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ORIGINAL ARTICLE

The comparison of erector spinae plane block and caudal block for postoperative analgesia in paediatric surgery - meta-analysis

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ABSTRACT

Aim To assess the efficacy of Erector Spinae Plane Block (ESPB) compared to caudal block in reducing postoperative pain in paediatric surgery.

Methods An electronic literature search was conducted using the Cochrane Library, PubMed, and Google Scholar databases, with data collected from January 2018 until September 2023. This meta-analysis includes English-language randomized controlled trials (RCTs) studies contrasting ESPB with caudal block in paediatric patients. The primary outcome was the 24-hour postoperative pain scores. The secondary outcome included the time to rescue analgesia, the number of patients requiring rescue analgesia, and the occurrence of post-operative nausea and vomiting (PONV) and urinary retention.

Results Five RCTs with 295 samples were included. The results showed no significant difference between ESPB and caudal block in postoperative pain scores at 1st hour SMD (standardized mean difference) of -0.17 (95% CI -0.70, 0.36; I2=76%; p= 0.53), 2nd hour of SMD: -0.50 (95% CI -1.21, 0.21; I2=88%; p=0.17), 6th hour SMD -1.09 (95% CI -2.21, 0.03; I2=95%; p = 0.06), 12th hour SMD -0.77 (95% CI -1.75, 0.21; I2=93%; p=0.12), and the 24th hour SMD -0.13 (95% CI -0.39, 0.12;, I2=2%; p=0.30) were found. Furthermore, there was no significant difference in the time first to rescue analgesia, the number of patients requiring analgesia rescue, PONV occurrence, and urinary retention.

Conclusion ESPB and caudal block showed equivalent analgesia efficacy and safety in paediatric surgery.

Keywords: erector spinae plane block, PONV, urinary retention, postoperative pain

INTRODUCTION

Surgery is responsible for a significant amount of tissue and bone trauma leading to substantial perioperative pain. Among those receiving surgery, paediatric patients are often at risk of inadequate pain management (1). Untreated severe pain in paediatrics can have significant long-term effects, including maladaptive behavioural changes, increased reliance on analgesia, slow postoperative recovery, and prolonged hospital stays (2). Furthermore, uncontrolled severe pain up to 2 weeks postoperative is a risk factor for the development of chronic pain in one year. Considering these potential long-term consequences, there is a need to manage acute postoperative pain in paediatric patients proactively.

Regional anaesthesia has significantly improved as a multimodal analgesia method in paediatric patients by blocking painful surgical areas and minimizing nerve activation due to surgical injury (3). When there are no contraindications, regional anaesthesia should be used in all paediatric surgery cases for postoperative pain management to minimize opioid requirements. Additionally,

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combining regional and general anaesthesia can reduce the need for volatile or intravenous agents, leading to faster extubation and recovery (4). Regional analgesia is one of the modalities for effectively managing postoperative pain in paediatric patients, compared to systemic analgesia, which minimizes surgical pain and expedites recovery. Regional anaesthesia can be performed in both awake and sedated patient setting, but several studies show that performing it under general anaesthesia resulted in higher success rate and lower complications (5). Among the regional anaesthesia methods, caudal block is the most commonly used for abdominal or lower extremity surgery (4). The procedure is typically landmark-based, where local anaesthesia is injected into the epidural space through the sacral hiatus, which make the caudal block as the most commonly applied regional anaesthesia method in paediatric surgery due to its ease of execution, particularly for beginners (6). Although the procedure has a high success rate, the caudal block can lead to motor block, urinary retention, and short duration of analgesia, potentially slowing down recovery (4).

The advancements in ultrasound and various regional anaesthesia methods provide excellent analgesia quality. These include erector spinae plane block (ESPB), which Forero first introduced in 2016 (7). In recent years, the use of fascial plane block has been increasing due to ease of administration, analgesia efficacy, and a low risk of complications (8). The ESPB is performed by injecting local anaesthesia along the deep fascial plane into the erector spinae muscle under ultrasound guidance. The mechanism of analgesia from ESPB is achieved by spreading local anaesthesia craniocaudally and paravertebrally through the costotransverse foramen, blocking the dorsal and ventral rami of the thoracoabdominal spinal nerves (4). Retrospective studies showed that this method provided optimal intraoperative analgesia in more than 70% of paediatric surgical cases (9). Furthermore, its application as an adjuvant analgesia in general anaesthesia can reduce perioperative opioid consumption, resulting in better postoperative analgesia (10,11). Due to this efficacy, ESPB can be an alternative option for regional anaesthesia alongside caudal block. The aim of this study was to assess the efficacy of ESPB analgesia compared to caudal block in reducing postoperative pain in paediatric surgery.

MATEIALS AND METHODS

Study design

This study aimed to evaluate the efficacy of ESPB compared to caudal block in paediatric patients. The primary outcome was the pain scores in 24 hours postoperatively. Secondary outcomes included the time to the first rescue analgesia requirement, the number of patients requiring rescue analgesia, and the occurrence of side effects, such as post operative nausea and vomiting (PONV) and urinary retention.

Methods

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (12). The literature search was conducted electronically through the Cochrane Library, PubMed, and Google Scholar databases using the keywords: "erector spinae plane block" or "ESP block" or "ESPB") and "caudal block" or "caudal epidural block") and "paediatric" or "children", with a timeframe from January 2018 until September 2023.

Two authors reviewed the identified articles and performed screening based on the PICO criteria (Population, Intervention, Comparison, Outcome, Study Design) (13). These included paediatric patients (age ≤18 years) receiving surgery (P), receiving ESPB (I), compared to caudal block (C), reporting postoperative pain scores (O), and data for this meta-analysis were only collected from randomized controlled trials (RCTs) (S).

Two authors independently carried out data extraction. The data obtained included first author, year of publication, sample size, type of surgery, ESPB and caudal block procedures, local anaesthesia used (type, concentration, and volume), postoperative analgesia administration, postoperative pain scores in 24 hours, pain assessment tools using either face, legs, activity, cry, consolability (FLACC) scale (14–17), Children's Hospital of Eastern Ontario pain scale (CHEOPS) (18), or numeric rating scale (NRS) (15), pain scores at the time of rescue analgesia administration, time first to rescue analgesia, the number of patients requiring rescue analgesia, and the occurrence of PONV and urinary retention.

Quality assessment and risk of bias evaluation were carried out by two authors using the Revised Cochrane risk-of-bias tool for RCTs (RoB 2.0) (19). At the same time, disagreements were discussed with a third author. From the evaluation, all the trials included in this study are ranked as low risk of bias with unclear risk of other bias. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) technique for specific outcomes was used to describe the degree of evidence: very low (downgrade the quality of evidence by one level because one study had a risk of biasing intervention and outcome assessment): a + b + c; low (downgrade the quality of evidence one level because of heterogeneity I2>30%;): a + c; moderate (downgrade the quality of evidence by one level because the number of samples did not meet the optimal information size) (20).

Statistical analysis

Continuous outcomes were recorded as mean values and standard deviations (SD). The results provided as median and interquartile ranges were then transformed to mean and SD using Hozo's formula (21). Continuous data with different outcome measures were presented as standardized mean difference (SMD) with 95% CI (confidence interval). Outcomes with the exact measurement

were presented as mean difference (MD) with 95% CI. The analysis of dichotomous data was carried out using Mantel-Haenszel risk ratios, and heterogeneity was assessed with the I2 statistic. Forest plots with low heterogeneity (I2 ≤30%) were presented in a fixed-effects model, while those with high heterogeneity (I2 >30%) were presented in a random-effects model. Data with high heterogeneity were evaluated through subgroup analysis.

RESULTS

This study included 295 samples from 5 RCTs (14–18) comparing the efficacy of ESPB to caudal block in paediatric surgery. In all RCTs, the ESPB and caudal block were performed after the patients underwent general anaesthesia. Four RCTs used 0.25% bupivacaine as the local anaesthetics for both ESPB and caudal block (14–17), one used 0.125% bupivacaine (18) (Figure 1).

The RoB 2.0 assessment showed that 2 RCTs (16,17) had a risk of bias with several considerations (Figure 2). Furthermore, evaluating evidence quality using the GRADE guidelines resulted in very low to moderate quality (Table **1**).

Postoperative pain scores in 24 hours

Four RCTs (14–17) assessed postoperative pain scores for 24 hours, while one study (18) only assessed for 12 hours postoperatively. Furthermore, 5 RCTs (14–18) performed postoperative pain assessments at 2, 6, and 12 hours. Four RCTs (14,16–18) evaluated pain at 1 hour, and other 4 (15–18) assessed pain at 24 hours postoperatively. Based on the results, there was no significant difference in pain scores between ESPB and caudal block groups (very low-quality certainty of evidence) either at 1st hour (SMD: -0.17; 95%CI [-0.70, 0.36]; I2=76%; p=0.53), 2nd hour (SMD: -0.50; 95% CI [-1.21, 0.21]; I2=88%; p=0.17), 6th hour (SMD: -1.09; 95%; CI [2.21, 0.03] ; I2=95%; p=0.06),12th hour (SMD: -0.77; 95%CI [-1.75, 0.21] ; I2=93%; p=0.12), and 24th hour postoperative (SMD: -0.13; 95%CI [-0.39, 0.12]; I2=2%; p=0.30) (Figure 3).

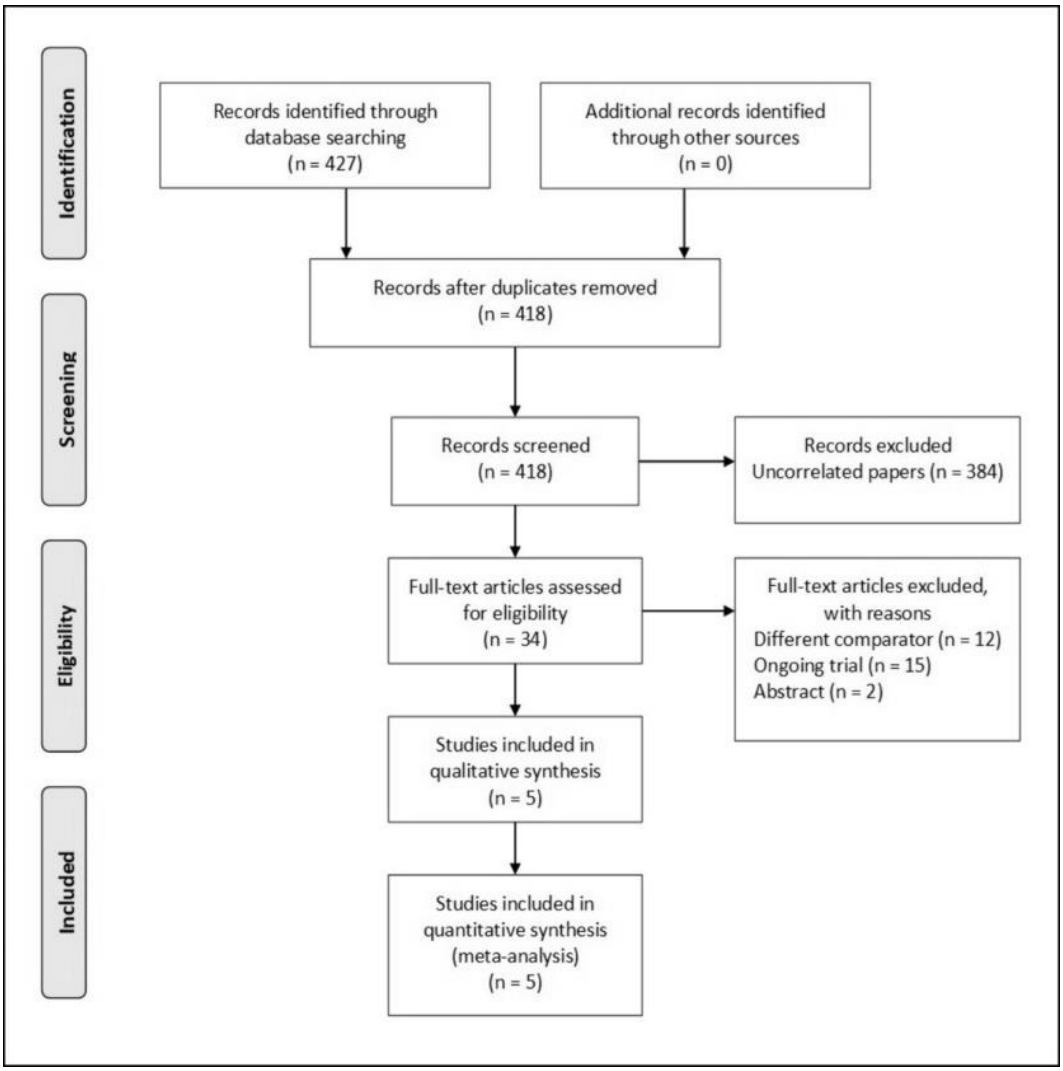

Figure 1. Selection of the included studies

Table 1. Certainty of evidence using the GRADE approach

Outcome	No of partcipants (studies)	Certainty of the evidence (GRADE)*	Relative effect (95%CI)	Anticipated absolute effect	
				Risk with (caudal block)	Risk difference with (ESPB)
Postoperative pain score at 1 hours	245 (4 RCTs)	Very low	-	-	SMD 0.17 SD lower (0.7 lower to 0.36 higher)
Postoperative pain score at 2 hours	295 (5 RCTs)	Very low	-	-	SMD 0.5 SD lower (1.21 lower to 0.21 higher)
Postoperative pain score at 6 hours	295 (5 RCTs)	Very low	-	-	SMD 1.09 SD lower (2.21 lower to 0.03 higher)
Postoperative pain score at 12 hours	295 (5 RCTs)	Very low	-	-	SMD 0.77 SD lower (1.75 lower to 0.21 higher)
Postoperative pain score at 24 hours	245 (4 RCTs)	Low	-	-	SMD 0.13 SD lower (0.39 lower to 0.12 higher)
Time to first rescue analgesia	245 (4 RCTs)	Very low	-	The mean time to first rescue analgesia was 0	MD 1.35 higher (0.85 lower to 3.56 higher)
Number of patients requiring rescue analgesia	166 (3 RCTs)	Very low	RR 0.78 (0.26 to 2.28)	699 per 1,000	154 fewer per 1,000 (517 fewer to 894 more)
PONV event	219 (4 RCTs)	Very low	RR 0.70 (0.22 to 2.18)	218 per 1,000	65 fewer per 1,000 (170 fewer to 257 more)
Urinary retention	90 (2 RCTs)	Moderate	RR 0.20 (0.01 to 3.92)	44 per 1,000	36 fewer per 1,000 (44 fewer to 130 more)

CI, confidence interval; ESPB, erector spinae plane block; GRADE, the Grading of Recommendations Assessment, Development, and Evaluation; MD, mean difference; RR, risk ratio; PONV, postoperative nausea and vomiting; RCTs, randomized controlled trials; SMD, standard mean difference

*Very low: a + b + c; Low: a + c; Moderate: c

A downgrade the quality of evidence by one level because one study has a risk of biasing intervention and outcome assessment; bDowngrade the quality of evidence one level because of heterogeneity I2>30%; cDowngrade the quality of evidence by one level because the number of samples does not meet the optimal information size

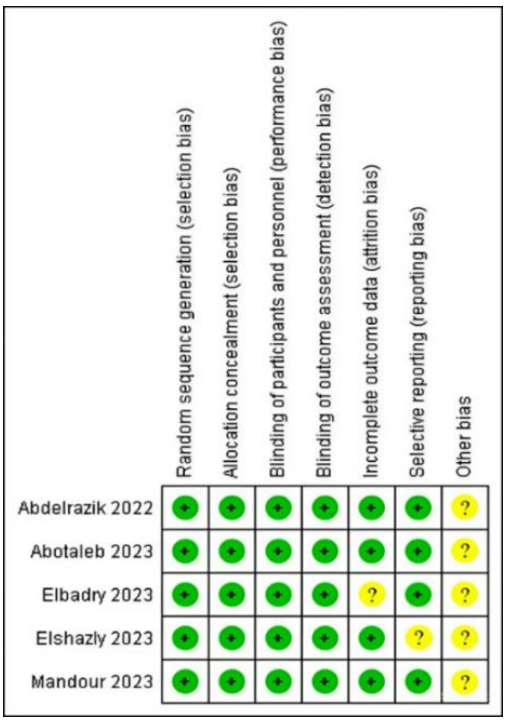

Figure 2. Risk of bias of included studies (by author's name and year of publishing using Cochrane tool) Green: low risk of bias; yellow: unclear risk of bias

All RCTs (14,16–18) assessed the duration of the time to the first rescue analgesia. However, one RCT (18) was excluded because the results reported that the ESPB group did not require rescue analgesia. In four RCTs (14–17) with a total sample size of 245, it was discovered that there was no significant difference in the time first to re cue analgesia between ESPB and caudal block groups, MD: 1.35; 95%CI (-0.85, 3.56); I2=98%; p=0.23 (very low-quality certainty of evidence) (Figure 4).

Three RCTs (14,16,18) with 166 samples reported the number of patients requiring postoperative rescue analgesia. The result revealed no statistically significant differences between the ESPB and caudal block groups: RR: 0.78; 95%CI (0.26, 2.28); I2=94; p=0.65 (low-quality certainty of evidence) (Figure 4).

Four RCTs (14–16,18) consisting of 219 samples assessed the occurrence of PONV. According to the findings, there was no discernible difference in the likelihood of developing PONV (RR: 0.70; 95%CI [0.22, 2.18]; I2=62%; p=0.53, low-quality certainty of evidence). Furthermore, two RCTs (14,18) that evaluated the occurrence of urinary retention showed no significant difference between ESPB and caudal block groups: RR: 0.20; 95%CI (0.01, 3.92); p=0.29, moderate quality certainty of evidence).

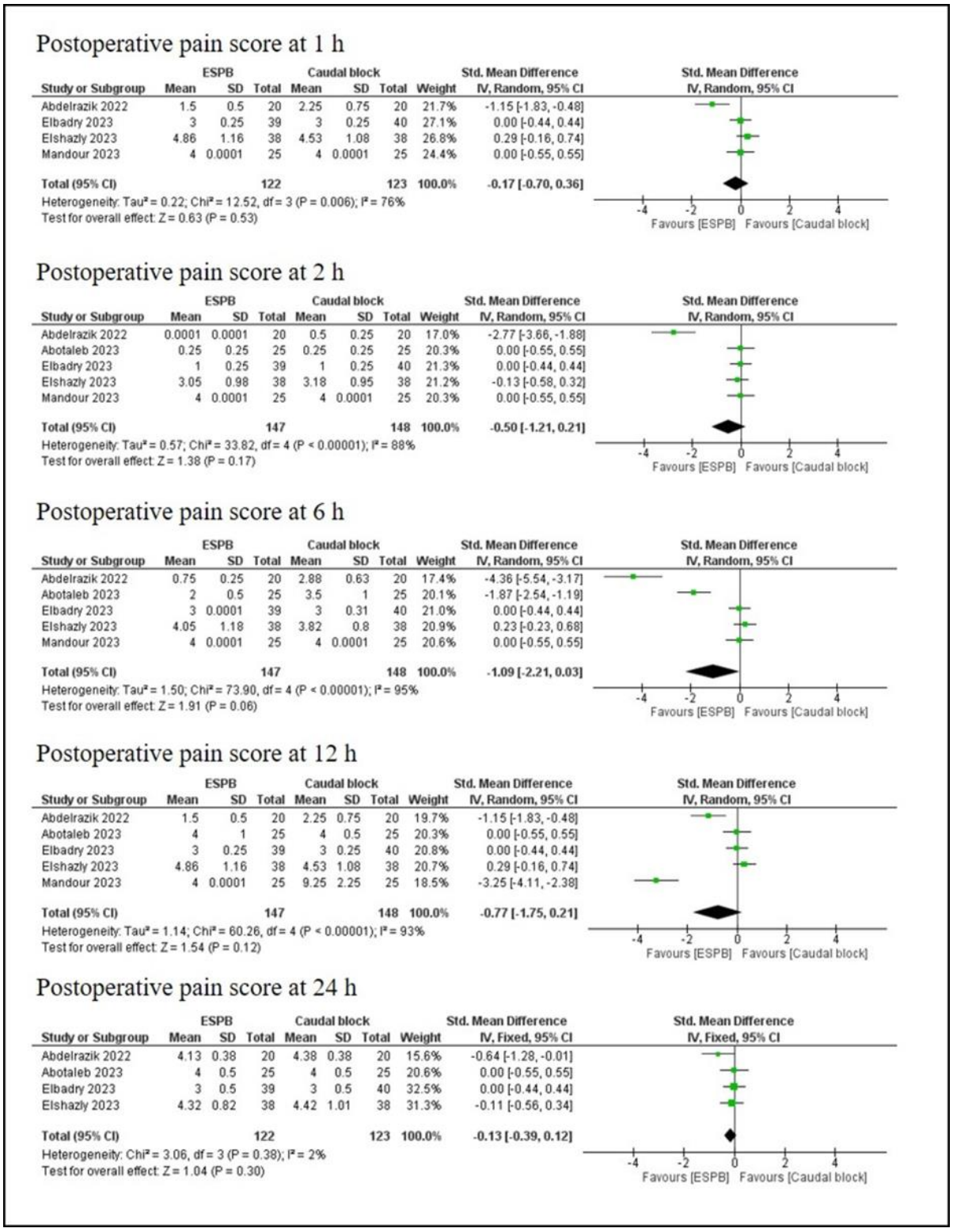

Figure 3. Forest plot of postoperative pain score at 1, 2, 6, 12, and 24 hours for erector spinae plane block (ESPB) versus caudal block

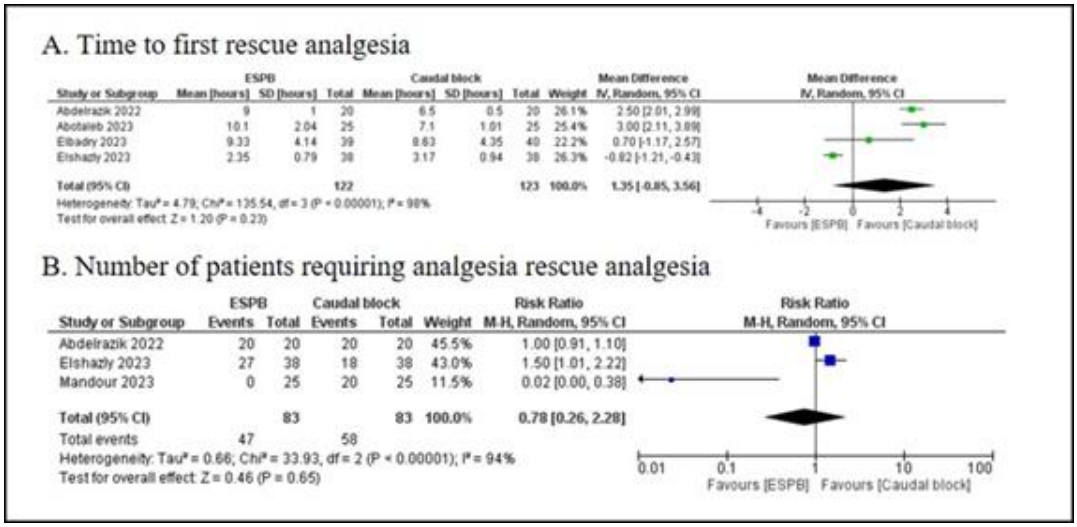

Figure 4. Forest plot of time to first rescue analgesia (A), number of patients requiring rescue analgesia (B) for erector spinae plane block (ESPB) versus caudal b

DISCUSSION

This study showed that ESPB did not have a significant difference in 24-hour postoperative pain scores compared to caudal block. Furthermore, there was no significant difference between the two groups regarding the time to rescue analgesia, the number of patients requiring rescue analgesia, and the occurrence of PONV and urinary retention. The recent postoperative pain management focused on the multimodal analgesia method, which aimed at minimizing opioid use or achieving opioid-free pain control. The concept of multimodal analgesia included using various drugs or analgesia methods, targeting multiple receptors in the nociceptive and neuropathic pain pathways, thereby reducing acute postoperative pain and the surgical stress response (22).

Ultrasound guidance has expanded the scope of regional anaesthesia methods, including fascial plane blocks such as the transversus abdominis plane, rectus sheath, quadratus lumborum, and ESPB. Compared to the caudal block, the location for injecting local anaesthesia in the fascial plane block is at a considerable distance from the spinal cord, resulting in a lower risk of spinal cord damage (23).

ESPB is a relatively new fascial plane block that is becoming increasingly popular among paediatric patients. Previous meta-analyses showed that ESPB caused lower pain scores 6 hours postoperatively, extended the duration of rescue analgesia, and reduced the need for postoperative analgesia compared to cases without the block in various types of paediatric surgeries (24). The first published application of caudal block in paediatrics dates back to 1933 (25), with other large-scale studies showing its safety as a regional anaesthesia method for paediatric surgery (26,27). Meta-analyses in paediatric inguinal surgery have shown that the analgesic efficacy of caudal block is superior to non-caudal. However, it increases the possibility of motor block and urinary retention (28).

This current meta-analysis showed that ESPB has analgesia efficacy equivalent to caudal block in paediatric surgery. The results indicated high heterogeneity due to the collection of various outcomes from different types of surgeries, with one RCT reporting that ESPB was superior to caudal block (18). Mandour et al. (18) showed that in 12 hours of postoperative open kidney surgery, the ESPB group did not require rescue analgesia. This superior efficacy was attributed to the surgical incision being made at the mid-thoracic level. In caudal block, the spread of local anaesthesia to the mid-thoracic level cannot be predicted, potentially affecting its success rate (4,6). Caudal block experienced relatively rapid regression from the lower thoracic segments (29). Another advantage of ESPB is the ability to be administered at the dermatome level of the surgical incision (9).

In contrast, caudal block is known for its ease of administration without requiring ultrasound guidance. Ultrasound-guided caudal block is recommended in infants, premature infants, and paediatric patients with spinal anomalies to prevent the risk of dural puncture or spinal cord injury (6). Meta-analysis studies also showed that this method did not improve success rates or the time required but had a lower complication rate than landmark methods (30). Regarding ESPB, two separate blocks are required for bilateral surgery, thereby prolonging the anaesthesia time. However, the time required for unilateral ESPB application is not different from that for caudal block (17).

The duration of analgesia from ESPB can last 6 hrs postoperatively (24). For prolonged analgesia, local anaesthesia can be administered periodically or continuously through a catheter (31–33). Compared to other regional methods, ESPB is superior to ilioinguinal-iliohypogastric block (34) but equivalent to quadratus lumborum block (35,36). Considering this efficacy, ESPB serves as an alternative opioid-sparing analgesia

modality with regional anaesthesia technique. This study's limitations include using a limited number of studies and sample size. Furthermore, there is high heterogeneity in the results due to different types of surgery, variations in pain assessment tools, and interventions providing rescue analgesia. The evidence quality ranges from very low to moderate. Several factors that reduce the quality of evidence include two studies with some concern about the risk of bias, inconsistency in results due to high heterogeneity, and limited sample size information.

In conclusion, this study indicated that ESPB and caudal block showed equivalent analgesia efficacy and safety for paediatric surgery. ESPB was considered the best alternative, as the site of local anaesthesia injection was far from the spinal cord, thereby preventing unwanted complications.

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TRANSPARENCY DECLARATION

Conflict of interests: None to declare.

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