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Original Research Article

Erector Spinae Plane Block versus Transversus Abdominis Plane Block for Postoperative Analgesia in Adult Abdominal Surgery: A Comparative Observational Study

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Abstract:

Background: Pain during the first postoperative day after abdominal surgery can blunt breathing effort, delay mobilisation, and increase opioid exposure. Ultrasound-guided fascial plane blocks are now routinely added to multimodal analgesia, yet the relative clinical performance of erector spinae plane (ESP) block and transversus abdominis plane (TAP) block across common abdominal procedures needs procedure-relevant evaluation.

Objectives: To evaluate and compare ESP block and TAP block in adult abdominal surgery patients with regard to serial pain scores, rescue analgesic profile, opioid requirement, sedation, adverse effects, recorded complications, and patient satisfaction.

Materials and Methods: Sixty adults undergoing abdominal surgery under general anaesthesia were analysed, with 30 patients each in the ESP and TAP groups. Study period: 2023-2025. The selected block was performed after induction and before incision using real-time ultrasound guidance and 0.25% plain bupivacaine. A 20 mL volume was used for unilateral blocks; sleeve gastrectomy patients received bilateral blocks with 20 mL per side. ESP block was performed at the T8 transverse process level. TAP block was given as an oblique subcostal block for cholecystectomy and sleeve gastrectomy, and as posterior TAP block for appendectomy and hernia repair. VAS scores at rest and with movement were recorded at 0, 2, 4, 6, 12, and 24 hours. Intravenous tramadol 50 mg in 100 mL normal saline was used for rescue analgesia when resting VAS was ≥4 or when the patient requested analgesia; 50 mg tramadol was counted as 5 MME.

Results: The two groups were comparable for age, sex distribution, BMI, ASA class, procedure type, surgical duration, and intraoperative fentanyl use. Resting and movement-related VAS scores were lower in the ESP group at every postoperative assessment. In patients who received rescue analgesia, the first dose was required later after ESP block than after TAP block (516.52±131.38 min vs 245.36±61.13 min, $p<0.001$). Mean 24-hour opioid consumption was also lower with ESP block (6.53±2.83 MME vs 13.40±4.52 MME, $p<0.001$). Satisfaction was higher in the ESP group (4.37±0.72 vs 3.13±0.73, $p<0.001$), while nausea, vomiting, and recorded complications did not differ significantly.

Conclusion: In this cohort, ESP block produced better early postoperative analgesia than TAP block, with lower VAS scores, delayed rescue analgesic requirement, reduced 24-hour opioid use, and higher satisfaction. The frequency of adverse effects and recorded complications remained low in both groups.

Keywords: Erector Spinae Plane Block, Transversus Abdominis Plane Block, Abdominal Surgery, Postoperative Pain, Tramadol, Morphine Milligram Equivalents, Visual Analogue Scale.

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Introduction

Pain after abdominal surgery is shaped by more than the skin incision. Even with small ports or limited dissection, nociception may arise from the abdominal wall, parietal peritoneum, visceral traction, pneumoperitoneum, and referred upper abdominal discomfort. For the anaesthesiologist, this is not a minor recovery-room issue. Poorly controlled pain can restrict cough and deep breathing, slow mobilisation, disturb sleep, increase opioid use, and leave the patient dissatisfied during the period when early recovery should ideally begin. Current guidance on postoperative pain therefore favours planned multimodal analgesia, matched to both the procedure and the individual patient, rather than waiting until severe pain has already developed.[1]

Laparoscopic abdominal operations create a mixed pain picture: somatic pain at the port or incision, visceral pain from intra-abdominal handling, irritation of peritoneal surfaces, and referred pain in selected patients.[2] Procedure-specific recommendations for laparoscopic cholecystectomy place regional analgesic techniques within a broader opioid-sparing strategy.[3] This has everyday relevance in Indian surgical units, where high list volume and the push for earlier mobilisation often leave little room for repeated rescue-based pain management. A regional block that is reliable, teachable, and safe can therefore make a visible difference in routine postoperative care.

The transversus abdominis plane (TAP) block has become a familiar option for abdominal wall analgesia. Originally described through the lumbar triangle and subsequently adapted to ultrasound guidance, the technique places local anaesthetic in the plane between the internal oblique and transversus abdominis muscles, close to the thoracolumbar nerves of the anterior abdominal wall.[4,5] Trials and pooled analyses have shown reductions in pain scores and opioid use after abdominal and laparoscopic surgery.[6,7] Its limitation is equally important: TAP block is strongest for somatic abdominal wall pain, while visceral discomfort may persist after procedures with substantial intra-abdominal manipulation.

The erector spinae plane (ESP) block is a newer interfascial plane technique introduced by Forero et al., in which the injectate is placed deep to the erector spinae muscle at the transverse process.[8] Its use has since widened from thoracic neuropathic pain to several thoracoabdominal procedures, including ventral hernia repair and bariatric surgery.[9] The suggested mechanism involves longitudinal fascial spread with possible extension towards dorsal and ventral rami, although the consistency of paravertebral spread is still discussed in the literature.[10] In practice, its relatively clear sonoanatomy and distance from the peritoneal cavity and neuraxis have encouraged wider perioperative use.

Direct comparisons between ESP and TAP blocks remain procedure-dependent. Analgesic effect may change with the surgical incision, block level, volume of local anaesthetic, timing of injection, and the balance between somatic and visceral pain. This study was designed to compare the postoperative analgesic profile of ESP block and TAP block in adults undergoing abdominal surgical procedures. Serial VAS scores and 24-hour opioid consumption were the main outcomes of interest; rescue analgesic requirement, time to rescue dose, sedation, satisfaction, nausea, vomiting, and recorded complications were also analysed.

Materials and Methods

Study Design and Setting: This hospital-based comparative observational study was conducted in the Department of Anaesthesiology. Sixty adults scheduled for abdominal surgical procedures were analysed. Thirty patients received an erector spinae plane block and 30 received a transversus abdominis plane block as part of perioperative analgesic care.

Study Period: 2023-2025.

Study Population: Adults undergoing cholecystectomy, appendectomy, hernia repair, or sleeve gastrectomy were included in the analysis. Patients were classified according to the regional analgesic technique used for postoperative pain control.

- Group ESP: Patients receiving ultrasound-guided erector spinae plane block with 20 mL of 0.25% plain bupivacaine for unilateral procedures and 20 mL per side for sleeve gastrectomy.
- Group TAP: Patients receiving ultrasound-guided transversus abdominis plane block with 20 mL of 0.25% plain bupivacaine for unilateral procedures and 20 mL per side for sleeve gastrectomy.

Block Technique and Postoperative Analgesic Regimen: The regional block was performed after induction of general anaesthesia and before the surgical incision. Positioning was adjusted to the planned block: sitting or lateral decubitus for ESP block and supine for TAP block. Under aseptic precautions, a high-frequency 6-13 MHz linear ultrasound probe covered with a sterile sheath was used. A 22-G, 80 mm short-bevel needle was advanced under continuous ultrasound visualisation.

Erector Spinae Plane Block: For the ESP block, the transducer was aligned parasagittally to visualise the T8 transverse process with the erector spinae muscle lying superficial to it. The needle was introduced in-plane from cephalad to caudad and advanced until the tip lay beneath the erector spinae muscle. After careful negative aspiration, 20 mL of 0.25% plain bupivacaine was injected. Correct placement was accepted when the injectate lifted the erector spinae muscle and spread craniocaudally along the fascial plane.

A unilateral ESP block was used for cholecystectomy, appendectomy, and inguinal or ventral hernia repair, with the injection given on the operative side. In sleeve gastrectomy, the block was bilateral, using 20 mL of 0.25% plain bupivacaine on each side, making a total block volume of 40 mL.

Transversus Abdominis Plane Block: For TAP block, probe placement depended on the approach required. For posterior TAP block, the probe was positioned in the mid-axillary line between the costal margin and iliac crest. For oblique subcostal TAP block, it was placed parallel to the costal margin. The needle was advanced in-plane until its tip reached the fascial plane between the internal oblique and transversus abdominis muscles. Following negative aspiration, 20 mL of 0.25% plain bupivacaine was injected on the required side, and separation of the fascial layers confirmed adequate spread.

Oblique subcostal TAP block was used for cholecystectomy and sleeve gastrectomy. Posterior TAP block was used for appendectomy and hernia repair. Laterality was matched to the ESP protocol: unilateral block for cholecystectomy, appendectomy, and hernia repair, and bilateral block for sleeve gastrectomy.

Rescue Analgesia: Postoperative pain was measured with the Visual Analogue Scale (VAS). Rescue analgesia was given when resting VAS reached 4 or more, or earlier if the patient requested pain relief. The rescue drug was tramadol 50 mg intravenously, diluted in 100 mL normal saline and infused over 15 minutes. If pain persisted, repeat dosing was allowed only after an interval of at least 8 hours. No additional opioid was used during the first 24 postoperative hours.

For analysis of opioid exposure, tramadol doses during the first 24 hours were converted into morphine milligram equivalents (MME). A dose of 50 mg tramadol was considered equivalent to 5 MME.

Outcome Measures: The primary outcomes were serial VAS scores at rest and during movement at 0, 2, 4, 6, 12, and 24 hours, together with cumulative opioid consumption during the first postoperative day. Secondary variables were rescue analgesia requirement, interval to first rescue dose, nausea, vomiting, sedation score, satisfaction score, and any recorded block-related or perioperative event.

Statistical Analysis: Continuous data were summarised as mean±standard deviation; medians with interquartile ranges were also reported where this added clinical meaning. Categorical variables were shown as counts and percentages. Normally distributed continuous variables were compared using the independent samples t-test, while ordinal or non-normally distributed variables were assessed using the Mann-Whitney U test. The chi-square test or Fisher exact test was used for categorical comparisons according to cell size. Statistical significance was set at $p<0.05$.

Results

Sixty patients were included in the final analysis, 30 in each block group. The overall age range was 29-60 years. Sex distribution was identical, with 15 males and 15 females in both groups.

The baseline profile was well matched. Mean age was 44.60±9.07 years in the ESP group and 44.77±9.24 years in the TAP group ($p=0.944$). BMI, ASA status, type of surgery, duration of operation, and intraoperative fentanyl requirement also showed no significant between-group difference (Table 1). Thus, the main postoperative comparisons were not obviously confounded by measured demographic or intraoperative variables.

Resting VAS scores favoured the ESP group throughout the 24-hour assessment period. At 6 hours, the mean resting VAS score was 3.53±0.97 after ESP block and 4.80±0.92 after TAP block ($p<0.001$). The difference remained evident at both 12 and 24 hours (Table 2). Figure 1 depicts the resting pain trajectory over time.

Movement-related pain followed the same direction. The mean VAS score on movement at 6 hours was 4.97±0.85 in the ESP group and 6.00±0.95 in the TAP group ($p<0.001$). At 12 hours, the corresponding values were 5.53±1.31 and 6.67±1.27 ($p=0.002$). The serial pattern for dynamic pain is presented in Figure 2.

Rescue analgesia was administered to 23 patients (76.7%) in the ESP group and 28 patients (93.3%) in the TAP group; this categorical difference was not statistically significant ($p=0.145$). The timing, however, differed substantially. Among those who required rescue analgesia, the mean interval to first rescue dose was 516.52±131.38 minutes with ESP block and 245.36±61.13 minutes with TAP block ($p<0.001$). Median rescue time was 540 minutes versus 240 minutes, respectively (Table 3, Figure 3).

Cumulative opioid requirement during the first 24 hours was lower after ESP block. Mean consumption was 6.53±2.83 MME in the ESP group compared with 13.40±4.52 MME in the TAP group ($p<0.001$). Median consumption showed the same separation: 6 MME after ESP block and 13 MME after TAP block (Table 3, Figure 4).

Patient satisfaction also favoured ESP block, with mean scores of 4.37±0.72 in the ESP group and 3.13±0.73 in the TAP group ($p<0.001$). Sedation scores were slightly but significantly lower after ESP block (1.97±0.56 vs 2.27±0.45, $p=0.032$). These findings are summarised in Table 3 and Figure 5.

Adverse events were uncommon. Nausea was documented in 4 patients (13.3%) after ESP block and 6 patients (20.0%) after TAP block (p=0.731). Vomiting occurred in 2 patients (6.7%) and 3 patients (10.0%), respectively (p=1.000). One hematoma was noted in the ESP group, while one vascular puncture was noted in the TAP group. Overall recorded complication frequency was identical between groups (Table 4, Figure 6).

Table 1: Baseline demographic and perioperative characteristics

Variable	ESP group (n=30)	TAP group (n=30)	p-value
Age, years	44.60±9.07	44.77±9.24	0.944
BMI, kg/m²	26.97±4.16	27.60±4.57	0.577
Male/Female	15/15	15/15	1.000
ASA I	10 (33.3%)	9 (30.0%)	
ASA II	16 (53.3%)	16 (53.3%)	0.921
ASA III	4 (13.3%)	5 (16.7%)	
Cholecystectomy	10 (33.3%)	11 (36.7%)	
Appendectomy	8 (26.7%)	7 (23.3%)	
Hernia repair	6 (20.0%)	6 (20.0%)	0.990
Sleeve gastrectomy	6 (20.0%)	6 (20.0%)	
Duration of surgery, min	73.83±17.10	76.83±17.69	0.507
Intraoperative fentanyl, mcg	158.00±53.07	169.00±54.48	0.431

Table 2: Postoperative VAS scores at rest and on movement

Time point	VAS rest ESP	VAS rest TAP	p-value	VAS movement ESP	VAS movement TAP	p-value
0 h	1.90±0.76	2.87±0.73	<0.001	2.90±0.76	3.87±0.73	<0.001
2 h	2.13±0.78	3.03±0.96	<0.001	3.13±0.78	4.03±0.96	<0.001
4 h	2.97±0.85	4.00±0.95	<0.001	3.97±0.85	5.00±0.95	<0.001
6 h	3.53±0.97	4.80±0.92	<0.001	4.97±0.85	6.00±0.95	<0.001
12 h	4.07±0.91	5.27±1.11	<0.001	5.53±1.31	6.67±1.27	0.002
24 h	3.07±0.91	4.10±0.99	<0.001	4.07±0.91	5.03±0.96	<0.001
VAS: visual analogue scale. Values are expressed as mean ± standard deviation; p-values are based on Mann-Whitney U test						

Table 3: Rescue analgesia, opioid consumption, sedation, and satisfaction

Outcome	ESP group	TAP group	p-value
Rescue analgesia required	23 (76.7%)	28 (93.3%)	0.145
Time to first rescue analgesia, min	516.52±131.38	245.36±61.13	<0.001
Median time to rescue, min (IQR)	540 (420–600)	240 (202–300)	<0.001
Total 24-hour opioid consumption, MME	6.53±2.83	13.40±4.52	<0.001
Median opioid consumption, MME (IQR)	6 (4–8)	13 (9–16)	<0.001
Sedation score	1.97±0.56	2.27±0.45	0.032
Satisfaction score	4.37±0.72	3.13±0.73	<0.001

Table 4: Adverse effects and recorded complications

Event	ESP group (n=30)	TAP group (n=30)	p-value
Nausea	4 (13.3%)	6 (20.0%)	0.731
Vomiting	2 (6.7%)	3 (10.0%)	1.000
Any recorded complication	1 (3.3%)	1 (3.3%)	1.000
Hematoma	1 (3.3%)	0 (0.0%)	
Vascular puncture	0 (0.0%)	1 (3.3%)	

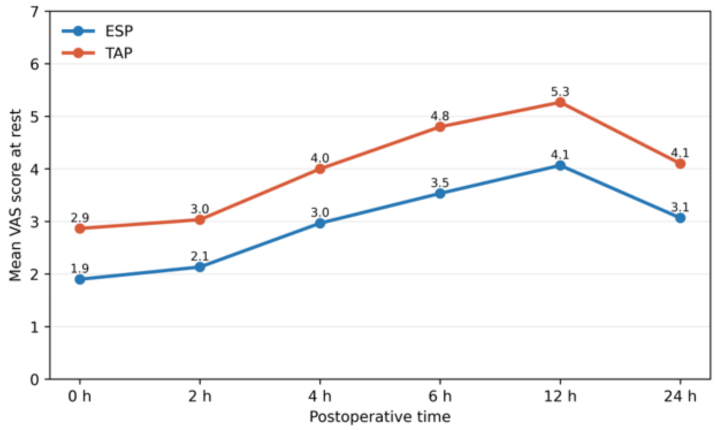

Figure 1. Trend of VAS score at rest over 24 hours in ESP and TAP groups

Values shown near points represent mean VAS scores at each postoperative time point

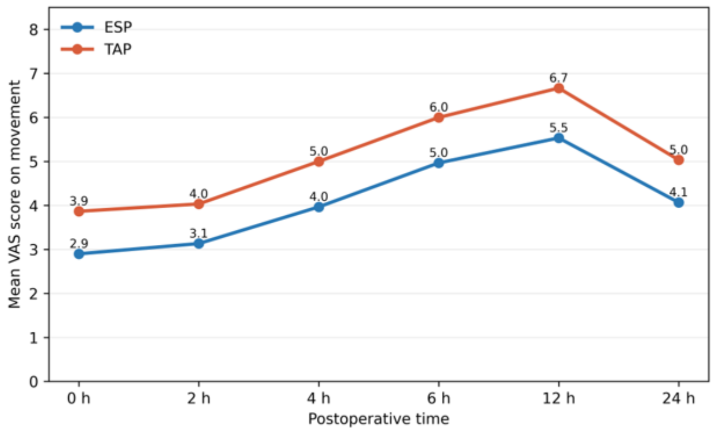

Figure 2. Trend of VAS score on movement over 24 hours in ESP and TAP groups

Values shown near points represent mean movement-related VAS scores at each postoperative time point

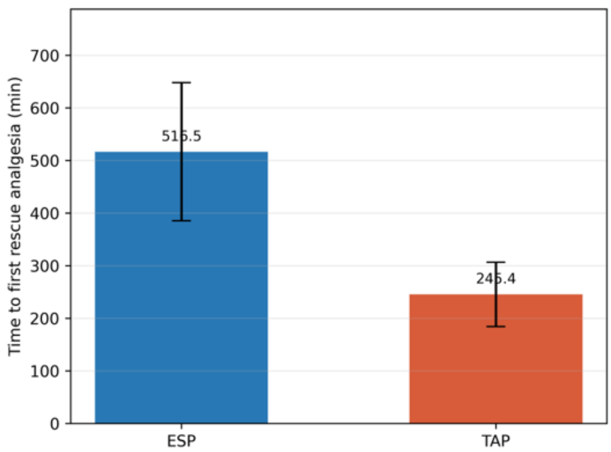

Figure 3. Time to first rescue analgesia among patients requiring rescue analgesia

Bars represent mean values with standard deviation error bars

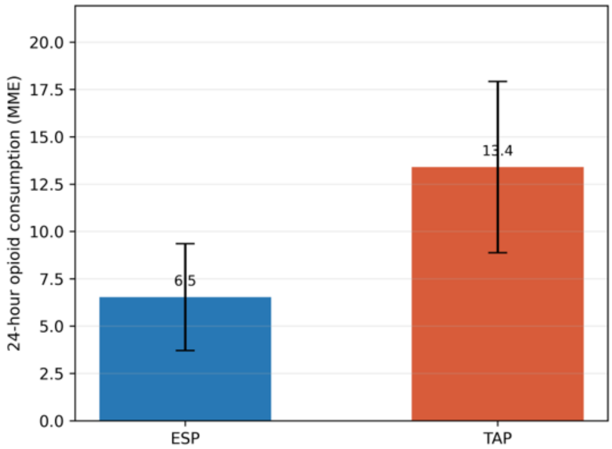

Figure 4. Total opioid consumption during the first 24 postoperative hours

Bars represent mean MME values with standard deviation error bars

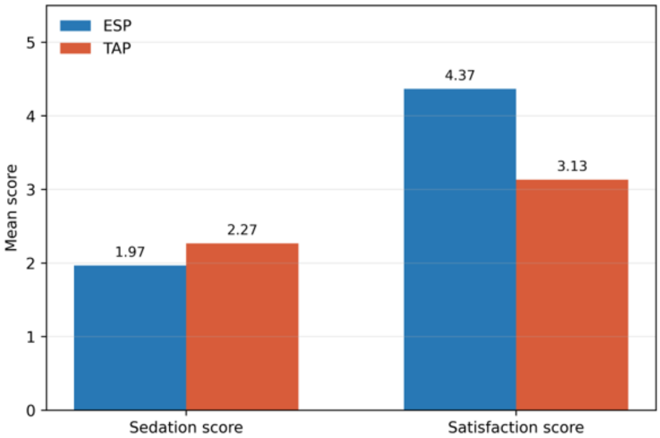

Figure 5. Sedation and patient satisfaction scores between ESP and TAP groups

Grouped bars show mean scores for each group

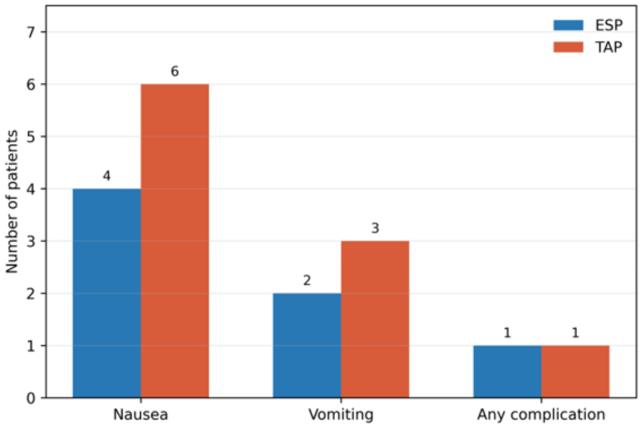

Figure 6. Adverse effects and recorded complications in both groups

Bars show the number of patients with each event

Discussion

The analysis showed a consistent postoperative analgesic advantage with ESP block over TAP block in this adult abdominal surgery cohort. The separation was not confined to one endpoint; pain scores, rescue timing, opioid consumption, sedation, and satisfaction all moved in the same direction. Because measured baseline and intraoperative characteristics were comparable, the observed postoperative differences are less likely to be explained by age, BMI, ASA grade, procedure mix, operative time, or fentanyl exposure alone.

The reduction in both resting and dynamic pain is clinically meaningful. Resting VAS gives an estimate of background comfort, but movement-related pain is what often decides whether a patient can cough, take deep breaths, sit up, turn in bed, or walk early. This matters in Indian postoperative wards, where the same team may be managing high patient turnover and analgesic reassessment may not always be as frequent as ideal. The ESP group maintained lower scores throughout the day, suggesting that the benefit extended beyond the immediate post-anaesthesia period.

Time to first rescue analgesia gives another view of block utility. Although the percentage of patients receiving at least one rescue dose was not significantly different, patients in the ESP group waited much longer before the first dose became necessary. That finding is clinically more persuasive than a single pain score, because it reflects the duration over which the block remained useful enough to postpone systemic opioid therapy.

This pattern is broadly aligned with procedure-specific literature. In laparoscopic cholecystectomy, Altıparmak et al. reported lower tramadol use and lower pain scores after ESP block than after oblique subcostal TAP block.[11] Engineer et al. also found that ESP block delayed first rescue analgesia and reduced overall analgesic use when compared with oblique subcostal TAP block.[12] In an Indian randomized study, Sahu et al. described comparable directionality, with ESP block showing favourable postoperative analgesic effects against oblique subcostal TAP block.[13]

The opioid-sparing difference deserves separate attention. A reduction from 13.40±4.52 MME to 6.53±2.83 MME over 24 hours is not just a statistical result; it may influence sedation, nausea, feeding tolerance, alertness, and willingness to mobilise. In the present cohort, nausea and vomiting were numerically less frequent after ESP block, though the event numbers were too small to establish a significant difference. The lower sedation score and better satisfaction score, however, are coherent with reduced systemic opioid exposure.

A plausible anatomical explanation exists, but it should be stated carefully. TAP block primarily covers the nerves of the anterolateral abdominal wall, making it well suited to incisional somatic pain. It does not reliably cover visceral pain. ESP block may provide broader cranio-caudal truncal spread and may reach neural structures closer to the paravertebral region, although cadaveric and imaging studies have shown variability in that spread. In a mixed abdominal surgery population, where pain is rarely purely somatic, this broader coverage may account for the better overall analgesic profile observed here.

Recent syntheses of comparative evidence support a cautious interpretation in favour of ESP block. Liheng et al. reported better postoperative analgesic outcomes with ESP block than TAP block across abdominal surgeries.[14] Zewdu et al., focusing on laparoscopic cholecystectomy, also found reductions in pain severity and morphine-equivalent use with ESP block, along with a longer interval before first analgesic request, although certainty differed across individual outcomes.[15] The present observations sit within that same clinical direction rather than standing as an isolated result.

Several limitations remain. The sample size was 30 patients per group, and the study included four surgical categories: cholecystectomy, appendectomy, hernia repair, and sleeve gastrectomy. This gives the findings pragmatic value, but it also introduces heterogeneity in incision site and visceral pain contribution. The observational design limits causal inference. Follow-up ended at 24 hours, so later outcomes such as time to full mobilisation, oral intake, discharge readiness, and persistent postsurgical pain were not evaluated. Even so, the internal consistency of the findings strengthens the clinical signal.

Both blocks continue to have a place in perioperative practice. TAP block is familiar, technically accessible, and useful for many abdominal wall procedures. ESP block may be preferable when wider truncal analgesia is desired or when the visceral component is expected to be relevant. The choice should be guided by surgical site, expected pain pathway, ultrasound skill, safe bupivacaine dosing, and institutional workflow, not simply by routine habit.

Conclusion

In adult patients undergoing abdominal surgery, ESP block was associated with better early postoperative analgesia than TAP block. It produced lower VAS scores at rest and during movement, prolonged the time to first rescue analgesia, reduced 24-hour opioid consumption, lowered sedation scores, and improved satisfaction. Adverse effects and recorded complications were infrequent in both groups. Larger procedure-specific studies with standardised block protocols would help clarify where ESP block offers the greatest advantage.

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