author, year | A | B | C | D | E | Overall |
|---|---|---|---|---|---|---|
| Baishya et al., 2022 | Low | Low | Low | Low | Low | Low |
| Bhatia et al., 2021 | Low | Low | Low | Low | Low | Low |
| Bryniarski et al., 2021 | Low | Low | Low | Low | Low | Low |
| Gultekin et al., 2020 | Low | Low | Low | Low | Low | Low |
| Ibrahim & Elnabtitiy, 2019 | Low | Low | Low | Some concerns | Low | Low |
| Lomate et al., 2022 | Low | Low | Low | Low | Some concerns | Some concerns |
| Prasad et al., 2022 | Low | Low | Low | Low | Low | Low |
| Ramachandran et al., 2021 | Low | Low | Low | Low | Low | Low |
| Sarkar et al., 2022 | Low | Low | Low | Low | Low | Low |
| Unal et al., 2022 | Low | Low | Low | Low | Low | Low |

A = Risk of bias arising from the randomization process
B = Risk of bias due to deviations from the intended interventions
C = Risk of bias due to missing outcome data
D = Risk of bias in measurement of the outcome
E = Risk of bias in selesction of the reported result
(green) Low risk of bias
(yellow) Some concerns

**Table 2. ROBINS- I assessment toward Pehlivan et al., 2022 study**

| | Judgement |
|---|---|
| Bias due to confounding | Low |
| Bias in selection of participants into the study | Low |
| Bias in classification of interventions | Low |
| Bias due to deviations from intended interventions | Low |
| Bias due to missing data | Low |
| Bias in measurement of outcomes | Low |
| Bias in selection of the reported result | Low |
| Overall bias | Low |

**Table 3. List of studies included and their characteristics**

| Author, year | Sample characteristics | Comparison | Outcome |
|---|---|---|---|
| Baishya et al., 2022[13] | -60 patients underwent GA<br>-ASA I-II<br>-18-65 years old | Control Group (30): 150 mcg of morpine (intratechally) and 2 mL of normal saline<br>ESPB Group (30): ultrasound-guided ESPB with 20 mL of 0.375% ropivacaine mixed with clonidine 0.5 mcg/kg before induction of anesthesia in space between T9-T11 | No statistically significant differences of postoperative VAS and first analgesic request timing (p=0.687 and p=0.78). Total dose of perioperative opioid consumption in the ESPB group was 355.0 (265.0, 485.0) mcg and intrathecal morphine was 240.0 (145.0, 370.0) mcg (P = 0.09). |
| Bhatia et al., 2021[14] | -64 patients underwent spinal anesthesia with subarachnoid block<br>-ASA I-II<br>-18-60 years old | Control Group (32): Tramadol 100 mg IV<br>ESPB Group: ultrasound-guided ESPB with 30 ml 0.5% ropivacaine post-operatively in T8 | VAS of ESPB Group was significantly lower than control group at 30 min, 2 h, 4h, 6h, 8h, 12h, 18h, and 24h (p<0.05).<br>Duration of first analgesia was longer in ESPB than control group (p=0.001). |
| Bryniarski et al., 2021[15] | -68 patients underwent GA<br>-ASA I-III<br>-18-70 years old | Control Group (34): PCA-delivered nalbuphine intravenously.<br>ESPB Group (34): ESPB preoperatively through T7 and standard general anesthesia with PCA | VAS of ESPB Group 2.9 ± 1.3 compared to control group 3 ± 1.3 (p=0.65).<br>Postoperative VAS 1 h was significantly lower in ESPB (2.3 vs 3.3; p=0.01).<br>No significant difference in rescue analgesia for both groups (group 1, 29.4; group 2, 26.4%; p = 1) |

| | | | |
|---|---|---|---|
| Gultekin et al., 2020[16] | -60 patients underwent GA<br>-ASA I-II<br>-18-65 years old | Control Group (30): conventional analgesia<br>ESPB Group (30): ESPB in T8 level after induction with 20 cc of 0.5% bupivacaine | ESPB group described statistically lower pain score at hours 0, 1, 6 and 24 (p= 0.001, 0.009, <0.001, and 0.014).<br>Administration of first analgesic longer in ESPB group, after 172.33 ± 180.5 minutes in the ESPB group and after 84.33 ± 71.12 minutes in the control group (P= 0.016). Tramadol and paracetamol administration was less in the ESPB group (60±72.3mg vs 120±55mg, p=0.001 and 1.8±0.76 gr vs 3.2±0.99 gr, p<0.001, respectively) |
| Ibrahim & Elnabtitiy, 2019[17] | -50 patients underwent GA<br>-ASA I-II<br>-18-65 years old | ESPB Group (25): given preoperatively in T11 with 30 ml 0.25% bupivacaine with ESPB.<br>Control Group (25): 30 ml normal saline with ESPB. | NRS was significantly lower in ESPB group than Control group at 2 and 12 h post surgery (median= 3 and 2, respectively vs. median= 4 and 3, respectively, p=0.02). Lower rescue of morphine administration in the ESPB group over 24 h (p=0.002). |

| | | | |
|---|---|---|---|
| Lomate et al., 2022[18] | -60 patients underwent GA<br>-ASA I-II<br>-18-60 years old | Control Group (30): peritubular infiltration with 20 ml of 0.25% levobupivacaine<br>ESPB Group (30): ESPB with 20 ml of 0.25% levobupivacaine | Rest and dynamic VAS scores were significantly lower in the ESPB group than in the Control Group at 8 and 12 hours (p=0.00). The number of rescue analgesics and total tramadol administration in 24 hours were less in the ESPB Group than in the Control Group (p=0.00). |
| Pehlivan et al., 2022[19] | -60 patients underwent GA<br>-ASA I-II<br>-18-65 years old | Control Group (30): didn't underwent ESPB<br>ESPB Group (30): 30 ml of 0.25% bupivacaine through T10 after induction | VRS were lower for the ESPB Group at 2, 6, 12, and 24 h ($P < 0.05$). Total morphine consumption of ESPB group at postoperative 2nd, 6th, and 24th h was less than Control Group ($P < 0.05$). Post-operative Analgesia administration in 24 h of ESPB Group was less than that of Group II ($P = 0.001$). |
| Prasad et al., 2020[20] | -61 patients underwent GA<br>-ASA I-II<br>-18-65 years old | Control Group (30): no ESPB.<br>ESPB Group (31): injection through fluoroscopic guidance in T8 with 20 ml of 0.375% ropivacaine | VAS score was lower in the ESPB Group at 0, 1, 2, 3, 4, 6, 12, 18, and 24 hours after PCNL ($P < 0.001$). Rescue analgesia dosage was significantly decreased in ESPB Group compared to Control Group. |

| | | | |
|---|---|---|---|
| Ramachandran et al., 2021[21] | -66 patients underwent GA<br>-ASA I-II<br>-18-70 years old | Control Group (33): at the end of surgery, 20 mL of 0.25% bupivacaine injected with subcutaneous infiltration at the incision site.<br>ESPB Group (33): 20 mL of 0.25% bupivacaine injected through T10 at the end of surgery. | NRS scores post-operative were significantly lower in ESPB group until 8 hour (p<0.0001). Tramadol consumption was significantly reduced at 24 h postoperatively in the ESPB group. |
| Sarkar et al., 2022[22] | -34 patients underwent GA<br>-ASA I-II<br>-18-60 years old | Control Group (17): 20 ml normal saline injected ESPB through L1.<br>ESPB Group (17): 20 ml of 0.25% Bupivacaine injected ESPB through L1 after induction | The tramadol requirement in 24 h was significantly lower (p=0.001), and the timing of the first demand of rescue analgesia was longer (p=0.001) in the ESPB group.<br>ESPB group had lower pain scores at 12 hours post-operatively (p=0.001). |
| Unal et al., 2022[23] | -60 patients underwent GA<br>-ASA I-II<br>-18-65 years old | Control Group (30): No preemptive analgesia<br>ESPB Group (30): 15 ml of 0.5% bupivacaine through T11 before induction | VAS and dynamic VAS at 0 h, 6h, and 24 h in the ESPB group were lower than in the control group (p<0.05 each).<br>ESPB Group had lower time and number of analgesic administration (p=0.004, p=0.046). |

Abbreviation: ASA, American Society of Anesthesiologists; ESPB, Erector Spinae Plane Block; GA, General Anesthesia; NRS, Numeric Rating Scale; PCA, Patient Controlled Analgesia; PCNL, Percutaneous Nephrolithotomy; VAS, Visual Analog Scale; VRS, Verbal Rating Scale

This systematic review found that the ESPB had a significantly superior outcome of decreasing pain score compared to the conventional analgesia (in 1 RCT), tramadol intravenously (in 1 RCT), peritubular infiltration (in 2 RCTs) and without ESPB or placebo (in 5 RCTs).[10,14,16–24] Multimodal analgesia such as Patient Controlled Analgesia (PCA) combined with ESPB is superior to PCA without ESPB (1 RCT).[17] Based on 1 RCT, ESPB had no significant differences with intrathecal morphine in the pain scale and first analgesic request. Still, the need for opioid consumption in ESPB is higher than in the intrathecal morphine group.[13] The timing of the first rescue analgesic administration in the ESPB group was longer and reduced opioid requirement in PCNL patients.

Ten of the study underwent general anesthesia (GA) for PCNL; both GA and regional anesthesia (RA) had similar efficacy. GA is a safe technique for PCNL, but it should be monitored cautiously. Accidental extubation or endotracheal tube obstruction caused by kinking of ET while positioning the patient. The body position should be well-positioned to avoid visual loss after surgery, pressure necrosis, and nerve injury. RA is considered when operative time is short, shivering incidence during surgery, pain induced by a prone position, and cooperative when the patient needs to hold their breath during surgery because the surgery location is close to the rib. The anesthesia and surgical team must be well coordinated.[25,26]

The study found site injections were around the transverse process of T7 until L1 because ureter and kidney innervation are from T10 until L2, so the anesthetic agent widely spread to craniocaudal, posterior, and lateral areas.[23]

Various ESPB timings were used in our study. The timing of the nerve block is still controversial. -Kassem et al. study found that there was no difference in Tranversus Abdominis Plane (TAP) block was administered preoperatively compared with postoperative in radical cystectomy.[27] In the TAP block systematic review, 88,9% of studies showed that TAP block had analgesic benefits when administered before incision compared with 44,4% of studies that had benefits after incision.[28]

Prone positioning is the standard position to perform ESPB equals to the surgical position in PCNL, although it can be given in lateral decubitus and sitting position. However, the investigation about the distribution of anesthetic agents regarding patient position in ESPB has not been studied yet.[29]

Anesthetic agents administered in our review are levobupivacaine, bupivacaine, and ropivacaine. There is no comparative study yet about the anesthetic agents used in ESPB. A peripheral nerve block study meta-analysis comparing levobupivacaine and ropivacaine found that levobupivacaine is more kind than ropivacaine.[30]

Although it has been reported that pneumothorax and unintended motor block occur after ESPB,[31,32] this review found no complications.

The systematic review has a promising result. However, the study has some limitations. First, several studies with small sample sizes were included. Second, there were differences in the anesthetic agents used and the timing of ESPB—the lack of anesthetic agent and dose as comparator, and comparison with another nerve block technique.

## CONCLUSION

ESPB is a potentially effective technique for providing post-PCNL analgesia. ESPB provides pain relief after surgery, and minimizes the requirement for additional analgesic drugs, including opioids.

It is recommended to assess the effectiveness of ESPB compared to other nerve blocks or with another anesthetic agent in PCNL procedure in further study, especially with a larger subject.

## CONFLICT OF INTEREST

The Authors declare that have no conflict of interest.

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