

Efficacy of External Oblique Intercostal Plane Block versus Transversus Abdominis Plane Block for Postoperative Analgesia in Laparoscopic Upper Abdominal Surgeries: A Randomised Clinical Study

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ABSTRACT

Introduction: Fascial plane blocks play a major role in aiding Enhanced Recovery After Surgery (ERAS) following upper abdominal wall surgeries. The External Oblique Intercostal (EOIC) plane block is a novel technique that targets the anterior and lateral cutaneous branches of the thoracoabdominal nerves.

Aim: To compare the efficacy of the EOIC plane block with the Transversus Abdominis Plane (TAP) block.

Materials and Methods: This double-blinded randomised clinical study was conducted at Narayana Medical College, Nellore, Andhra Pradesh, India, between June 3, 2023, and February 25, 2024, on 100 patients after obtaining ethical committee approval. These patients underwent upper abdominal surgeries, with 50 patients receiving bilateral EOIC block (Group E) and 50 patients receiving bilateral TAP block (Group T) using 0.25% Levobupivacaine and 8 mg Dexamethasone in a total volume of 30 mL on each side. The demographic details studied included age, sex, American Society of Anaesthesiologists (ASA) physical status, weight and key parameters such as dermatomal distribution, extent of analgesia, Numerical Rating Scale (NRS), time for first rescue analgesia, number of rescue analgesic doses and the Bruggemann comfort scale. Data were analysed using the Chi-square test for categorical data and the unpaired Student's t-test for numerical data.

Results: The demographic data did not differ significantly between the groups. Both groups had comparable average ages (Group E: 66.8 years; Group T: 67.1 years) and similar gender distributions. The distribution of patients across ASA classifications I, II and III, as well as heights and body weights, was also statistically similar and lacked significant differences. Patients who received the EOIC block exhibited greater dermatomal blockade from T4 to T10 in the midclavicular, anterior axillary and midaxillary lines compared to those who received the TAP block. The NRS scores at 6, 12 and 24 hours after surgery in Group E were lower than in Group T. The time taken for the first rescue analgesia was 12 ± 4.2 hours in Group E compared to 4.4 ± 3.02 hours in Group T, which was statistically significant. The number of rescue analgesic doses was 1.06 ± 0.84 in Group E, compared to 3.52 ± 1.3 in Group T, which was also significant ($p < 0.05$). The Bruggemann comfort scale was superior in Group E compared to Group T, with statistical significance.

Conclusion: The EOIC block is a superior and effective alternative to the TAP block for postoperative analgesia in laparoscopic upper abdominal wall surgeries. The extent of analgesia and dermatomal distribution of the EOIC block was greater than that of the TAP block, making the EOIC block more efficacious.

Keywords: Bruggemann comfort scale, Intercostal nerves, Laparoscopy

INTRODUCTION

Laparoscopic surgeries are often considered minimally invasive but stressful owing to mild to moderate pain [1]. Pain relief is an integral component of Enhanced Recovery After Surgery (ERAS) [2], as it hastens recovery and discharge. There has been a recent shift from central neuraxial analgesia to ultrasound-guided abdominal wall plane blocks for upper abdominal wall surgeries [3], among which the TAP block is the most widely performed truncal block for postoperative analgesia in both open and laparoscopic upper abdominal surgeries [4,5]. However, the limitations of the TAP block include its inability to block lateral cutaneous nerves and sparing of dermatomes in the midaxillary and posterior axillary lines [6].

Other techniques such as the Quadratus Lumborum block [7,8], Erector Spinae block [9,10] and Serratus Anterior Plane block [11,12] are widely used due to their effectiveness in providing visceral analgesia, but changing the patient's position for these blocks can

be cumbersome. The External Oblique Intercostal (EOIC) plane block is a newer advancement that promises to block both the anterior and lateral cutaneous branches of the thoracoabdominal nerves by injecting local anaesthetic in the plane between the External oblique and External intercostal muscles at the level of the 6th rib, according to a cadaveric study by Elsharkawy H et al., [13].

Very few studies have been conducted on the EOIC block. Elsharkawy H et al., performed a cadaveric study assessing the potential analgesic effects of the EOIC block and found consistent dermatomal sensory blockade from T6 to T10 at the anterior axillary line and from T6 to T9 at the midline in patients receiving the EOIC block [13]. Korkusuz M et al., compared two groups of patients, one with the EOIC block and the other group without any block and concluded that the EOIC plane block resulted in less postoperative tramadol consumption and lower Numeric Rating Scale (NRS) scores postoperatively, leading to an overall better quality of recovery compared to the control group [14].

Till date, none of the studies have compared the EOIC block with other blocks. Given this gap in the literature, the authors aimed to compare the newer EOIC block with the most widely used TAP block.

MATERIALS AND METHODS

This was a double-blinded randomised clinical study conducted at Narayana Medical College, Nellore, Andhra Pradesh, India, between June 3, 2023 and February 25, 2024, with the approval of the Institution's Ethics Committee (No. IEC/NMC/22.10.22-2). The study was registered with the Clinical Trials Registry of India (CTRI) under the number CTRI/2024/01/062113. A total of 104 patients undergoing laparoscopic cholecystectomy were enrolled in the study, of which four refused to participate. All patients were informed about the study protocol, the assessment of pain using the Numeric Rating Scale (NRS) and written informed consent was obtained during the Preanaesthetic Check (PAC) clearance. Randomisation (n=100) was performed using computer-generated random numbers and concealment was achieved using a sealed envelope method. It was a double-blinded study, wherein all participants and the analysts of the parameters were blinded.

The primary outcomes measured included dermatomal distribution, extent of analgesia (assessed with the help of pinprick) and NRS scores. Secondary outcomes included the time for first rescue analgesia, the number of rescue analgesic doses, the Bruggemann comfort scale and haemodynamic parameters such as heart rate, Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP). These parameters were assessed immediately after extubation

and continued until 24 hours postoperatively. The Declaration of Helsinki ethical guidelines were followed. Details of the Consolidated Standards of Reporting Trials (CONSORT) are shown in [Table/Fig-1].

Sample size calculation: Sample size was calculated using the formula:

$$n = \frac{2 \times (Z\alpha + Z\beta)^2 (\sigma^2)}{(X1 - X2)^2}$$

The mean total tramadol consumption in each group was 155 and 125, as reported in a previous study [15]. The sample size was calculated using the formula above, assuming a significance level of 0.05 (alpha=1.96) and a power of the study of 80% (beta=0.20).

Zα=1.96

Zβ=0.84

X1=155

X2=125

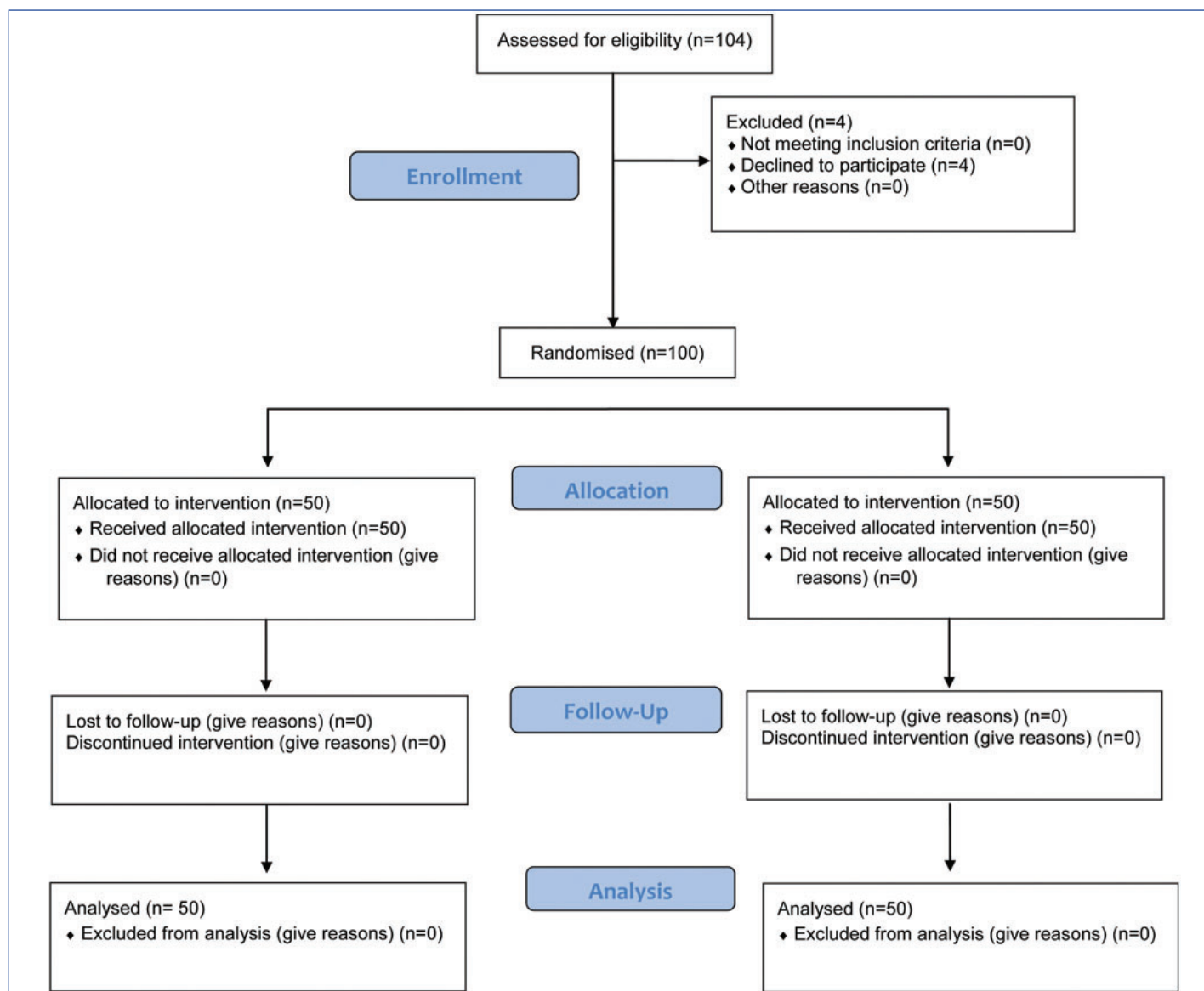
σ=50

Thus, n=2×{(1.96+0.842)²×50²}/{155-125}²

n=43.5.

The sample size was calculated to be 43.5 per group; for better consistency of results, the authors decided to include 50 participants in each group. They performed a pilot study with 10 cases, five in each group.

Inclusion criteria: Patients aged between 18 and 65, belonging to ASA categories I, II, or III, regardless of gender, who were listed for



[Table/Fig-1]: CONSORT 2010 flow diagram.

upper abdominal surgery met the inclusion criteria (n=104 included in the study).

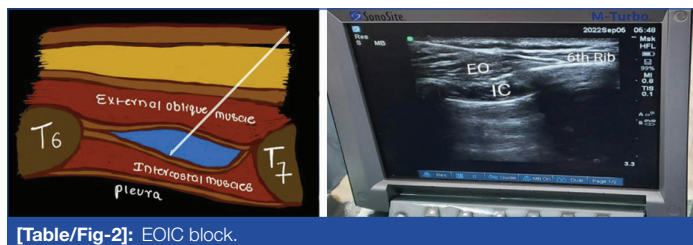
Exclusion criteria: Those who refused to participate (n=4), individuals allergic to local anaesthetic agents, those with local skin infections, patients with hepatic, renal, or cardiac ailments, individuals with bleeding diathesis and those using anticoagulants.

Study Procedure

One hundred patients scheduled for laparoscopic cholecystectomy were randomised into two groups: Group E and Group T. Inj. Dexmedetomidine 1 mcg/kg intravenous (i.v.) and 20 mg/kg MgSO₄ were administered separately in 100 mL saline over 10 minutes. An opioid-free general anaesthesia with a supraglottic airway was provided to all patients, using intravenous Inj. Propofol 2 mg/kg, Inj. Cisatracurium 0.2 mg/kg and maintenance with O₂, air, Inj. Cisatracurium 0.02 mg/kg and sevoflurane at 1-2 MAC. Inj. Paracetamol 1 g was given to all patients before the port incisions [16]. Balanced crystalloid was used for fluid administration and intra-abdominal pressures were maintained below 12 mmHg. At the end of the surgery, before extubation, an EOIC block was given in Group E and a TAP block in Group T using a Sonosite ultrasound machine with a linear probe under stringent aseptic precautions.

Group E: A total of 50 patients received a bilateral EOIC block with 0.25% Levobupivacaine and 8 mg Dexamethasone (30 mL on each side) [16].

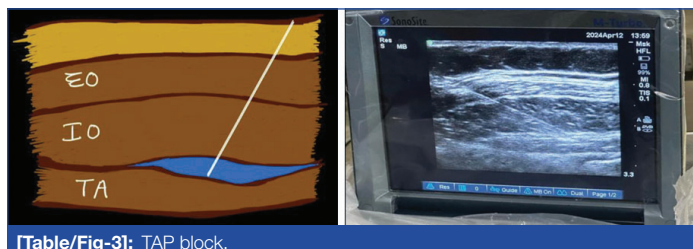
Technique: A high-frequency linear Ultrasonography (USG) probe (13-6 MHz) was placed in the sagittal plane between the midclavicular and anterior axillary lines at the level of the 6th rib. The plane between the External Oblique (EO) muscle and the External Intercostal (IC) muscle was identified. Under strict aseptic precautions, a 20 G intravenous cannula stylet was introduced using an in-plane approach in a craniocaudal direction and the needle was placed in the fascial plane between the external oblique and external Intercostal muscles, where the study drug (0.25% Levobupivacaine and 8 mg Dexamethasone, 30 mL) was deposited [Table/Fig-2].



[Table/Fig-2]: EOIC block.

Group T: A total of 50 patients received a bilateral TAP block with 0.25% Levobupivacaine and 8 mg Dexamethasone (30 mL on each side; 8 mg is given routinely).

Technique: A high-frequency linear USG probe (13-6 MHz) was placed in the midaxillary line between the bony prominences of the subcostal margin and the iliac crest. The three muscular layers of the abdominal wall—the EO, Internal Oblique (IO) and Transversus Abdominis (TA) muscle s—were identified. Under strict aseptic precautions, a 20 G intravenous cannula stylet was introduced using an in-plane approach in an anterior-posterior direction and the needle was placed in the plane between the IO and TA muscles, where the drug (0.25% Levobupivacaine and 8 mg Dexamethasone, 30 mL) was deposited [Table/Fig-3].



[Table/Fig-3]: TAP block.

After extubation, patients were kept in the Postanaesthesia Care Unit (PACU) and assessed for various parameters. The dermatomal distribution of loss of sensation to pinprick was evaluated from T4-T10 levels at the midclavicular, anterior axillary, midaxillary and posterior axillary lines after one hour of the block. The Numerical Rating Score (NRS) at rest was assessed at 0, 2, 4, 6, 8, 12 and 24 hours. Rescue analgesia with Inj. Tramadol (100 mg) was administered when the NRS exceeded three. The time for first rescue analgesia and the number of rescue analgesic doses in the first 24 hours were recorded and patient comfort was assessed using the Bruggemann Comfort Scale [17].

Complications, such as injury to the pleura in the EOIC block and intraperitoneal injection in the TAP block, along with local anaesthetic toxicity and haematoma formation, were carefully monitored and avoided.

STATISTICAL ANALYSIS

The recorded data were entered into Microsoft (MS) Excel and analysed using SPSS software version 20.0. Results were expressed as means, standard deviations and percentages. For categorical data (sex, ASA physical status), the Chi-square test was used, while the unpaired Student's t-test was employed to analyse numerical data (age, weight, dermatomal distribution, extent of analgesia, NRS). A p-value of <0.05 was considered significant.

RESULTS

The study found no significant differences between Group E and Group T in terms of age, gender, ASA classification and physical measurements. Both groups had comparable average ages (Group E: 66.8 years, Group T: 67.1 years) and similar gender distributions. The distribution of patients across ASA classifications I, II and III, as well as heights and body weights, were also statistically similar. These demographic similarities suggest that further comparisons or results will not be influenced by these baseline characteristics [Table/Fig-4].

Characteristics	Group E (n=50)	Group T (n=50)	p-value
Age (Years)	66.8±5.89	67.1±6.01	0.801
Gender (M/F)	17/33	22/28	0.307
ASA (I/II/III)	6/15/29	7/16/27	0.913
Height (cm)	158.26±4.36	159.68±3.78	0.084
Body Weight (Range) Kg	65.14±5.28 (60-71)	65.94±4.77 (61-72)	0.428

[Table/Fig-4]: Demographic details.

In the midclavicular line, loss of sensation to pinprick was observed in 48 (96%) patients in Group E at the T4, T5, T6, T7, T8 and T9 levels. Additionally, 42 (84%) patients reported loss of sensation at T10. In contrast, in Group T, loss of sensation to pinprick was observed in none of the patients at T4 and T5, and for 8 (16%) patients at T6, 10 (20%) patients at T7, 20 (40%) patients at T8, 32 (64%) patients at T9, 45 (90%) patients at T10. The authors observed that the extent of analgesia was greater with the EOIC block than with the TAP block, which was highly statistically significant (p-value <0.00001) [Table/Fig-5].

Dermatomes	Midclavicular line			Anterior axillary line		
	Group E (n=50)	Group T (n=50)	p-value	Group E (n=50)	Group T (n=50)	p-value
T4	48 (96%)	0	<0.001	48 (96%)	0	<0.001
T5	48 (96%)	0	<0.001	48 (96%)	0	<0.001
T6	48 (96%)	8 (16%)	<0.001	47 (94%)	1 (2%)	<0.001
T7	48 (96%)	10 (20%)	<0.001	46 (92%)	5 (10%)	<0.001
T8	48 (96%)	20 (40%)	<0.001	44 (88%)	10 (20%)	<0.001
T9	48 (96%)	32 (64%)	<0.001	42 (84%)	29 (58%)	0.004
T10	42 (84%)	45 (90%)	<0.001	35 (70%)	25 (50%)	0.041
T11	0	18 (36%)	<0.001	1 (2%)	20 (40%)	<0.001
T12	0	5 (10%)	<0.001	0	2 (4%)	0.153

[Table/Fig-5]: Dermatomal distribution between Group E and Group T.

In the anterior axillary line, loss of sensation to pinprick was observed in 48 (96%) patients at the T4 and T5 levels, 47 (94%) patients at T6, 46 (92%) patients at T7, 44 (88%) patients at T8, 42 (84%) patients at T9 and 35 (70%) patients at T10 in Group E. In Group T, loss of sensation to pinprick was observed in none of the patients at T4 and T5, in only 1 (2%) patient at T6, 5 (10%) patients at T7, 10 (20%) patients at T8, 29 (58%) patients at T9 and 25 (50%) patients at T10, which was highly statistically significant (p -value <0.00001) [Table/Fig-5].

In the midaxillary line, loss of sensation to pinprick was observed in 48 (96%) patients at T4, 46 (92%) patients at T5 and 47 (94%) patients at T6 and T7 in Group E. Additionally, 46 (92%) patients experienced loss of sensation at T8, 42 (84%) patients at T9 and 40 (80%) patients at T10. In contrast, in Group T, loss of sensation to pinprick was observed in none of the patients at T4, T5 and T6, in 1 (2%) patient at T7, 8 (16%) patients at T8, 3 (6%) patients at T9 and 5 (10%) patients at T10, which was highly statistically significant (p -value <0.00001) [Table/Fig-6].

Midaxillary line				Posterior axillary line		
Dermatomes	Group E (n=50)	Group T (n=50)	p-value	Group E (n=50)	Group T (n=50)	p-value
T4	48 (96%)	0	<0.001	0	0	0.999
T5	46 (92%)	0	<0.001	20 (40%)	0	<0.001
T6	47 (94%)	0	<0.001	25 (50%)	0	<0.001
T7	47 (94%)	1 (2%)	<0.001	35 (70%)	0	<0.001
T8	46 (92%)	8 (16%)	<0.001	35 (70%)	0	<0.001
T9	42 (84%)	3 (6%)	<0.001	22 (44%)	0	<0.001
T10	40 (80%)	5 (10%)	<0.001	10 (20%)	0	<0.001
T11	2 (4%)	0	0.153	1 (2%)	0	0.317
T12	1 (2%)	0	0.317	0	0	0.999

[Table/Fig-6]: Dermatomal distribution between Group E and Group T in midaxillary line.

In the posterior axillary line, Group E exhibited loss of sensation to pinprick in none of the patients at T4, 20 (40%) patients at T5, 25 (50%) patients at T6, 35 (70%) patients at T7 T8, 22 (44%) patients at T9, 10 (20%) patients at T10. Whereas in group T, none of the patients had loss of sensation to pin prick which was highly statistically significant (p -value <0.00001) [Table/Fig-6].

Pain was assessed using a Numerical Rating Scale (NRS) ranging from 0, representing no pain, to 10, representing the worst pain. The NRS pain scores of patients in Group E were significantly lower compared to those in Group T (p -value <0.0001) during the first 24 hours postoperatively. The mean NRS scores in Group E did not exceed 2.9 within 24 hours, whereas in Group T, the mean NRS scores exceeded 3.1 by four hours postoperatively, which was highly statistically significant (p -value <0.0001). This indicates that the EOIC block is more effective in alleviating pain [Table/Fig-7].

NRS	Group E (Mean±SD)	Group T (Mean±SD)	p-value
0 h	0.32±0.13	0.87±0.32	0.0001
2 h	0.93±0.46	1.97±0.68	0.0001
4 h	1.26±0.82	3.11±1.12	0.0001
6 h	1.89±1.16	3.94±1.87	0.0001
12 h	2.28±1.24	4.67±1.96	0.0001
24 h	2.91±1.82	5.78±2.26	0.0001

[Table/Fig-7]: NRS score of Group E and Group T patients.

The mean time until the first rescue analgesia in Group E was 12.54±4.2 hours, compared to 4.4±3.02 hours in Group T, which was statistically significant (p -value <0.0001). Group E also required significantly fewer rescue analgesic doses (1.06±0.84) than Group T (3.52±1.3), which was statistically significant (p -value <0.0001). All patients received rescue analgesia, but the time periods varied. This shows

that Group E provided more effective pain relief compared to Group T [Table/Fig-8].

Parameters	Group E (Mean±SD)	Group T (Mean±SD)	p-value
Time for 1 st rescue analgesia (hours)	12.5±4.2	4.4±3.02	<0.0001
Number of rescue analgesic doses	1.06±0.84	3.52±1.3	<0.0001

[Table/Fig-8]: Time for 1st rescue analgesia and number of doses among Group E and Group T.

There was no statistically significant difference in heart rates, SpO₂, SBP and DBP between the two groups at any point of time. All p -values obtained from the study were above 0.05, indicating that neither of the blocks significantly impacted heart rate, SpO₂, SBP, or DBP, thereby maintaining haemodynamic stability in both groups.

The authors used the Bruggemann Comfort Scale to compare postoperative patient comfort levels between Group E and Group T. Group E reported consistently higher comfort levels than Group T, with statistically significant differences at all times except for the initial 30 minutes. These results suggest that the block administered to Group E resulted in greater patient satisfaction and comfort during the postoperative period [Table/Fig-9].

Comfort scale	Group E (Mean±SD)	Group T (Mean±SD)	p-value
30 min	1.02±0.26	0.78±0.4	0.157
60 min	1.78±0.45	1.05±0.52	0.003
90 min	2.18±0.62	1.64±0.56	0.046
3 h	2.47±0.36	2.06±0.24	0.029
6 h	2.53±0.31	2.18±0.38	0.041
12 h	3.27±0.68	2.61±0.59	0.024
18 h	3.61±0.82	2.84±0.72	0.031
24 h	3.94±0.67	3.05±0.58	0.003

[Table/Fig-9]: Bruggemann Comfort scale comparison between Group E and Group T.

DISCUSSION

Ultrasound-guided fascial plane blocks are an effective method of providing analgesia for laparoscopic surgeries. Although the TAP block has been widely used for these procedures, a major limitation is its sparing of the lateral branches of the IC nerves, which may not adequately cover the lateral port incision [18]. In the quest for a block that can provide analgesia for the anterolateral abdominal wall, the authors have compared the newer External Oblique Intercostal (EOIC) block with the most widely used TAP block.

The EOIC block is a novel intercostal fascial plane block that has been less explored. Very few randomised controlled trials and case series [13,18] have been published on the EOIC block till date. From the limited literature available, it appears to be a promising technique for upper abdominal surgeries due to its ability to reliably block both the anterior and lateral cutaneous branches of the intercostal nerves, providing analgesia to the anterior and lateral abdominal wall.

In the present study, the authors report that the dermatomal distribution of the EOIC block in Group E showed that T4-T10 levels were blocked in 96% of patients. In contrast, Group T had the majority of patients reporting dermatomal levels of T7-T10 in the midclavicular and anterior axillary lines. In the mid and posterior axillary lines, the TAP block did not produce analgesia, whereas the EOIC block resulted in a loss of sensation, as assessed by pinprick, in the majority of patients.

A possible explanation for the blockade of the T4 and T5 dermatomes could be the cephalad spread of the injected drug when administered at the T6 level. The single study published till date [14] did not explore the dermatomal distribution of analgesia. Hamilton DL [19] investigated drug diffusion after injecting dye into the thoracic fascial plane in a cadaver, both superficial and deep

to the EO muscle and observed better staining of the anterior and lateral cutaneous branches when the dye was injected deep to the EO muscle at the T6 rib. Elsharkawy H et al., demonstrated the staining of both the anterior and lateral branches of the intercostal nerves from T7 to T10 when dye was injected in the plane between the EO and external intercostal muscles at the T6 rib. They also observed staining from T6 to T10 levels in the anterior axillary line and from T6 to T9 in the midline [13]. This dermatomal extent of analgesia was similar to the cadaveric staining of intercostal nerves.

Till date, no randomised controlled trials have compared the EOIC block with other abdominal wall blocks, such as the TAP and rectus sheath blocks, which are commonly administered for laparoscopic upper abdominal surgeries. The authors have either compared the EOIC block with control groups or with port site infiltration [14]. In the present study, we compared the EOIC block with the TAP block.

The mean NRS score in Group E was 2.91 ± 1.82 at 24 hours postoperatively, whereas in Group T, the NRS score exceeded 3.11 ± 1.12 at four hours postoperatively, which was statistically significant. The mean time for first rescue analgesia was 12.5 hours in Group E compared to 4.4 hours in Group T. Additionally, the number of rescue analgesic doses was also fewer in Group E, with an average of 1.06 compared to 3.5 in Group T. Therefore, the NRS scores, time for first rescue analgesia and the number of analgesic doses required were all significantly lower in Group E compared to Group T.

Korkusuz M et al., conducted a study on 80 patients undergoing laparoscopic cholecystectomies, with 40 patients receiving an EOIC block and another 40 receiving no block. They observed that the EOIC block reduced tramadol consumption and resulted in lower NRS scores postoperatively, leading to an overall better quality of recovery compared to the control group [14]. Doymus O et al., compared the EOIC block with port site infiltration in obese patients undergoing laparoscopic sleeve gastrectomy and found that VAS scores were significantly lower during resting at 1, 2, 4, 8 and 12 hours postoperatively [20]. The VAS scores were also lower during active movement and opioid consumption along with the number of rescue analgesic doses was significantly lower with the EOIC block compared to port site infiltration.

The results of the present study were similar to those of Korkusuz M et al., and Doymus O et al., concerning NRS scores, time to the first rescue analgesia and the number of opioid doses requested. However, these previous studies did not assess the dermatomal level of analgesia with the EOIC block [14,20].

In the present study, the authors used 30 mL of local anaesthetic on each side, while Korkusuz M et al., used 25 mL and Doymus O et al., used 30 mL on each side as well [14,20]. There was no standardisation of volume for the EOIC block in the literature. Petiz C et al., published a case series reporting the usefulness of the EOIC block in five patients who underwent live nephrectomy [18]. Liotiri D et al., also published a case series on the EOIC block with bilateral catheters following liver surgery, highlighting the usefulness of the block and the feasibility of catheter insertion in the EOIC plane [21].

The advantage of the EOIC block lies in its location, as it does not involve the surgical site and is situated superficially, making it easily accessible for obese patients. However, the block must be performed with caution to avoid injury to the pleura and vessels in the plane [13]. In the present study, the authors did not encounter any complications.

The Bruggemann Comfort Score, which is widely used to assess patient comfort in the postoperative period, was found to be superior in patients who received the EOIC block compared to those who received the TAP block.

Limitation(s)

The major limitation of both EOIC and TAP blocks is that they provide only somatic analgesia and not visceral analgesia. Other limitations include the potential for inadvertent damage to the underlying pleural and abdominal structures.

CONCLUSION(S)

Postoperative pain management is a major concern for laparoscopic upper abdominal wall surgeries. Thoracoabdominal nerves from T6 to T9, including both the anterior and lateral cutaneous branches, were blocked using the EOIC plane block. In the present study, the EOIC plane block demonstrated promising results in terms of a greater number of dermatomes blocked and the extent of analgesia when compared to the TAP block. Therefore, the EOIC plane block is a potential alternative to the TAP block for laparoscopic upper abdominal wall surgeries.

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