Efficacy of erector spinae plane block for postoperative analgesia after percutaneous nephrolithotomy: A systematic review and meta-analysis of randomized controlled trials

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Abstract

Introduction: Erector spinae plane block (ESPB) is a relatively newer approach to the paraspinal fascial plane block. The analgesic efficacy of this block is presently being established in percutaneous nephrolithotomy (PCNL). This meta-analysis was designed to assess the effectiveness of ESPB as a perioperative analgesic technique when compared with conventional analgesia (control) in PCNL.

Material and Methods: We performed a systematic review and meta-analysis on the use of ESPB for perioperative analgesia in PCNL for renal stone disease. A systematic literature search was conducted in PubMed, Scopus, ProQuest, and EMBASE using the terms ((erector spinae plane block) AND ((Analgesia) OR (visual analogue scale) OR (VAS) OR (opioid*) OR (morphine) OR (tramadol))) AND ((percutaneous nephrolithotomy) OR (PCNL)) with an intention to include all the randomized studies comparing ESPB with the control group. The risk of bias was assessed using RoB2.

Results: A total of 187 records were identified and after the exclusions, a total of 10 trials (560 patients, 503 for primary outcome) were included. Pain scores were significantly lower in the ESPB group as compared to the control group except at the 12th postoperative hour. There were significantly better pain scores at 24 h in the ESPB group as compared to the control group (Standardized mean difference (SMD) −0.46, 95% CI (−1.05, 0.13), moderate GRADE evidence). The total opioid consumption was significantly lower in the ESPB group (SMD −1.50, 95% CI (−1.7 to −1.29, moderate GRADE evidence).

Conclusions: ESPB is more effective than conventional analgesia in terms of postoperative opioid consumption after PCNL. Future studies should incorporate better double-blinding techniques, transparent reporting of methods, and sham controls (such as additional dressing post general anesthesia) which were lacking in the current studies.

Keywords: Erector spinae plane block, meta-analysis, percutaneous nephrolithotomy, regional anesthesia

Introduction

Percutaneous nephrolithotomy (PCNL) is the most widely performed surgery for managing large (more than 2 cm) and complex renal calculi. It has the advantage of being less invasive, with a significantly lower complication rate and rapid recovery profile as compared to the open approach.[1]

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Post-PCNL pain may originate from sites other than the skin puncture site, such as the renal capsule and ureter.[2] The T10–11 nerve roots supply the majority of the cutaneous innervation of the PCNL incision and tract, which are often made from the subcostal or 11th or 10th intercostal regions.[3] The degree of pain would depend upon the number of ports, duration of surgery, disease burden, and individual patient sensitivity. Consequently, in the absence of regional anesthesia, this increases the need for systemic rescue analgesia which in the immediate postoperative phase involves the use of opioids and nonsteroidal anti-inflammatory drugs (NSAID).

NSAIDs, which could otherwise give effective analgesia, are not a sustainable option since they run the risk of causing renal damage especially since a subset of these individuals have deranged renal function. Opioids are associated with severe adverse effects such as nausea, vomiting, constipation, and respiratory depression. These side effects contribute to poor quality of care and can delay healing and discharge.[4] Multimodal postoperative pain management such as the additional use of pre-emptive regional analgesia can assist in lowering postoperative opioid and NSAID-related adverse effects. These techniques include epidurals, paravertebral nerve blocks (PVB), intercostal nerve blocks, and the new erector spine block (ESPB).[5]

ESPB is a relatively recent technique of paraspinal fascial plane block and has been utilized to provide effective pain management during abdominal and thoracic procedures.[6,7] In ESPB, local anesthetic is injected in the plane between the transverse process (TP) and the erector spinae muscle at a site away from the site of the intended surgical puncture while delivering substantial analgesia. The ability to provide regional analgesia using a site distant from the surgical site potentially avoids any local complications that might otherwise contraindicate puncturing at that point.[7–9] The effectiveness of ESPB in reducing postoperative opioid consumption has been studied in different surgical populations; however, very few individual studies to date have been powered to detect a difference in this outcome in PCNL.[10–13] However, the *a priori* power calculations even in these studies remain questionable. The question whether ESPB reduces postoperative opioid consumption in adults undergoing PCNL under general anesthesia remains unclear. Hence, this systematic review and meta-analysis was designed to examine the analgesic efficacy of perioperative ESPB in PCNL surgery in terms of postoperative opioid consumption.

Material and Methods

A systematic literature search followed by meta-analysis of quantitative data was performed using a frequentist approach. Standard Preferred reporting Items for Systematic reviews and Meta-analysis (PRISMA) guidelines were pursued while conducting this review. It was prospectively registered in PROSPERO (CRD42021246120).

Search strategy

Two investigators (APS and AS) independently searched PubMed, Scopus, Proquest, and EMBASE [Figure 1a] to identify published medical literature on the role of ESPB on postoperative analgesia in patients undergoing PCNL for renal stone disease. There was no language restriction, and conference abstracts were excluded. Additional articles were sought by hand searching from the references of the articles selected for full-text review. The last search was conducted on August 12, 2023. Keywords and MeSH (Medical Subject Headings) terms were used in developing the search strategy. As an example (also see supplement), the PubMed search string was as follows: ((erector spinae plane block) AND ((Analgesia) OR (visual analogue scale) OR (VAS) OR (opioid*) OR (morphine) OR (tramadol))) AND ((percutaneous nephrolithotomy) OR (PCNL)). References were stored and sorted in Zotero desktop 6.026 (Corporation for Digital Scholarship, Roy Rosenzweig Centre for History and New Media, George Mason University, Fairfax, VA 22030, United States).

Selection criteria

For this review, we included randomized studies (Study design – S) comparing the use of ESPB (Intervention – I) with conventional analgesia (Comparison – C) arm for patients undergoing PCNL for renal stone disease (Participants – P) in terms of postoperative analgesic consumption and pain scores at different time points (Outcomes – O). The included study was required to provide data on the use of perioperative ESPB in PCNL for pain control, including the pain scores and total analgesic consumption. Nonrandomized or quasi-randomized controlled studies, reviews, letters, case reports, and case series were excluded. Three authors (AS, APS, VG) performed title and abstract screening. Articles were then selected for full-text review. Disputes or ties about the inclusion or exclusion of a study were addressed by arbitration by the remaining review authors (PV, NN, NK).

Outcomes

Primary and secondary outcomes

The primary outcome of this study was postoperative opioid consumption. Secondary outcomes included pain scores (Visual Analogue Scale (VAS) or Numeric Rating Scale (NRS)) after surgery at various time points.

The time points for the pain scores were defined as follows:

a. 0 h – immediately after extubation or within 30 min of PACU (post anesthesia care unit) arrival

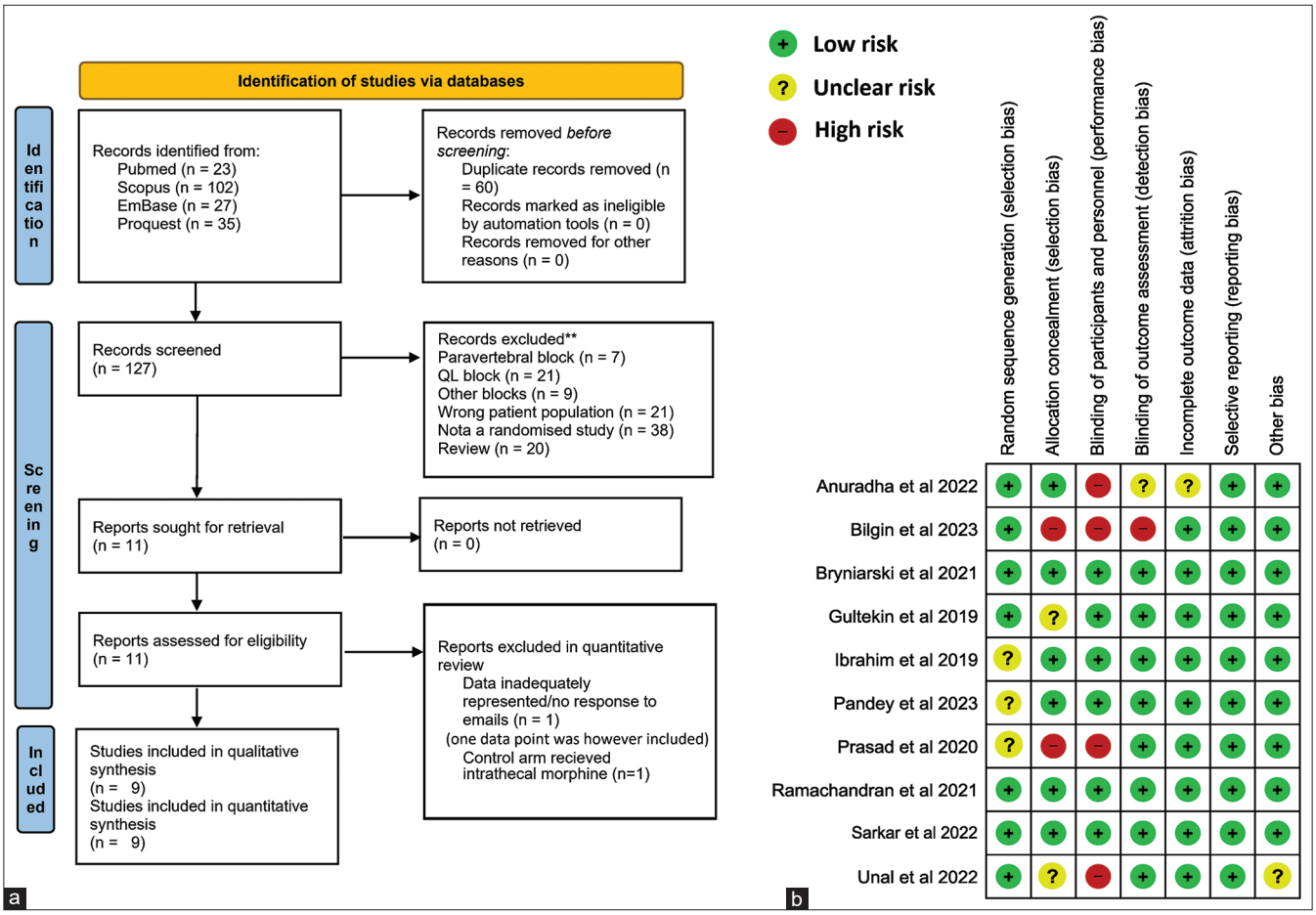

Figure 1: (a) Study flow diagram (PRISMA); (b)Risk of bias summary of included studies

b. 1 h – 1 h after extubation
c. 6 h – 6 h after extubation
d. 12 h – 12 h after extubation
e. 24 h – 24 h after extubation or postoperative day 1.

Risk of bias

The assessment of bias was conducted with the Cochrane risk of bias tool for randomized controlled trials. In accordance with PRISMA guidelines, two study authors (PS and NN) independently assessed the risk of bias across the six domains, and a third author was consulted in the event of a discrepancy (PV).

Data extraction

Two review investigators (VG and RG) independently reviewed the entire texts of all the included papers. The data from each of these studies were then extracted into a predefined template, which included the first author's name, year, country of origin, type of study, age group, gender distribution, and the intervention drug used for ESPB. In addition, data for quantitative evaluation of primary and additional outcome factors were collected and reviewed for consistency. In the event of a discrepancy, the data were rechecked, and a third investigator (GS) functioned as the deciding element in the event of a subjective tie. If data could not be extracted from the full-text or the accompanying images (figures), we contacted the respective study authors via email.

Statistical analysis

Statistical analysis was performed using the RevMan 5.2™ (the Cochrane Collaboration, Copenhagen, Denmark) and the "metafor" package in R (RStudio Team (2023). RStudio: Integrated Development for R. Rstudio, PBC, Boston, MA URL http://www.rstudio.com/.; R version 4.2.3 (2023-03-15 ucrt)). Chi^2 and I^2 tests were used to assess heterogeneity across each variable in the quantitative analysis. Due to the presence of significant heterogeneity (defined by $I^2 > 50\%$, or a $P < 0.10$ in the Chi^2 test for heterogeneity, as well as methodological inconsistencies, and since there were differences in the pain scores and analgesics used, random effects model (inverse variance) was used to analyze each outcome. For continuous variables, standard mean difference (SMD) was used as an effect measure as there was a difference in the scoring methods (some authors used NRS while others used VAS) and the type of analgesic used (tramadol and morphine). According to the formulae outlined by Wan *et al.*,

the median and interquartile range (IQR) were converted to the mean and standard deviation.[14,15] Data from images, when there was no response to three emails to the concerned author, were extracted using the "juicr" package from R.[16] In each outcome of interest, the data that were missing, after nonresponse to author emails, and could not be extracted from figures were not included in quantitative synthesis. Standard errors were converted to standard deviations using formulae as suggested by Cochrane Handbook 5.1.[17] Contour-enhanced funnel plot and Egger's test for funnel plot asymmetry were used to look for publication bias. Based on the presence or absence of publication bias, a subgroup analysis was performed for the primary outcome. A leave-one-out sensitivity analysis was performed to evaluate the reliability of the generated evidence and the effect of missing results.

Results

Search protocol and study selection

A literature search of the four databases listed above produced a total of 187 articles. Of these 187 articles, 60 duplicates were deleted, and the titles and abstracts of the remaining 127 articles were reviewed. One hundred sixteen articles were eliminated because they did not meet the inclusion criteria, leaving 11 for full-text review [Figure 1a]. One of them was omitted due to a different control group. [Figure 1a].

Study characteristics

A total of 286 records were identified, and following exclusions, the eligibility of 11 full-text reports was evaluated. Ten were included in the quantitative synthesis after full-text evaluations.[10–12,18–24] The study characteristics are outlined in Table 1. Outcomes studied across the studies were either pain scores and total dose of conventional analgesics such as tramadol, morphine, and paracetamol. The study level details of the ESPB blocks are depicted in Table 1.

Risk of bias

The risk of bias was assessed using the tools in Review Manager 5.3 and updated to RoB2. This has been graphically presented in Figure 1b.[25] "High risk of bias" was assigned when study characteristics have not been mentioned or when they have been mentioned wrong. "Some concerns" was assigned when the study characteristics were partially mentioned in the respective article. RoB2 was assessed by two independent investigators (APS and AS) and in case of ties a third investigator (NN) settled the disputes.

Outcomes

Total opioid consumption

The total opioid consumption was significantly lower in the ESPB group as compared to the conventional analgesia group (SMD −1.36, 95% CI (−2.12 to −0.59). However, the heterogeneity was high (I^2 = 90%). On removing studies with publication bias, this effect came to an SMD of −2.24, 95% CI of −2.55 to −1.92 with an I^2 of 0 [Figure 2]. The standardized mean difference (effect estimate) and a random effects model were used as different opioids were used for rescue analgesia. Eight studies reported the use of tramadol, while one study reported the use of nalbuphine and morphine [Table 1]. The postoperative analgesic requirement in one of the studies was reported as number of doses rather than the dose of tramadol and hence was not used for quantitative synthesis.[20]

Pain scores

The common end points at which the scores were taken were 0, 1, 6, 12, and 24 h. At each point, the pain scores were significantly lower in the ESPB group as compared to the conventional analgesia group except at 12 h [Figure 3]. A summary of findings table has also been provided with GRADE (Grading of Recommendations Assessment, Development and Evaluation) quality in Table 2.

Sensitivity analysis

Sensitivity analysis analyzing the effect of removing single studies from the group did not show a significant change in the magnitude or direction of this effect [Figure 4]. This shows that our conclusion is robust given the available data. Hence, ESPB effectively reduces analgesic consumption in the postoperative period. The pain scores at 24 h were also significantly lower in the ESPB group (SMD −0.47, 95% CI (−0.71 to −0.23). [Figure 2]. Sensitivity analysis of this outcome at 24 h also shows us that this beneficial effect of ESPB is reliable.

Discussion

From our results, we found that ESPB reduced opioid consumption in PCNL by a large effect size; however, the GRADE of the evidence was moderate in view of heterogeneity and publication bias [Table 2]. This analgesic effect of ESPB was also reflected by the lower pain scores across varying time points across the majority of the included studies.

Pain in the postoperative period is known to affect the quality of life with anxiety and several negative aspects such as prolonged bed rest, immobilization, and increased postoperative complications.[26–29] In the era of ERAS (enhanced recovery after surgery), adequate postoperative analgesia would no doubt logically lead to early mobilization, and a lesser duration of hospital stay. The advent of ultrasound-guided regional anesthesia has facilitated the placement of

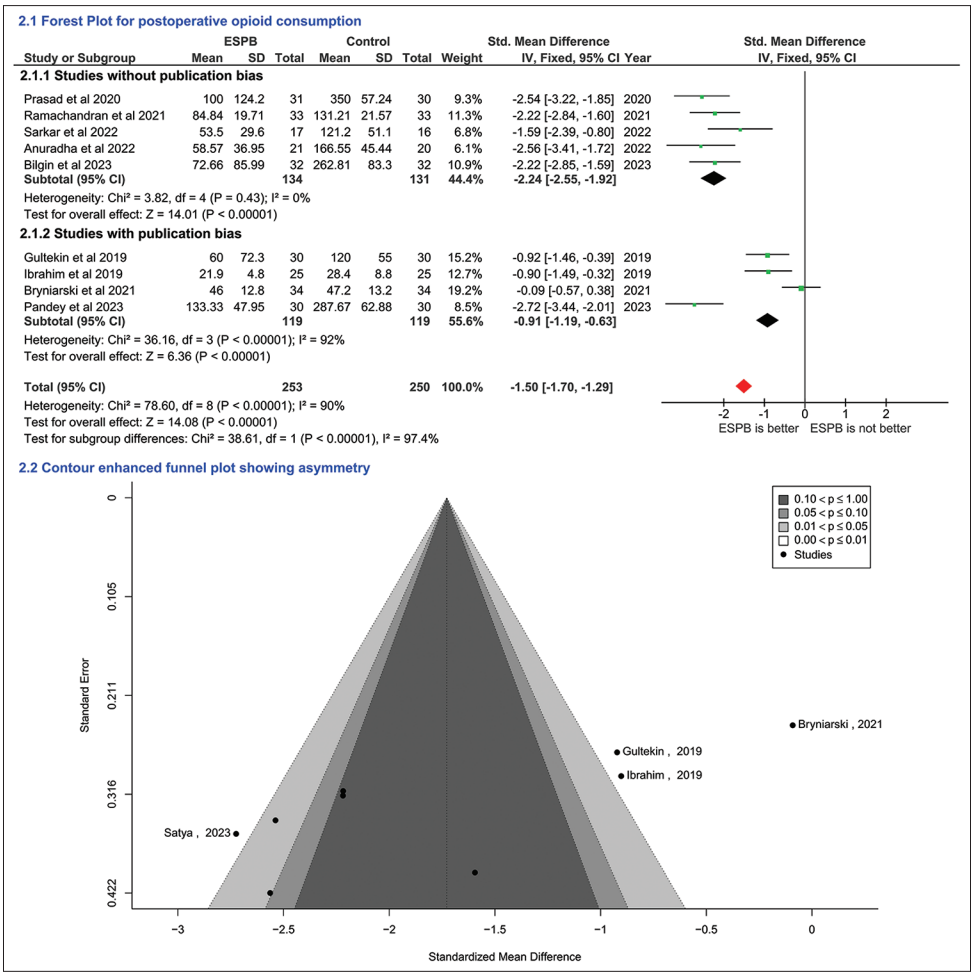

Figure 2: (2.1) Forest plot of comparison: ESPB Vs Control, outcome: Postoperative Opioid consumption, subgrouped by publication bias; (2.2) Contour-enhanced funnel plot demonstrating publication bias through asymmetry (labelled studies); SMD – Standardized Mean Difference

otherwise technically difficult blocks enabling anesthesia care providers to give potentially better analgesia to their patients.

With respect to pain scores, Unal *et al.*[20] demonstrated that pain during deep inspiration and cough (dynamic VAS) was lower in the ESPB group compared to controls. There was, however, no difference in the time to mobilization or length of hospital stay. In the study by Ramachandran *et al.*,[21] patients receiving ESPB block had significantly lower NRS scores at intervals of 30 min, 60 min, hourly for 6 h, and four hourly till 24 h as compared to group receiving local site infiltration. ESPB also reduced intraoperative fentanyl consumption, lowered postoperative pain scores at 2 and 12 h, and increased time to first use of rescue analgesia.[12] Similarly, Gultekin *et al.*[18] found that the first rescue analgesic was applied after 172.33 ± 180.5 min in the ESPB group and after 84.33 ± 71.12 min in the control group with a lower use of tramadol and paracetamol in the ESPB group. These findings further provide support to the observation that ESPB reduces postoperative pain scores while increasing the time to first postoperative analgesic consumption.

Most of the included studies reported a higher incidence of nausea and vomiting in the control group. Bryniarski *et al.*[22] reported 17.6% incidence of nausea and vomiting in the ESPB group against a 14.7% incidence in the control group. Ibrahim *et al.*[12] reported a 24% and 28% incidence of nausea and vomiting, respectively, in the ESPB group against a more than 70% incidence of these events in the control group. In the study by Prasad *et al.*,[19] nausea and vomiting occurred only in the control group (6%). However one of the studies showed that the number of patients with nausea was higher by 1 in the ESPB group, although this was not statistically significant.[21] Patient satisfaction scores were better in the ESPB group than in the control group.[12,19,24] These findings suggest that ESPB provided adequate postoperative analgesia while facilitating a reduction in postoperative opioid consumption and the opioid-associated adverse effects of nausea and vomiting. This probably improved the perceived quality of care and contributed to better patient satisfaction scores.

To obtain appropriate analgesia for PCNL, both somatic and visceral nerves that innervate skin, muscle, kidneys, and ureters

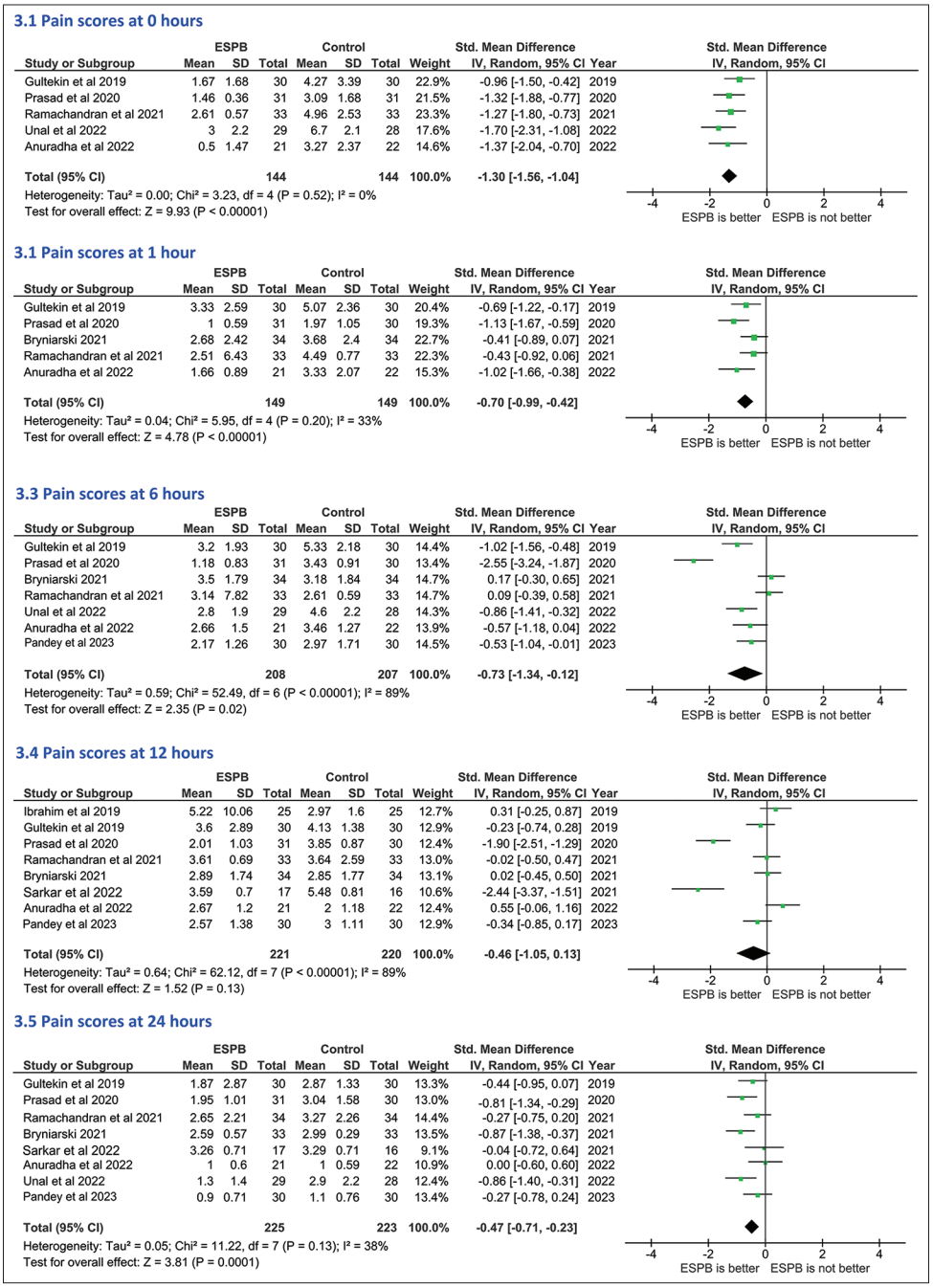

Figure 3: (3.1 to 3.5) Forest plot of comparison: ESPB Vs Control, outcome: Pain scores at time points in order immediately after extubation (end of anesthesia – 0 h), 1, 6, 12, and 24 h after extubation, respectively

must be blocked.[30] Despite its 2016 inception, ESPB's mode of action is the subject of significant dispute. Initial cadaveric investigations revealed that the deposition of either dye below the erector spinae muscles resulted in a wide cephalocaudal distribution of the dye/contrast, as well as subsequent dissemination into the epidural, paravertebral, and intercostal areas.[30] This could likely explain the block's effectiveness.

Paravertebral blocks have long been demonstrated to reduce postoperative opioid consumption and consequently the adverse effects of these agents.[31] However, the placement of these para-neuraxial techniques requires well-trained medical personnel as there is a risk of significant complications such as pneumothorax (0.5–2.58%), local anesthetic systemic toxicity, etc.[32,33] To maintain the benefits of regional anesthesia while diminishing the possible complications, fascial plane blocks were evaluated and proved effective in multiple populations. Pioneer studies have shown their efficacy in ventral hernia or mastectomy.[34] ESPB has also been associated with a 33% higher block success rate and a zero complication rate

Table 1: Study characteristics

Author/Year	Sample size in ESPB/ Non ESPB group	Timing of block placement	Local anaesthetic used	Specific analgesia/ sham block in non-ESPB group	Intraoperative analgesia	Postoperative/ rescue analgesia	Complications	Comments
Gultekin *et al.* 2019	30/30	After induction of general anesthesia at T8 level	20 cc 0.5% bupivacaine (USG)	Not mentioned in methodology	Not mentioned in methodology	Tramadol and paracetamol	None reported	Inadequate methodology. Nothing has been mentioned regarding sample size calculation
Ibrahim *et al.* 2019	25/25	Before general anesthesia at T11 level	30 cc 0.25% bupivacaine (USG)	30 cc normal saline as placebo	Fentanyl (induction and intermittent boluses), nitrous oxide, Lornoxicam 8 mg, Paracetamol 1g	Morphine PCA and paracetamol	6 in ESPB and 19 in Control had nausea. No other complications in either group	Clear methodology. Some misrepresentations in tables and figures.
Prasad *et al.* 2020	31/30	At the end of surgery under general anesthesia at T8 level	20 cc 0.375% ropivacaine + 10 cc normal saline (Fluoroscopy)	Not mentioned in methodology	Fentanyl (induction), nitrous oxide	Tramadol (2 mg/ Kg), 4 doses in 24 hours as rescue.	2 in control arm had nausea vomiting. No other complications in either group	Blinding is presented in a confusing manner. The target effect estimate has not been mentioned in the sample size calculation
Ramachandran *et al.* 2021	33/33	At the end of surgery under general anesthesia at T10 level	20 cc 0.25% bupivacaine (USG)	20 cc bupivacaine (concentration unknown) subcutaneous wound infiltration	Fentanyl (induction and intermittent boluses), Dexamethasone	Tramadol 50 mg and paracetamol 1 g. Fentanyl (0.5 mics/ kg) in between periods of NRS assessment)	4 in ESPB and 3 in Control had nausea. No other complications in either group	Clear methodology
Bryniarski *et al.* 2021	34/34	Before general anesthesia at T7 level	20 cc 0.5% bupivacaine (USG) + 0.1 mg/ kg intravenous dexamethasone	Not mentioned in methodology	Fentanyl (induction), remifentanil (maintenance)	Nalbuphine PCA and paracetamol, Dexketoprofenum	6 in ESPB and 5 in Control had nausea. No other complications in either group	VAS has been presented in mm and this is not consistent across other included studies
Sarkar *et al.* 2022	17/16	After general anesthesia, before the surgery at L1 level	20 cc 0.25% Bupivacaine (USG)	20 cc normal saline as placebo (USG)	Fentanyl (induction and intermittent boluses), paracetamol (postinduction)	Paracetamol q8h. Tramadol (1 mg/ kg) as rescue	No complications	The samples size calculation was based on morphine consumption at the 4th post-operative hour while the primary outcome was total tramadol consumption in 24 hours
Unal *et al.* 2022	29/28	Before general anesthesia at T11 level	15 ml 0.5% bupivacaine (USG)	None	Fentanyl (induction), remifentanil (maintenance)	Paracetamol q8h. Tramadol 100 mg as rescue	No complications	The basis for effect estimates in the sample size calculation has not been elaborated
Anuradha *et al.* 2022	21/22	Before general anesthesia at T10 level	20 ml of 0.5% bupivacaine	None	Fentanyl (premedication, induction and intermittent boluses), nitrous oxide,	Paracetamol q8h. Tramadol 1 mg/ kg mg as rescue		Open label (as per CTRI), authors do not mention any detail of primary outcome or sample size calculation.

Contd...

Table 1: Contd...

Author/Year	Sample size in ESPB/ Non ESPB group	Timing of block placement	Local anaesthetic used	Specific analgesia/ sham block in non-ESPB group	Intraoperative analgesia	Postoperative/ rescue analgesia	Complications	Comments
Bilgin *et al.* 2022	32/32	After general anesthesia before surgery at T7 – T10 vertebra levels	20 cc 0.25% Bupivacaine (USG)	None	Remifentanil (induction and maintenance) Paracetamol	Paracetamol q8h. Tramadol (1 mg/ kg) as rescue	No complications	Open label, additional dose of bupivacaine through ESPB catheter at the 6th hour post op
Pandey *et al.* 2023	30/30	At the end of surgery under general anesthesia at T9 level	Combination of 10 cc 0.5% bupivacaine, 5 cc 2% Lidocaine, 1 ml (50 μg) of fentanyl, 4 ml saline. (USG)	20 cc normal saline as placebo (USG)	Fentanyl 2 μg/kg, Paracetamol 15 mg/kg	Tramadol 100 mg (up to 400 mg) as rescue	No complications	

CTRI – Clinical Trials Registry India, ESPB – Erector Spinae Plane Block, USG – Ultrasound Guided, VAS - Visual Analogue Scale

compared to PVB.[35] Fascial plane blocks are regarded as a safe procedure; however, complications such as pneumothorax or artery puncture rarely occur.[36] None of the included studies in this systematic review reported block associated side effects such as pneumothorax or local anesthetic systemic toxicity demonstrating the relative safety of ultrasound guided ESPB. This absence of complications could be because in ESPB the operator targets a bony landmark (TP) with a hard stop to reach the fascial plane. This provides a larger margin of safety compared to the small paravertebral space between the TP and the pleura in PVB. Underreporting of complications, however, cannot be ruled out.

Future studies should focus more on the reporting of both block-related and postoperative opioid-related adverse events, incorporate better double-blinding techniques, perhaps include sham controls in the form of an additional dressing (without needling for ethical reasons), which were deficient in the current studies. In addition, examining the learning curve for ESPB in naïve operators may also be useful. The limitation of our analysis is the high heterogeneity. This is probably because of the type, timing, and dose of local anesthesia used for the ESPB. Some studies have presented the effect estimates as median [IQR], while others have mentioned these as mean (SD) for outcomes such as pain scores measured on VAS (continuous) or NRS (ordinal). Uniform scales of measurement (in terms of central tendency and dispersion) across studies would facilitate more meaningful combination of the effect estimates in future meta-analyses should more robust estimates be required. Few studies have compared paravertebral blocks with ESPBs. Given the increased risk profile of paravertebral blocks, we advocate conducting additional research to evaluate whether or not ESPBs are equivalent to paravertebral blocks in terms of analgesia in various settings. Although it is quite likely that the ESPB is a safer extension of the paravertebral block, more research is necessary to understand its precise efficacy and mode of action.

Conclusions

ESPB is associated with lower opioid consumption and is more effective than conventional analgesia for pain relief after PCNL in the first 24 postoperative hours. The certainty of this evidence, however, remains moderate. Future studies should focus on adverse event reporting, and incorporate better double-blinding techniques, and sham controls (such as additional dressing) which were lacking in the current studies.

Author contributions

Ajay Singh, Aditya Prakash Sharma, and Narendar Kaloria were involved in conceptualization, designing the study,

Table 2: Summary of findings

Outcomes	Anticipated absolute effects* (95% CI)		No. of participants (studies)	Certainty of the evidence (GRADE)	Comments	Risk of bias	Inconsistency	Imprecision	Indirectness
	Risk with Conventional Pain Management	Risk with ESPB							
Pain scores at time 0 (from extubation till first 30 min of the postoperative phase)	The mean pain scores ranged from 3.09 to 4.96	SMD 1.30 lower (1.56 lower to 1.04 lower)	288 (5 RCTs)	⊕⊕⊕⊕ HIGH[1,6,7]	Homogenous results. I^2 of 0%. *P* value for heterogeneity=0.60	Serious	Not serious	Not serious	Not serious
Pain at 1 hours	The mean pain scores ranged from 1.97 to 5.07	SMD 0.70 lower (0.99 lower to 0.42 lower)	298 (5 RCTs)	⊕⊕⊕ MODERATE[1,3,7]	Moderate I^2 of 37%. *P* value for heterogeneity=0.19	Serious	Not serious	Serious	Not serious
Pain scores at 6 hours	The mean pain scores ranged from 2.61 to 5.33	SMD 0.73 lower (1.34 lower to 0.12 lower)	415 (7 RCTs)	⊕⊕⊕ LOW[1-3,7]	Substantially heterogenous result. I^2 of 99%. *P* value for heterogeneity <0.00001	Serious	Serious	Serious	Not serious
Pain scores at 12 hours	The mean pain scores ranged from 2 to 5.48	SMD 0.46 lower (1.05 lower to 0.13 higher)	441 (8 RCTs)	⊕⊕ LOW[1-3,7]	Substantially heterogenous result. I^2 of 89%. *P* value for heterogeneity <0.00001	Serious	Serious	Serious	Not serious
Pain scores at 24 hours	The mean pain scores ranged from 1 to 3.27	SMD 0.47 lower (0.71 lower to 0.23 lower)	448 (8 RCTs)	⊕⊕⊕ MODERATE[1,3,7]	Moderate I^2 of 38%. *P* value for heterogeneity=0.27	Serious	Not serious	Serious	Not serious
Postoperative Opioid consumption	The mean dose of opioids consumed ranged from 28.4 to 350	SMD 1.5 lower (1.7 lower to 1.29 lower)	503 (9 RCTs)	⊕⊕⊕ MODERATE[1,2,5-7]	I^2 of 90%. *P* value for heterogeneity <0.00001. ESPB results in large reduction in postoperative Opioid consumption a. When studies with publication bias were removed from the analysis I^2 was 0 and the results still favoured ESPB. [Figure 2]	Serious	Not serious after removing studies with publication bias	Not serious	Not serious

*Explanations: a. This, however, includes a combination of morphine and tramadol. Hence, standardized mean differences have been used for comparison. *The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). Table generated from GRADEpro GDT: GRADEpro Guideline Development Tool [Software]. McMaster University, 2020 (developed by Evidence Prime, Inc.). Available from gradepro.org. CI: Confidence interval; ESPB: Erector Spinae Plane Block; SMD: Standardized mean difference. GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect. Reasons for downgrading: 1. High risk of bias (method of random sequence generation not mentioned, allocation concealment not mentioned, blinding out outcome assessment was unclear, incomplete outcome data). 2. Inconsistency (I^2 >50% and P<0.10, use of additives or mixture of local anesthetics). 3. Imprecision (95% CI crossing SMD of−0.5, moderate effect as per Hedge's g). 4. Indirectness of evidence (different age of population, difference in comorbidity profile, difference in preoperative anxiety scores if mentioned, additional spinal anesthesia, additional local infiltration). 5. Publication bias (assessed using Funnel plot asymmetry). Reasons for upgrading: 6. Large magnitude of effect (SMD to the left of−0.8, large effect as per Hedge's g). 7. Opposing plausible residual bias and confounding (The studies did not mention the stone burden or extent of dissection involved if any; however, the duration of surgery was comparable across most studies and hence these are unlikely to affect the true effect estimate)*

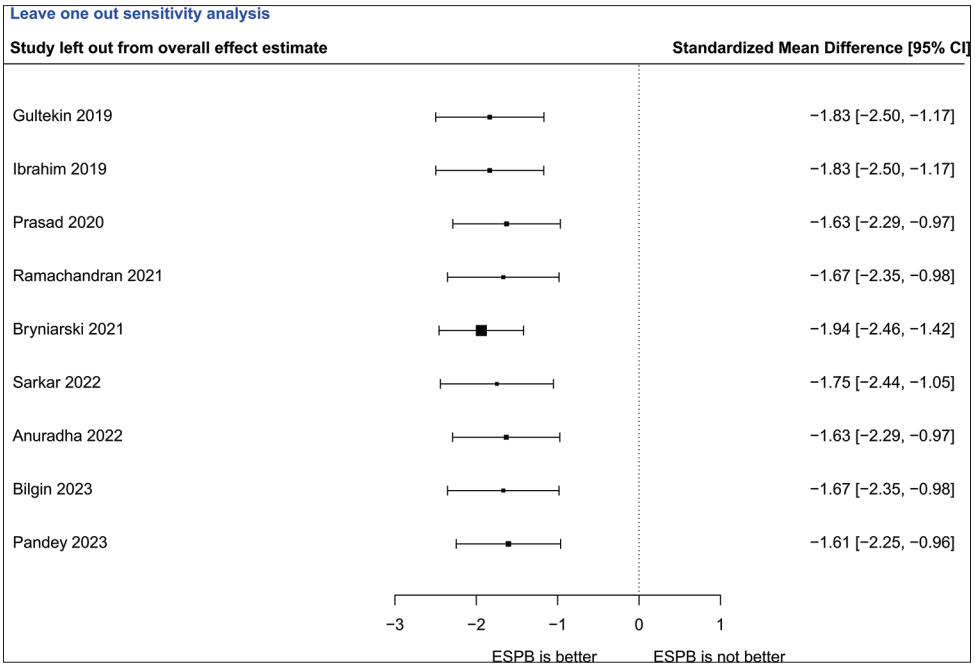

Figure 4: Sensitivity analysis: Leave one out analysis for ESPB Vs Control, outcome: postoperative opioid consumption

literature search, manuscript writing, and editing. Venkata Ganesh, Gopal Sharma, and Rekha Gupta were involved in data extraction, data analysis, interpretation, and manuscript editing. Prerna Varma, Priyanka Sethi, and B Naveen Naik were involved in risk of bias assessment and manuscript writing and revision. All authors were involved in manuscript revision and final approval of the manuscript.

Data availability statement

The data is available on appropriate request to the corresponding author. The data has not been deposited in any repository.

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Conflicts of interest

There are no conflicts of interest.

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