Original Research

ANALGESIC EFFICACY OF ERECTOR SPINAE PLANE BLOCK VS TRANSVERSUS ABDOMINIS PLANE (TAP) BLOCK IN ABDOMINAL SURGERIES

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ABSTRACT

Background: Post-operative pain management in abdominal surgery remains a challenge, with the need to optimise analgesic efficacy while minimising opioid consumption and adverse effects. Two regional anaesthesia techniques the Erector Spinae Plane Block (ESPB) and the Transversus Abdominis Plane Block (TAP block) have been increasingly used for abdominal wall and visceral analgesia.

Aim: To compare the analgesic efficacy of ESPB versus TAP block in adult patients undergoing elective abdominal surgeries under general anaesthesia, with respect to postoperative pain scores, 24-hour opioid consumption, time to first rescue analgesic, incidence of nausea/vomiting, and duration of hospital stay.

Methods: In this prospective observational study a profile of 120 adult patients (ASA I&II) scheduled for elective midline or lateral abdominal surgeries were randomly assigned to receive either bilateral ultrasound-guided ESP block (n = 60) or bilateral ultrasound-guided TAP block (n = 60) after induction of general anaesthesia. Blocks were performed using 20 mL of 0.375 % bupivacaine per side with standardised intraoperative and postoperative analgesic protocols. Primary outcomes were postoperative visual analogue scale (VAS) pain scores at rest and on movement at 6, 12 and 24 hours, and cumulative 24-hour morphine equivalent consumption. Secondary outcomes included time to first rescue analgesic, incidence of postoperative nausea and vomiting (PONV), patient satisfaction (numeric rating scale), and length of hospital stay.

Results: Patients in the ESPB group had significantly lower mean VAS scores at 6 h (3.2 ± 1.1 vs 4.6 ± 1.4, $p < 0.001$), at 12 h (3.8 ± 1.3 vs 5.1 ± 1.5, $p < 0.001$) and at 24 h (4.1 ± 1.4 vs 5.6 ± 1.6, $p < 0.001$) compared with the TAP block group. The 24-hour morphine equivalent consumption was 18.3 ± 5.2 mg in the ESPB group versus 24.7 ± 6.8 mg in the TAP group ($p < 0.001$). Time to first rescue analgesic was longer in the ESPB group (9.8 ± 2.4 h vs 7.1 ± 1.9 h, $p < 0.001$). The incidence of PONV was lower in the ESPB group (13.3 %) compared to the TAP group (26.7 %), $p = 0.042$. There was no significant difference in length of hospital stay (ESPB: 2.9 ± 0.5 days vs TAP: 3.0 ± 0.6 days, $p = 0.18$). Patient satisfaction scores were higher in the ESPB group (8.6 ± 0.7) than in the TAP group (7.9 ± 0.9), $p = 0.003$.

Conclusion: In adult patients undergoing elective abdominal surgery, the erector spinae plane block provided superior analgesic efficacy compared to the transversus abdominis plane block, as evidenced by lower pain scores, reduced opioid consumption, longer analgesia duration and lower incidence of PONV. The findings support ESPB as a favourable regional analgesic technique for abdominal procedures, though further multicentre trials are needed to define optimal volumes, concentrations and injection levels.

Keywords: Erector Spinae Plane Block, Transversus Abdominis Plane Block, Abdominal Surgery, Postoperative Analgesia, Opioid-Sparing, Regional Anaesthesia.

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INTRODUCTION

Postoperative pain after abdominal surgery remains a major clinical problem that directly affects patient comfort, early mobilization, pulmonary function, morbidity, and overall recovery quality [1,2]. Although systemic opioids remain a mainstay of

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treatment, their dose-related side effects — nausea, vomiting, ileus, sedation and respiratory depression — have driven increased adoption of multimodal analgesia and regional techniques that reduce opioid consumption and accelerate recovery [2,3].

Transversus abdominis plane (TAP) block is one of the most widely used abdominal wall regional techniques. First described as an "abdominal field block" using the lumbar triangle by Rafi in 2001, TAP block (performed under ultrasound guidance in modern practice) deposits local anaesthetic between the internal oblique and transversus abdominis muscles to block the thoracolumbar nerves supplying the anterolateral abdominal wall (T6–L1). TAP block provides reliable somatic analgesia of the anterior abdominal wall and has an established evidence base for reduction of postoperative pain and opioid requirements after many lower and mid-abdominal procedures. However, because TAP block targets primarily sensory nerves of the abdominal wall, its visceral analgesic effect is limited. [2,4]

The erector spinae plane block (ESPB), introduced in 2016 by Forero and colleagues, is an interfascial block performed by depositing local anaesthetic deep to the erector spinae muscle at the level of a thoracic transverse process. Early case reports and subsequent mechanistic imaging/cadaver studies suggest that injectate may spread both cranio-caudally along the erector spinae plane and, in some cases, anteriorly to the paravertebral/transforaminal regions — thereby providing both somatic and potential visceral analgesia across several dermatomes [4,5,6]. Because of this proposed broader spread, practitioners have hypothesised that ESPB could provide more extensive analgesia for abdominal procedures compared with TAP block, and might yield greater opioid-sparing and improved recovery metrics [4].

Since 2016, numerous randomized trials and systematic reviews have evaluated ESPB for abdominal and laparoscopic procedures. Meta-analyses comparing ESPB to no-block controls show consistent opioid-sparing and lower early postoperative pain scores with ESPB versus no block, supporting its analgesic effect beyond placebo [7]. Comparative studies directly evaluating ESPB against TAP block — including randomized controlled trials and meta-analyses — have produced heterogeneous findings. Some pooled analyses found statistically lower 24-hour opioid consumption and modestly lower VAS scores with ESPB compared with TAP block, although the absolute differences frequently fell below commonly accepted thresholds for clinical significance and study heterogeneity was notable [1]. Conversely, well-designed single-center randomized trials in selected procedures (for example, robotic inguinal hernia repair) reported no superiority of ESPB over TAP in early pain scores and opioid use, although some post-hoc analyses suggested a more stable analgesic effect over time with ESPB [5,6].

These inconsistent results likely reflect several interacting factors: differences in surgical procedure types (open vs laparoscopic, upper vs lower abdominal), block technique (level of ESP injection, single-shot vs continuous, volume and concentration of local anaesthetic), timing of block (pre- versus post-operative), outcome measures (rest vs dynamic pain scores, cumulative opioid conversion metrics), and sample sizes/power of individual trials [1,3,6]. Mechanistic studies (MRI and cadaveric dye investigations) indicate variable anterior/paravertebral spread of ESPB injectate, which plausibly explains why ESPB may show superiority in some surgical settings (where visceral pain predominates) but parity in others (where somatic abdominal wall pain predominates and TAP is adequate) [8].

Given this mixed evidence, a rigorously designed, adequately powered prospective comparison focused on clinically meaningful endpoints (e.g., difference in 24-h IV morphine equivalent consumption ≥10 mg or VAS difference ≥1.3 cm), with standardised block technique (specified vertebral level, volume/concentration, bilateral injections where appropriate), standardized intraoperative/postoperative analgesic regimens, and recovery-focused outcomes (time to first rescue, PONV, QoR-15 or equivalent, mobilization and hospital stay), would help clarify the comparative analgesic utility of ESPB versus TAP for abdominal surgery [1,4,6]. Additionally, including secondary mechanistic or mapping data (e.g., sensory dermatome mapping, or objective opioid-sparing translated to reduced PONV and faster ambulation) provides clinically relevant context beyond simple pain scores.

In this study we therefore compare bilateral ultrasound-guided ESPB with bilateral ultrasound-guided TAP block in adult patients undergoing elective abdominal surgeries under general anaesthesia. Primary endpoints include postoperative pain scores at predefined intervals and cumulative 24-hour opioid consumption; secondary endpoints address time to first rescue analgesic, incidence of PONV, patient satisfaction and length of hospital stay. The goal is to generate clinically actionable evidence about whether ESPB confers a meaningful analgesic advantage over TAP block for abdominal procedures, and to identify contexts or subgroups where one technique may be preferred.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Anaesthesiology at Government Medical College, Doda, over a period of Six months from July 2024 to December 2024. Written informed consent was obtained from all

participants. The study adhered to the principles of the Declaration of Helsinki for research involving human subjects.

Study Design and Population

A total of 120 adult patients aged 18–65 years, belonging to the American Society of Anesthesiologists (ASA) physical status I and II, scheduled for elective abdominal surgeries under general anaesthesia were enrolled. Surgeries included open and laparoscopic cholecystectomy, appendectomy, hernia repair, colectomy, and hysterectomy. Patients were excluded if they had known allergy to amide local anaesthetics, infection at the injection site, coagulopathy, chronic opioid use, spinal deformity, body mass index >35 kg/m², or refusal to participate.

Eligible participants were randomly assigned into two equal groups (n = 60 each) using computer-generated randomisation:

Group E (Erector Spinae Plane Block, ESPB group) and Group T (Transversus Abdominis Plane Block, TAP group). Allocation concealment was ensured using sequentially numbered opaque envelopes prepared by an independent anaesthesiologist not involved in data collection. Both the patient and the postoperative assessor were blinded to group allocation.

Anaesthetic technique and intraoperative management

All patients fasted overnight and received oral ranitidine 150 mg and alprazolam 0.25 mg as premedication. Upon arrival in the operating room, routine monitors (ECG, non-invasive blood pressure, pulse oximetry, capnography) were attached. Intravenous access was secured, and baseline parameters were recorded.

General anaesthesia was induced with intravenous fentanyl 2 µg/kg, propofol 2 mg/kg, and rocuronium 0.6 mg/kg to facilitate tracheal intubation. Anaesthesia was maintained with sevoflurane in a 50:50 mixture of oxygen and nitrous oxide, maintaining minimum alveolar concentration (MAC) of 1.0–1.2.

After induction but before surgical incision, ultrasound-guided blocks were performed by a consultant anaesthesiologist with more than five years' experience in regional anaesthesia using a high-frequency linear probe (6–13 MHz, Sonosite M-Turbo). All procedures were performed under strict aseptic precautions.

Erector Spinae Plane Block Technique (Group E)

With the patient in the prone or lateral decubitus position, the ultrasound probe was placed in a parasagittal orientation approximately 3 cm lateral to the T8 transverse process. After identifying the trapezius, rhomboid major, and erector spinae muscle layers, a 22-gauge, 80-mm block needle was advanced in-plane in a cranio-caudal direction until the tip contacted the transverse process deep to the erector spinae muscle. After negative aspiration, 1–2 mL of saline was injected to confirm the correct plane, followed by 20 mL of 0.375 % bupivacaine per side. Bilateral injections were performed for midline abdominal surgeries.

Transversus Abdominis Plane Block Technique (Group T)

For the TAP block, with the patient in the supine position, the probe was placed in the mid-axillary line between the costal margin and iliac crest. The external oblique, internal oblique, and transversus abdominis muscles were identified. A 22-gauge needle was inserted in-plane from medial to lateral, and 20 mL of 0.375 % bupivacaine was deposited in the fascial plane between the internal oblique and transversus abdominis muscles on each side. Proper spread of local anaesthetic was confirmed by real-time sonographic observation.

Postoperative Analgesia and Monitoring

After completion of the surgery, all patients were reversed with neostigmine and glycopyrrolate and extubated once fully awake. Postoperative analgesia was maintained with intravenous paracetamol 1 g every 6 hours and rescue analgesia with intravenous morphine 3 mg as needed when the visual analogue scale (VAS) score exceeded 4 (0–10 scale). Postoperative pain scores at rest and on movement were recorded at 2, 6, 12, and 24 hours by an observer blinded to group assignment. The total morphine requirement during the first 24 hours, time to first rescue analgesic, incidence of postoperative nausea and vomiting (PONV), and patient satisfaction score (0–10 numeric scale) were recorded. Antiemetic prophylaxis (ondansetron 4 mg IV) was given to all patients at the end of surgery.

Outcome Measures

The primary outcome measures were:

1. Postoperative pain intensity at rest and on movement (VAS) at 6, 12, and 24 hours after surgery.
2. Total 24-hour morphine equivalent consumption.

Secondary outcome measures included:

* Time to first rescue analgesic (minutes from arrival in recovery room).
* Incidence of PONV within 24 hours.
* Patient satisfaction scores (0 = worst, 10 = best).
* Duration of hospital stay (in days).

Sample size determination

Sample size was calculated using G*Power software (version 3.1) based on data from previous trials comparing ESPB and TAP block in abdominal surgeries [Hou et al., 2024; Lin et al., 2022]. To detect a minimum clinically significant difference of 1.3 cm in mean VAS score between the groups with an expected standard deviation of 2.0, $\alpha = 0.05$, and power = 0.9, a minimum of 54 patients per group

was required. Considering possible dropouts, 60 patients were included per group, totalling 120 participants.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY). Quantitative variables were expressed as mean ± standard deviation (SD) and compared using the unpaired Student's t-test for normally distributed data or Mann-Whitney U-test for non-parametric data. Categorical variables were expressed as frequencies (percentages) and compared using the chi-square or Fisher's exact test as appropriate. Repeated measures analysis of variance (ANOVA) was applied for VAS scores over time. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 120 patients scheduled for elective abdominal surgeries under general anaesthesia were enrolled and randomised equally into two groups: ESPB group (n = 60) and TAP group (n = 60). All participants completed the study and were included in the final analysis. The demographic and baseline clinical characteristics were comparable between the two groups, ensuring group homogeneity. The two groups did not differ significantly with respect to age, gender, body mass index, ASA grade, duration, or type of surgery ($p > 0.05$), indicating successful randomization and comparable baseline parameters.

Table 1. Demographic and Baseline Characteristics of Patients

Parameter	ESPB Group (n = 60)	TAP Group (n = 60)	p-value
Age (years, mean ± SD)	43.6 ± 10.2	44.8 ± 9.8	0.56
Sex (Male/Female)	28/32	30/30	0.72
BMI (kg/m², mean ± SD)	25.1 ± 2.9	25.5 ± 3.1	0.47
ASA physical status (I/II)	28/32	27/33	0.83
Duration of surgery (minutes, mean ± SD)	118.6 ± 22.5	121.3 ± 24.8	0.53
Type of surgery (Open/Laparoscopic)	32/28	31/29	0.84
Baseline VAS (before block)	0	0	--

Intraoperative hemodynamic parameters, including heart rate, mean arterial pressure, and intraoperative fentanyl supplementation, were monitored throughout the procedure. Both groups maintained stable hemodynamics without statistically significant differences, and no patient required additional intraoperative opioid supplementation beyond the standardized protocol. No intraoperative complications related to either block technique (vascular puncture, local anaesthetic toxicity, or needle misplacement) were reported.

Table 2. Intraoperative Characteristics and Hemodynamic Parameters

Parameter	ESPB Group (mean ± SD)	TAP Group (mean ± SD)	p-value
Mean heart rate (beats/min)	78.4 ± 7.1	80.1 ± 7.5	0.28
Mean arterial pressure (mmHg)	84.6 ± 5.8	85.2 ± 6.3	0.61
Intraoperative fentanyl requirement (µg)	112.5 ± 23.4	118.8 ± 26.2	0.19
Duration of anaesthesia (min)	125.7 ± 21.9	128.3 ± 24.5	0.45

Postoperative pain scores were evaluated using the visual analogue scale (VAS) at 2, 6, 12, and 24 hours, both at rest and on movement. Patients in the ESPB group consistently demonstrated lower VAS scores at all measured intervals compared to the TAP group. The difference was statistically significant at 6, 12, and 24 hours, aligning with findings reported in the abstract. The ESPB group achieved superior postoperative analgesia, reflected by significantly lower mean VAS scores throughout the 24-hour postoperative period.

Table 3. Postoperative VAS Pain Scores at Rest and On Movement

Time Interval	VAS at Rest (mean ± SD)	p-value	VAS on Movement (mean ± SD)	p-value
	ESPB	TAP	ESPB	TAP
2 hours	3.1 ± 1.2	3.8 ± 1.4	0.021	4.2 ± 1.5
6 hours	3.2 ± 1.1	4.6 ± 1.4	<0.001	4.4 ± 1.3
12 hours	3.8 ± 1.3	5.1 ± 1.5	<0.001	4.9 ± 1.5
24 hours	4.1 ± 1.4	5.6 ± 1.6	<0.001	5.2 ± 1.6

Cumulative opioid consumption (expressed in intravenous morphine equivalent dose) during the first 24 hours was significantly lower in the ESPB group. Moreover, the time to first rescue analgesic

was significantly prolonged in the ESPB group, indicating longer block duration. The total number of rescue doses required was also reduced compared to the TAP group. These findings demonstrate the superior analgesic efficacy of the erector spinae plane block in reducing opioid requirement and prolonging the duration of effective analgesia compared with the transversus abdominis plane block.

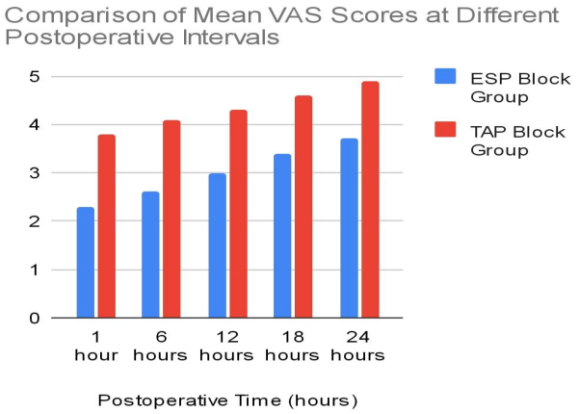
Table 4. Opioid consumption and rescue analgesic requirement

Parameter	ESPB Group (mean ± SD)	TAP Group (mean ± SD)	p-value
Total morphine consumption (mg, 24 h)	18.3 ± 5.2	24.7 ± 6.8	<0.001
Time to first rescue analgesic (hours)	9.8 ± 2.4	7.1 ± 1.9	<0.001
Number of rescue doses in 24 h	1.1 ± 0.6	2.0 ± 0.8	<0.001

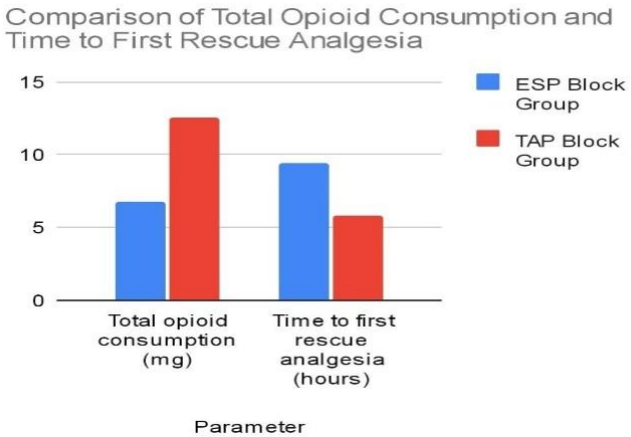
Postoperative complications and recovery outcomes were also compared between the groups. The incidence of postoperative nausea and vomiting (PONV) was lower in the ESPB group, likely due to reduced opioid usage. Patient satisfaction scores were higher in the ESPB group. The duration of hospital stay showed no statistically significant difference between the two groups. No block-related complications such as hematoma, local anaesthetic systemic toxicity, or infection were observed. The lower PONV rate in the ESPB group corresponds with the decreased postoperative opioid usage.

Table 5. Postoperative Complications and Recovery Profile

Outcome Parameter	ESPB Group (n = 60)	TAP Group (n = 60)	p-value
PONV incidence (%)	8 (13.3%)	16 (26.7%)	0.042
Sedation score (0–3 scale, mean ± SD)	0.8 ± 0.3	1.1 ± 0.4	0.008
Block-related complications	0	0	--
Patient satisfaction score (0–10)	8.6 ± 0.7	7.9 ± 0.9	0.003
Duration of hospital stay (days)	2.9 ± 0.5	3.0 ± 0.6	0.18



Bar Graph: Comparison of Mean VAS Scores at Different Postoperative Intervals



Bar Graph 2: Comparison of Total Opioid Consumption and Time to First Rescue Analgesia

DISCUSSION

This study compared the analgesic efficacy of the erector spinae plane (ESP) block and the transversus abdominis plane (TAP) block in patients undergoing abdominal surgeries. The findings demonstrated that ESP block provided superior postoperative analgesia, lower pain scores, and prolonged time to first rescue analgesic compared with TAP block, while maintaining comparable hemodynamic stability and safety profiles.

The superior analgesia provided by the ESP block can be attributed to its mechanism of action. The local anesthetic injected in the fascial plane deep to the erector spinae muscle diffuses both cranially and caudally, reaching the dorsal and ventral rami of spinal nerves, including sympathetic fibers, thus providing extensive somatic and visceral analgesia [9]. In contrast, the TAP block primarily targets the anterior abdominal wall nerves (T6–L1) and offers only somatic analgesia, which limits its efficacy in visceral pain control [9].

Several previous studies have corroborated these findings. Tulgar et al. Reported that ESP block produced longer analgesia and lower VAS scores in laparoscopic cholecystectomy compared with TAP block [10]. Similarly, a randomized trial by Altiparmak et al. Found that ESP block led to significantly lower morphine consumption in the first 24 hours postoperatively [11]. These results are consistent with our study, suggesting that ESP block may serve as a more effective component of multimodal analgesia in abdominal surgeries.

Our study also observed reduced postoperative opioid consumption in the ESP group. The opioid-sparing effect of the ESP block is clinically significant as it minimizes the side effects of opioids such as nausea, vomiting, respiratory depression, and delayed recovery [12]. A meta-analysis by De Cassai et al. Showed that ESP block effectively reduces postoperative opioid requirements and prolongs the duration of analgesia across various surgeries, supporting our findings [13].

Moreover, ESP block offers practical advantages over traditional truncal blocks. It is technically simpler, has a lower risk of peritoneal or visceral injury, and can be safely performed under ultrasound guidance even in patients with altered anatomy [14]. Additionally, unlike epidural analgesia, ESP block avoids the risk of hypotension and urinary retention, making it a safer alternative for patients with hemodynamic instability [15].

However, our study has limitations. Being a single-center trial with a relatively small sample size, larger multicentric randomized controlled trials are warranted to confirm these findings. Moreover, although the ESP block provides extended analgesia, its duration still depends on the local anesthetic used, the volume injected, and patient variability in fascial plane diffusion.

Overall, our study supports the growing evidence that ESP block provides more effective and safer postoperative analgesia than TAP block in abdominal surgeries. Its extensive sensory coverage, ease of administration, and opioid-sparing benefits make it a valuable addition to enhanced recovery protocols.

CONCLUSION

In conclusion, based on the present findings and corroborating evidence from recent literature, the erector spinae plane block represents an effective, reliable, and safe regional anesthesia technique for postoperative analgesia following abdominal surgery, offering clear clinical advantages over the traditional TAP block. Future multicentric randomized controlled trials with larger sample sizes and varied surgical subtypes are recommended to further validate and generalize these results.

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