Original Article

A Comparative Study Between the Efficacy of Ultrasound-Guided Erector Spinae Plane Block and Transverse Abdominis Plane Block for Postoperative Analgesia for Laparotomy in Cases of Hollow Viscus Perforation

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Abstract

Background: Abdominal operations are linked to considerable postoperative discomfort. The spectrum of musculo-fascial plane blocks for effective perioperative and postoperative pain relief has expanded with the introduction of ultrasound-guided techniques. This study aimed to compare the analgesic efficacy of ultrasound-guided fascial plane blocks such as the Erector Spinae Plane Block (ESPB) and transversus abdominis plane (TAP) block for postoperative analgesia for laparotomy in cases of hollow viscous perforation. **Materials and Methods:** Seventy patients receiving laparotomy for hollow viscous perforation were split into two groups in this randomised prospective study: Group E (n = 35) underwent bilateral ESPB with 20 mL of 0.125% levobupivacaine, whereas Group T (n = 35) received bilateral TAP with the same dosage. Postoperative pain was assessed with the Numerical Rating Scale (NRS), and rescue analgesia in the form of Tramadol 100mg IV was given if the Numerical Rating Scale (NRS) ≥4. The first-time analgesia was requested, the total amount of rescue analgesia used in 24 hours, and any side effects were recorded. **Results:** There were notable variations between the two groups' analgesic needs and pain scores. At 1–8 hours, there were notable variations in the two groups' perceptions of pain. Group E had considerably lower mean NRS scores than Group T ($P < 0.05$). The time to the first analgesic request was significantly longer in Group E (8.4hrs vs 6.5 hrs, p= <0.001). The total rescue analgesic (Inj. Tramadol) requirement was significantly lower in Group E (144.00mg vs 218.50 mg, p=0.008). The incidence of side effects did not change statistically significantly between the two groups, suggesting a similar safety profile. **Conclusion:** In emergency procedures like laparotomy for hollow viscous perforation, erector spinae plane block (ESPB) offers better pain relief than transversus abdominis plane (TAP) block, especially in the early postoperative phase. This supports its incorporation into ERAS protocols for the best perioperative pain management.

Keywords: Postoperative Analgesia, Ultrasound-guided block, Regional anaesthesia, Erector Spinae Plane Block, transversus abdominis plane block, Midline laparotomy.

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Introduction

Postoperative pain remains a significant concern for patients undergoing abdominal surgery, particularly midline laparotomy. Uncontrolled pain is not only distressing but also has multiple adverse physiological and psychological consequences, including impaired pulmonary function, increased thromboembolic risk, delayed gastrointestinal recovery, and prolonged hospital stay, all of which will increase healthcare expenditures and decrease patient satisfaction.[1-3] Effective pain management is therefore a cornerstone of perioperative care and forms an essential component of enhanced recovery after surgery (ERAS) protocols.

Traditionally, systemic opioids have been widely used for postoperative analgesia. However, there are well-established side effects linked to opioid-based regimens, including respiratory depression, drowsiness, nausea, vomiting, ileus, itching, and dependency.[4] These complications can prolong hospital stay, increase healthcare costs, and reduce patient satisfaction. To maximise pain relief while reducing side effects, multimodal analgesia techniques have been created that combine

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non-opioid drugs, opioids, and regional anaesthesia.[5]

Among regional anaesthesia techniques, ultrasound-guided blocks have gained popularity due to their safety, accuracy, and efficacy.[6] Fewer difficulties arise from the direct observation of the needle, nerves, and surrounding anatomical features facilitated by ultrasound-guided procedures. A variety of interfascial plane blocks have been established for the management of post-operative pain and to lessen the overall necessity for opioids, such as the Erector spinae plane block (ESPB), transversus abdominis plane block (TAP), Quadratus lumborum block (QLB), and paravertebral block.[7,8]

The TAP block, an interfascial plane blocking technique pioneered by Rafi in 2001, entails the injection of local anaesthetics between the planes of the transverse abdominis and internal oblique muscles. TAPB reduces pain after abdominal surgery by interfering with the sensory nerves of the anterolateral abdominal wall (T6-L1).[9] A considerable volume of investigations has affirmed that TAPB can ensure safe and effective postoperative analgesia for individuals enduring an assortment of abdominal procedures, including laparoscopic cholecystectomies.[10] hysterectomies.[11], and gastrointestinal interventions.[12]

The Erector spinae plane block (ESPB) is a technique for an interfascial plane block that was initially delineated by Forero and his colleagues in 2016. It consists of administering a local anaesthetic into the region between the deep fascia of the erector spinae muscle and the transverse process. From cadaveric and contrast analyses, it is inferred to function near the commencement of spinal nerves.[13,14] Despite its initial application for chronic pain, ESPB has since been extensively utilised for postoperative analgesia across numerous surgical procedures.

The current research was formulated with the main aim of assessing analgesic effectiveness using the NRS pain score in the ESPB and TAP cohorts for emergency laparotomy in instances of hollow viscous perforation. The secondary aim was to evaluate the overall usage of analgesics postoperatively.

By evaluating the relative efficacy of these two regional techniques, this research aims to reduce opioid requirements, improve recovery, and contribute to evidence supporting their role within ERAS protocols.

Materials and Methods

This was a single-blinded randomised clinical trial conducted in the Department of Anaesthesia at VIMSAR, Burla, Sambalpur, Odisha, after approval from the institutional ethics board (VIREC NO. 071-2022/I-S-O/53/Dt.17.05.2022) over a period of one year. We also performed this study in accordance with Consolidated Standards of Reporting Trials (CONSORT) guidelines. A total of 70 patients, either sex, aged between 18 and 60 years, ASA physical status I E to II E, who were undergoing emergency laparotomy for hollow viscous perforation surgery under general anaesthesia, were included in the study. Patients on vasopressors, experiencing serious complications associated with other systems (such as severe cardiac insufficiency, renal failure, and hepatic encephalopathy); allergy to local anaesthetics, coagulopathy, local infection at the injection site, any anatomical spinal deformity or refusal to participate were excluded from the study.

All eligible patients were screened during their preoperative assessment, and those meeting the inclusion criteria were invited to participate after providing written informed consent. They were also informed about NRS during the pre-operative period.

A computer-generated randomisation table was used to randomly assign patients to two groups. Allocation was disguised using the consecutively numbered opaque-sealed envelope technique; it was opened in the preoperative holding room following recruitment. Group E received ultrasound-guided bilateral Erector Spinae Plane Block (ESPB), and Group T received ultrasound-guided bilateral TAP block. Both groups received 20 mL of 0.125% levobupivacaine bilaterally for each block after surgery [Figure 1]. Because of the nature of the procedures, the anesthesiologist performing the block could not be blinded. However, patients, surgeons, and data collectors responsible for assessing postoperative outcomes were blinded to group allocation. The statistician analysing the data was also blinded.

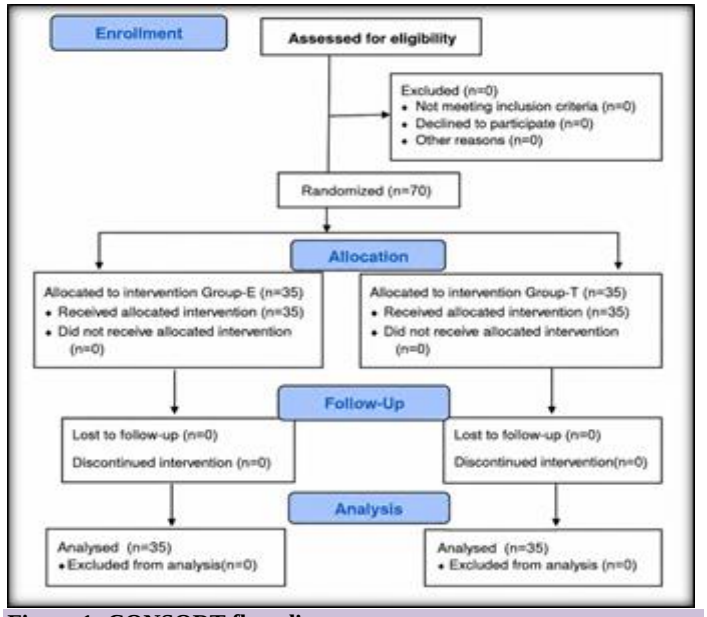

Figure 1: CONSORT flow diagram.

In the preoperative area, patients were informed about the procedure, including Rapid Sequence Intubation (RSI) and the block application. After establishing intravenous access, baseline monitoring of ECG, non-invasive blood pressure (NIBP), SpO2, and temperature was performed and recorded. All patients received standardised general anaesthesia. Patients were premedicated with inj midazolam (0.05mg/kg), inj ondansetron(0.1mg/kg), inj Nalbuphine (0.2mg/kg), inj. Glycopyrrolate (0.005mg/kg), and general anaesthesia was induced using propofol 2 mg/kg and succinylcholine 1.5 mg/kg. RSI was performed with cricoid pressure applied, and the trachea was intubated with appropriate size cuffed endotracheal tube. Anaesthesia was maintained with a mixture of oxygen and N2O 2:1, sevoflurane (1–2%). Muscle relaxation was sustained with atracurium (loading dose 0.5 mg/kg followed by maintenance

doses of 0.2 mg/kg). Towards the end of the surgery, all patients received injection of paracetamol 1 gm intravenously.

Following surgery, and before extubation, blocks were administered by trained anaesthesiologists with over one year of experience in ultrasound-guided techniques. In Group E, ESPB was performed at the T7/T8 level using a 6–13 MHz linear ultrasound probe in lateral position. The thoracic level was identified using the inferior angle of the scapula (T7) as a landmark. USG probe was placed in the longitudinal parasagittal orientation at the T7/T8 vertebral level 3-5cm lateral to the midline over the ribs, and then slid towards the midline. After localisation of the transverse process, sonographic needle (21-gauge, 10-centimetre) was advanced in-plane to the ultrasound probe until it reached the transverse process. Hydro-dissection of ESP fascia from the transverse process confirmed the correct position of the needle. After negative aspiration, 20 mL of 0.125% levobupivacaine was injected. The same procedure was repeated on the other side.

In Group T, TAP block was performed by placing the 6–13 MHz linear ultrasound probe on the abdominal wall, in an oblique plane below the below the costal edge to identify three layers of muscles (abdominal external oblique muscles, abdominal internal oblique muscles, and abdominal transverse muscles) lateral to the linea semilunaris in supine position. After localisation of the three muscle layers, a sonographic needle (21-gauge, 10-centimetre) was advanced medial-to-lateral in-plane to the ultrasound probe until it was placed in the space between the internal oblique muscle and the transverse muscle. After negative aspiration, 20 mL of 0.125% levobupivacaine was injected into the fascial plane between the internal oblique and transversus abdominis muscles using hydrodissection guided by real-time ultrasound. The block was similarly repeated on the other side with the same volume. After completion of the blocks, the tracheal extubation was done after reversing the neuromuscular blockade and transferred to the postoperative recovery room (PACU) for observation. Vital parameters, including heart rate, blood pressure, and SpO2, were recorded every 30 minutes for the first hour and then every two hours. Pain severity was assessed using the Numeric Rating Scale (NRS) at 30 minutes, 1, 2, 4, 8, 12, 16, 20, and 24 hours postoperatively. Each patient also received paracetamol 15 mg/kg intravenously every eight hours. Rescue analgesia in the form of Tramadol 100 mg IV was provided if the NRS score was ≥4, and the time to the first analgesic requirement and total requirement within the first 24 hours were recorded.

The primary outcome of the study was assessment of pain using the Numeric Rating Scale (NRS) score. Secondary outcomes included: time to request of the first rescue analgesia, total number of administrations of rescue analgesia in the initial 24 hours, block-related complications such as local anaesthetic systemic toxicity, hematoma, or infection, and incidence of postoperative adverse effects or complications, such as pruritus, hypotension, and nausea/vomiting.

Sample Size and Statistical analysis: From a previous study by Lingaraj Sahu et al. [15], the minimum sample size was calculated to be 31 (in each group) with 95% CI and Power of study 80%. To simplify data handling and ensure balanced group sizes, the total no. of study subjects in the ESP and TAP blocks was taken to be 35 in each group.

Data analysis was performed using SPSS version 28.0 (SPSS, Chicago, Illinois). Continuous variables were presented as mean ± standard deviation or median (min–max), and categorical variables as number and percentage. Continuous variables with normal distribution were analyzed using the unpaired t-test, while the Mann-Whitney U test was applied for non-normally distributed variables. Categorical variables were assessed using Fisher's Exact Test or the Chi-Square Test, as appropriate. A p-value of <0.05 was considered statistically significant.

Results

The study included 70 patients who satisfied the eligibility requirements. The two groups' baseline features and demographic information, such as age, height, weight, BMI, ASA grade distribution, and length of operation, were similar. The ESPB and TAP groups' block performance times did not differ statistically. All blocks were performed smoothly with no block-related complications (bleeding, emphysema, pneumothorax, LA toxicity, etc.) observed in the study. This confirms comparability at baseline and indicates that differences in outcomes were not attributable to demographic or operative factors. [Table 1]

Table 1: The demographic data and Baseline Characteristics of Patients between two groups

Parameters	Group E (n=35)	Group T (n=35)	p value
Age (years) (Mean±SD)	35.1 ± 7.4	36.4 ± 6.05	0.43
Gender (Male/Female)	24 / 11	23 / 12	0.72
Weight (Kg) (Mean±SD)	55.74 ± 5.63	56.31 ± 6.11	0.685
Height (cm) (Mean±SD)	165.09 ± 5.76	163.37 ± 5.61	0.211
BMI (Kg/m2) (Mean±SD)	21.6 ± 1.3	21.3 ± 1.3	0.37
ASA Grade I E:II E	13:22	10:25	0.445
Duration Of surgery(mins) (Mean±SD)	97.3 ± 14.3	97.4 ± 13.7	0.98
Block performing time (min)	12.65±1.08	10.54±1.36	0.491
Duration Of anaesthesia(mins) (Mean±SD)	118.6 ± 17.2	113.4 ± 12.3	0.56

NRS scores at 30 minutes, 1, 2, 4, 8, 12, 16, 20, and 24 hours for each group are shown in [Table 2]. Significant differences were observed in pain perception between the two groups in the 1 hr to 8hr time frame ($P < 0.05$). However, there were no significant differences in pain scores for 30mins-1hr and 16hr–24hr time frames postoperatively ($P > 0.05$). When average NRS scores for 24 h were compared between groups, no statistically significant difference was found ($P > 0.05$).

The time to the first analgesic request was significantly longer in Group E (8.4±1.1hrs) compared to Group T (6.5±1.1hrs),

with a p-value of <0.001. The mean total consumption of rescue analgesic (Inj. Tramadol) was significantly lower in Group E (144.00±75.40 mg) compared to Group T (218.50±95.50 mg) with a p-value of 0.008. [Table 3]

Table 2: Comparison of post-operative NRS score at various time intervals between two groups

NRS Score	Group E (n=35)	Group T (n=35)	p value
30 mins	0.00±0.00	0.04±0.28	0.32
1hr	0.08±0.27	0.18±0.66	0.30
2hr	1.3±0.52	1.7±0.61	0.0385
4hr	1.54±1.18	3.14±0.63	<0.001
8hr	3.45±0.05	2.72±1.7	<0.001
12hr	2.4±0.5	2.68±0.74	0.465
16hr	2.25±0.99	2.55±0.28	0.328
20hr	2.1±0.63	2.4±1.2	0.164
24hr	2.0±0.56	2.30±0.47	0.102

Table 3: Postoperative analgesic requirement

Parameters	Group E (n=35)	Group T (n=35)	p value
Time to 1st rescue analgesia (hours) (Mean±SD)	8.4±1.1	6.5±1.1	<0.001
No of rescue analgesia in first 24 hours (Mean±SD)	1.3 ± 0.5	1.6 ± 0.5	0.0214
Total Tramadol requirement in first 24 hours (mg) (Mean±SD)	144.00±75.40	218.50±95.50	0.008

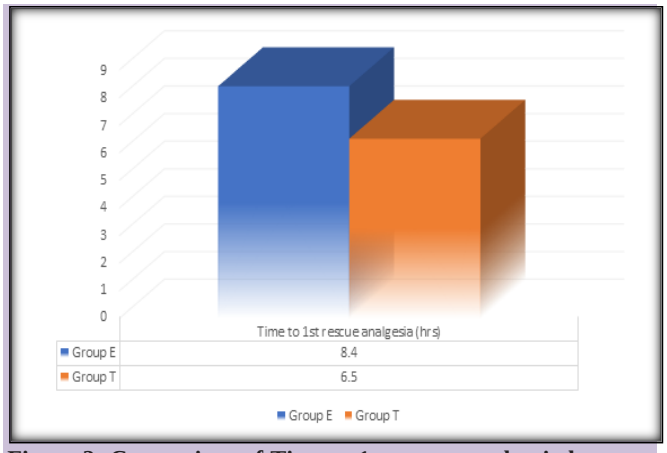

Figure 2: Comparison of Time to 1st rescue analgesia between two groups

There was no incidence of block-related complications like haematoma, pneumothorax and LA-related complications. A total of nine patients developed nausea (six from ESP and three from TAP) and were treated with ondansetron. However, this was not statistically significant (p=0.432). Hemodynamic parameters, including heart rate and mean arterial pressure, remained stable across both groups throughout the perioperative period, with no significant differences noted.

Discussion

Effective management of postoperative pain remains a cornerstone of enhanced recovery after surgery (ERAS), particularly for patients undergoing midline laparotomy. This prospective randomised study aimed to evaluate the analgesic efficacy of Erector Spinae Plane Block (ESPB) compared to transversus abdominis plane block (TAP) in adult patients undergoing emergency laparotomy for hollow viscous perforation, a topic with limited prior research. The patients were randomized into two groups: Group E, which received ultrasound-guided bilateral Erector Spinae Plane Block (ESPB), and Group T, which received ultrasound-guided bilateral transversus abdominis plane block (TAP). The findings demonstrated that ESPB offered superior postoperative analgesia compared to TAP Block, particularly in the immediate postoperative period. Importantly, no major complications were observed, underscoring the safety of both blocks when performed under ultrasound guidance.

In this study, during the early postoperative phase (8 hours), patients receiving ESP block reported significantly reduced NRS scores compared to TAP block, highlighting its benefit in immediate pain control. Interestingly, at 8 hours, a peak in pain intensity was observed in the ESP group, which may reflect a waning block effect or delayed requirement for rescue analgesia. Beyond this point, ESP again provided better pain relief, with significantly lower scores. Although TAP demonstrated a steadier trend, its overall pain control remained inferior to ESP. These findings suggest postoperative pain scores were consistently lower in the ESP group compared to the TAP group across most time intervals, indicating superior analgesic efficacy of ESP block.

Our findings further validated the hypothesis that ESP Block provides better analgesic coverage compared to TAP Block. This was evident from the significantly reduced consumption of rescue analgesics (Inj Tramadol) in the ESPB group. The mean total Tramadol consumption in Group E was 144.00±75.40 mg compared to 218.50±95.50 mg in Group T during the first 24 hours post-surgery (p = 0.008). These results emphasise the superior pain relief offered by ESP Block in the immediate postoperative period. Importantly, the time to first rescue analgesia was significantly longer in the ESP group (8.4 ± 1.1 hrs) compared to the TAP group (6.5 ± 1.1 hrs), highlighting the prolonged duration of analgesia provided by ESP block. Additionally, the number of rescue analgesia doses was lower in the ESP group, further supporting its superior analgesic profile.

Our findings are consistent with those of previous trials where ESP blocks demonstrated better analgesia in various abdominal surgeries.[16,17,18] The ability of the ESP block to affect both visceral and somatic pain may explain its enhanced performance, making it an appealing alternative in multimodal analgesic strategies for cesarean deliveries. Other studies also found good analgesic efficacy with the ESP block compared to placebo or

OSTAP, and the time for first analgesic request was longer in the ESP group.

Our findings align with earlier evidence that supports the role of regional anaesthesia in reducing postoperative pain and opioid consumption. Niraj et al. showed that TAP block significantly reduced opioid consumption compared to conventional systemic analgesia in abdominal surgery patients.[19] Similarly, Charlton et al. confirmed the analgesic benefit of TAP block in a systematic review, though they noted that the magnitude of benefit varied with surgical site and block technique.[14] While TAP block provides effective analgesia for lateral abdominal incisions, its limitations in covering midline incisions have been well documented.[20] In contrast, the anatomical rationale of the ESP block, which directly targets the terminal branches of the intercostal nerves supplying the central abdominal wall, provides a mechanistic explanation for its superior efficacy in midline laparotomy.[17]

Safety is another critical consideration. In this study, no block-related adverse events—including local anesthetic systemic toxicity, hematoma, or infection—were observed. This finding reinforces the safety of ultrasound-guided fascial plane blocks when performed by trained anesthesiologists, consistent with recent literature.[7,8] Nevertheless, as with all regional techniques, operator experience and strict adherence to aseptic and dosing protocols remain essential.

Our study faced several limitations, primarily due to being conducted in a single centre; our sample size was small. Conducting future studies with a larger sample would enhance the statistical power and reliability of our findings. Additionally, we did not evaluate long term pain outcomes or duration of hospital stay, which are important factors in assessing the overall impact of ESPB and TAP blocks. The block was given under general anaesthesia, so the success of the block was not checked by dermatomal spread. Moreover, the absence of a control group for comparison to standard care limits our ability to fully contextualise the relative benefits of ESPB and TAP block. Addressing these aspects in future research could provide a more comprehensive understanding of their clinical benefits.

Conclusion

Erector Spinae Plane Block (ESPB) provides a better analgesic profile compared to transversus abdominis plane block (TAP) in adult patients undergoing emergency laparatomy surgeries for hollow viscous perforation, particularly in the initial postoperative hours. Decreased rescue analgesic consumption in the ESP block group further highlights its effectiveness. These findings suggest that while both blocks represent reliable regional anaesthesia options in emergency laparotomy surgeries for hollow viscous perforation, the erector spinae plane block may be preferentially considered when enhanced early postoperative analgesia is desired, without compromising overall safety.

Declaration of Patient Consent

The authors hereby certify that they have obtained appropriate patient consent forms. In the form, the patient has given his/her consent for clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity.

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Conflicts of interest

There are no conflicts of interest.

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