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Original Research Article

Comparison of Analgesic Efficacy of Ultrasound-Guided External Oblique Intercostal Plane Block and Modified Thoracoabdominal Nerve Block via Perichondrial Approach in Patients Undergoing Upper Abdominal Surgeries: A Randomized Controlled Study

Divyashree R.[1], S. B. Gangadhar[2], Samveda S. G.[3]

[1]Senior Resident, Department of Anaesthesiology & Critical Care, Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, India

[2]Professor and Head, Department of Anaesthesiology & Critical Care, Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, India

[3]Senior Resident, Department of Anaesthesiology & Critical Care, Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, India

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Corresponding author: Dr. Divyashree R

Conflict of interest: Nil

Abstract

Background and Aims: Effective postoperative pain management following upper abdominal surgeries improves recovery and reduces opioid requirements. Recently described ultrasound guided fascial plane blocks such as the External Oblique Intercostal Plane (EOIP) block and modified thoracoabdominal nerve block via the perichondrial approach (M-TAPA) provide analgesia of anterior and lateral abdominal wall. This study aimed to compare the postoperative analgesic efficacy of EOIP and M-TAPA blocks with conventional analgesia in patients undergoing upper abdominal surgeries.

Material and Methods: This prospective randomized study included 45 patients undergoing elective upper abdominal surgery under general anaesthesia. Patients were randomly allocated into three groups (n=15 each). Control group (Group C) receiving general anesthesia with standard systemic analgesia, Group E receiving ultrasound-guided EOIP block, Group T receiving ultrasound-guided M-TAPA block in addition to general anesthesia. The primary outcome was postoperative pain assessed using Numerical Rating scale (NRS) at predetermined time intervals in the first 24 hours. Secondary outcomes included Demographic variables, sensory dermatomal spread, total opioid consumption, NSAID consumption and postoperative complications were recorded. Statistical analysis was performed using ANOVA and Chi-square tests.

Results: Postoperative NRS scores were significantly lower in Group E and T compared with the control at multiple postoperative time points (p<0.001). Both EOIB and M-TAPA groups demonstrated reduced opioid consumption and prolonged time to first rescue analgesia compared with the control group. However, no statistically significant difference was observed between Group E and T with respect to pain scores, opioid requirement, or duration of analgesia. The incidence of adverse effects was comparable among the three groups. The mean age was comparable between Groups (Group C: 45.3±11.2years, Group E: 46.1±10.8 years, Group T: 44.7± 12.1years; p>0.05). Mean 24-hour opioid consumption was significantly higher in the control group (300± 0mg) compared to EOIP (73.3±59.4 mg) and M-TAPA (86.7±74.3 mg) groups (p<0.001). Similarly, NSAIDS consumption was significantly higher in the control group (3000±0 mg) compared with EOIP (1333±488 mg) and M-TAPA (1267±458 mg). Both blocks produced adequate dermatomal spread from T6 to T11.

Conclusions: Ultrasound-guided External oblique intercostal plane (EOIP) block and Modified thoracoabdominal nerve block via the perichondrial approach (M-TAPA) blocks have emerged as effective techniques for managing postoperative pain in patients undergoing upper abdominal surgeries. These blocks provide multi-dermatomal analgesia, significantly reducing opioid consumption and contributing to improved patient outcomes. With minimal complications reported, EOIP and M-TAPA blocks can be safely incorporated into multimodal analgesia protocols, enhancing pain management strategies. Clinically, M-TAPA block demonstrates better sensory dermatomal spread (T6-T12) compared to EOIP block, with slight increase in duration of analgesia suggesting a potential advantage in certain clinical scenarios. Hence I recommend M-TAPA block for better postoperative analgesia following upper abdominal surgeries. However, both techniques demonstrate comparable analgesic efficacy, making them valuable additions to pain management approaches for upper abdominal surgeries.

Keywords: Abdominal surgeries; EOIP block; M-TAPA block; Postoperative analgesia; Ultrasound guided nerve block.

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Introduction

Postoperative pain following upper abdominal surgeries remains a major clinical challenge. Inadequate analgesia can lead to impaired respiratory mechanics, delayed ambulation, prolonged hospital stays, and increased opioid consumption.

Multimodal analgesia strategies incorporating regional anesthesia techniques have been widely adopted to improve postoperative pain control while minimizing opioid related adverse effects. The external oblique intercostal plane (EOIP) block is a recently described ultrasound guided fascial plane block that provides analgesia by blocking the anterior and lateral cutaneous branches of the intercostal nerves as they pass between external oblique and intercostal muscles at the level of 6th costal cartilage. Similarly, the modified thoracoabdominal nerve block via the perichondrial approach (M-TAPA) is performed at 10th costal cartilage and targets thoracoabdominal nerves supplying the anterior lateral abdominal wall. Although both blocks have shown promising results, comparative clinical data evaluating their analgesic efficacy remain limited.

Therefore, this study aimed to compare the postoperative analgesic efficacy of EOIP block and M-TAPA block with conventional analgesia in patients undergoing upper abdominal surgeries.

Materials and Methods

The study was approved by the institutional ethics committee (IEC approval number: SSMC/MED/IEC− 173/November- 2025) and registered in the clinical trials registry of India at https://ctri.nic.in (CTRI/2025/12/099549). Informed written consent taken from all the patients. Ultrasound procedures were done by anesthesiologists with adequate training. Forty-five patients aged 18 to 65years, ASA 1 & 2 undergoing supraumbilical surgeries under general anaesthesia were included in this study. The patients excluded were those who had contraindications to general anaesthesia and refused to give informed consent for the procedure.

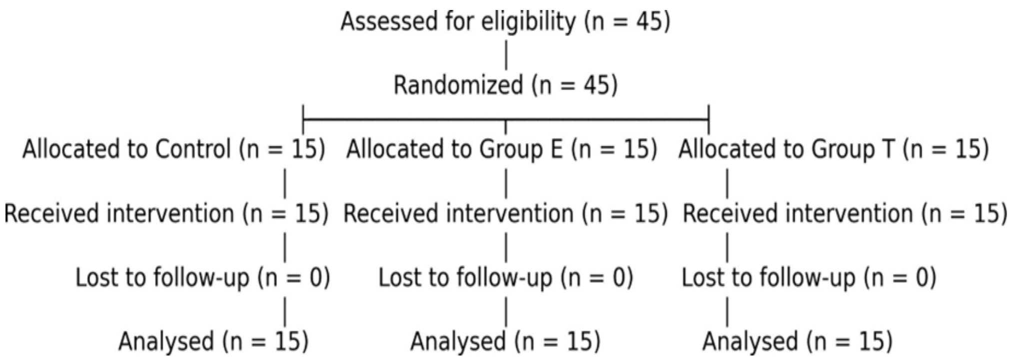

Figure 1: Flow diagram of the study

Forty-five patients were randomized into 3 groups of 15 each by a computer-generated random sequence table. The allocation was concealed and opened only by the anaesthesiologist performing the procedure. Preoperatively, 18G Intravenous line secured for the patient and they were started on 5 to 10 ml/kg ringer lactate solution.

The patient shifted to the operative room, with table in neutral position and patient in left lateral decubitus position standard ASA monitors attached to monitor pulse rate, blood pressure, oxygen saturation and ECG. General anesthesia with airway securement was the common technique in all the groups. Premedication with injection glycopyrrolate 0.2mg and injection fentanyl 2mcg/ kg was given intravenously 20 mins prior to induction, Patients were preoxygenated and are induced with injection propofol 2mg/kg iv, Injection Succinylcholine 1.5mg/kg iv. The airway was either secured with endotracheal tube or i-gel based on duration of surgery.

Patients underwent routine anesthesia monitoring intraoperatively (noninvasive blood pressure, electrocardiography, heart rate, and peripheral oxygen saturation measurements). To maintain general anesthesia, isoflurane (1-2% concentration) was administered in a mixture of oxygen and air at a flow rate of 4 L/min and injection Atracurium iv.

Intraoperative analgesia was provided with 1 µg/kg fentanyl & Iv paracetamol at 15mg/kg before the end of surgery. Blocks were given just before extubation then extubated and followed up.

Block procedure: After appropriate site hygiene, under ultrasound guidance with a linear ultrasound sonography (USG) probe (10–18 MHz)

External oblique intercostal plane block (EOIP block): For the EOIP block, the linear USG probe was placed sagittally in a craniocaudal direction just medial anterior axillary line at the level of 6th costal cartilage coinciding with Xiphisternum. The probe will be advanced in a craniocaudal direction to identify the 6th, 7th, and 8th costal cartilages. At the 6th costal cartilage level, A 100-mm, 22-gauge ultrasound-visible peripheral nerve block needle was directed craniocaudally using an in-plane technique. After confirming the position of the needle between external oblique and intercostal muscle plane by hydrodissection, 25ml of bupivacaine (0.25% concentration) along with injection dexamethasone 4mg will be injected bilaterally. The spread of local anesthetic was observed beneath the external oblique muscle and intercostal muscle.

Modified thoracoabdominal nerve block via the perichondrial approach (M-TAPA block): To administer the M-TAPA, a linear USG probe will be placed in the sagittal plane at the level of the 10th costal cartilage medial to anterior axillary line to identify the transversus abdominis, external, and internal oblique muscles. To visualize the undersurface of the 10th costal cartilage at the midline better, the probe will be angled deeply and sagittally along the edge of the cartilage. A 22-gauge ultrasound-visible peripheral nerve block needle will be advanced cranially using the in-plane technique, and the needle tip was directed posteriorly. After placing the needle tip on the cranial edge of the 10th costal cartilage and the lower surface of the chondrium, 25ml of bupivacaine (0.25% concentration) along with injection dexamethasone 4mg will be injected bilaterally. For patients with a numerical rating scale (NRS) score greater than 5, in all three groups, rescue analgesia was planned with 1 g of paracetamol and 100mg of tramadol administered intravenously at 8-hour intervals, up to a maximum of three times per day. All block procedures were performed by the same anesthesiologist.

The primary outcome for this study was the NRS scores at 2, 4, 6, 12, and 24 h postoperatively.

The secondary outcomes were the tramadol and Paracetamol consumption (24 h postoperatively), sensory block distribution level (pinprick test), side effects (nausea and vomiting). Furthermore, we collected patients' demographic characteristics (age, height, BMI, and sex) and the duration of surgery.

In case of failure of the block, then postoperatively analgesia will be maintained using intravenous analgesia using injection Tramadol 100mg TID and injection Paracetamol 1g TID.

Pinprick test: The pinprick test was performed using a blunt 20-gauge needle. To ascertain the extent of the sensory block, the abdominal region and left shoulder were selected as reference points.

The needle was initially applied to the abdominal region and presence or absence of sensation was evaluated. The test was then conducted on the shoulder region for confirmation. The pinprick response was recorded on a two-point scale, with the value of 1 indicating presence of sensation and 0 indicating absence of sensation. Pinprick commenced from the dermatome supplied by the 5th intercostal nerve to the 12th intercostal nerve along the midclavicular and midaxillary line.

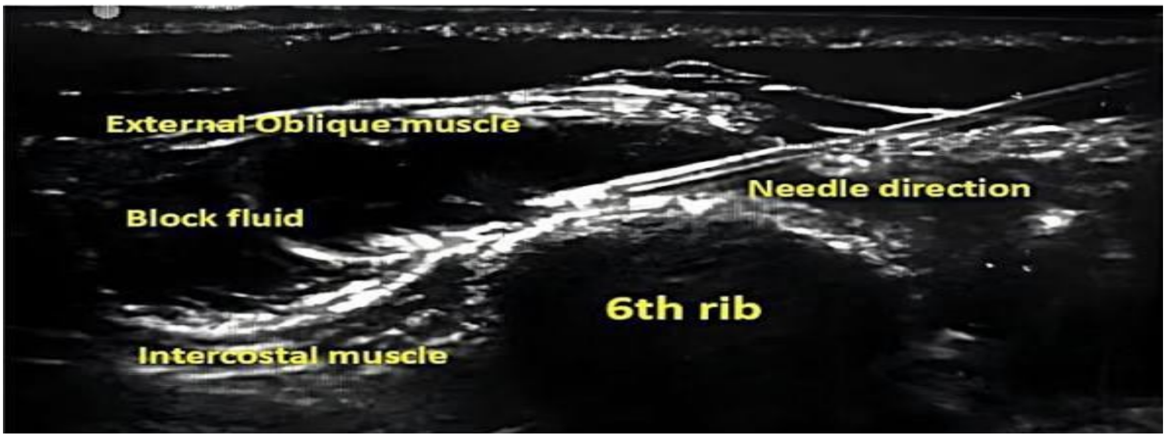

Figure 2: Ultrasound image of EOIP block

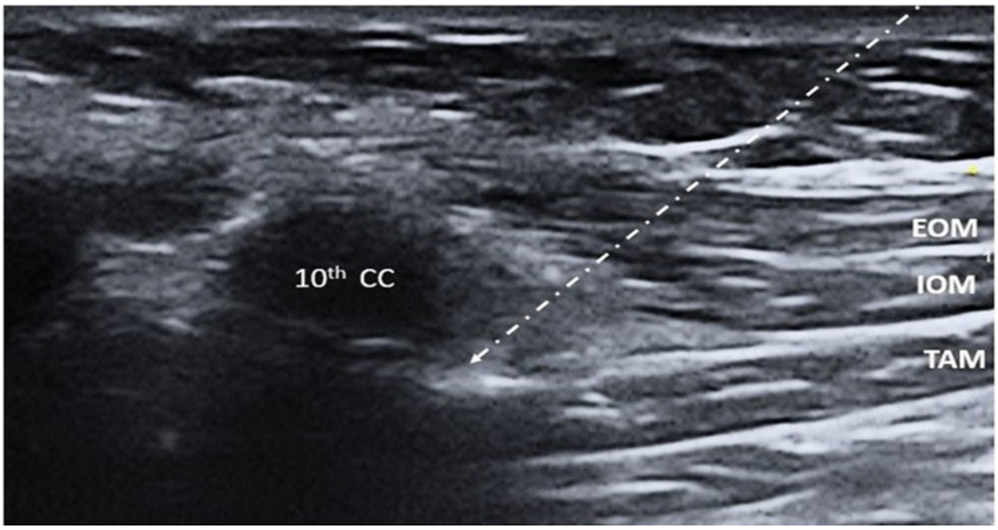

Figure 3: Ultrasound image of M-TAPA block [10th cc- 10th costal cartilage, EOM- External oblique muscle, IOM- Internal oblique muscle, TAM- Transverse abdominis muscle]

Sample size was estimated based on the study by Okmen K et al based on the mean 6th hour postoperative NRS score. The sample size was estimated to be 15 with alpha of 0.05, a power of 0.8, a confidence level of 95% and taking into account a 10% drop out. Thus, a total of 45 subjects were randomized into 3 groups of 15 each by a computer-generated randomised sequence.

The collected data were entered in the Microsoft Excel 2016 and analysed with IBM SPSS Statistics for Windows, Version 29.0 and jamovi software, version 2.6.44. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significant difference in the multivariate analysis the one-way ANOVA with Tukey's Post hoc test was used and similarly the Kruskal Wallis test followed by of Dwass steel critchloww finger test was used. In all the above statistical tools the probability value 0.05 is considered as significant level.

Results

A total of 45 patients completed the study. Baseline demographic variables including age, gender, and ASA physical status were comparable among the three groups. [Table 1]

Postoperative pain scores (at rest as well as during movement) were significantly lower Group E & T (p<0.001) compared to control group at all time intervals. [Table 2 & Figure 2] Total analgesic consumption during the first 24 hours was significantly lower in the intervention groups compared with the control group. [Table 3]

This reduction indicates improved analgesic efficacy and reduced need for rescue analgesics. There was no significant difference between the sensory loss between the intervention groups extending from T6 to T11 dermatomes at midclavicular and midaxillary level. The incidence of adverse effects such as nausea and vomiting was low and comparable across all groups. [Table 4] No serious complications were reported.

Table 1: Demographic data

Variable	Control (n=15)	Group E (n=15)	Group T (n=15)	Test	p value
Age(years)	45.3±11.2	46.1±10.8	44.7±12.1	One way ANOVA	0.88
Gender(M/F)	8/7	6/9	7/8	Chi-square	0.76
ASA I	3	5	5	Chi-square	0.64
ASA II	12	10	10		

Table 2: Comparison of NRS scores at rest

Time (hr)	Control	Group E	Group T	F value	p value
2hr	5.53±0.52	0.53±0.64	0.40 ± 0.51	188.4	<0.001
4hr	4.60±1.12	0.40±0.51	0.40 ± 0.51	110.2	<0.001
6hr	4.40±0.63	2.00±0.00	1.60 ±0.51	95.7	<0.001
12hr	5.27±0.46	4.33±0.49	3.67± 0.49	42.8	<0.001
24hr	5.47±0.52	4.13±0.35	4.00± 0.00	38.4	<0.001

Post-hoc Tukey Test

Comparison	Mean Difference	p value
Control vs Group E	Significant	<0.001
Control vs Group T	Significant	<0.001
Group E vs Group T	Not significant	>0.05

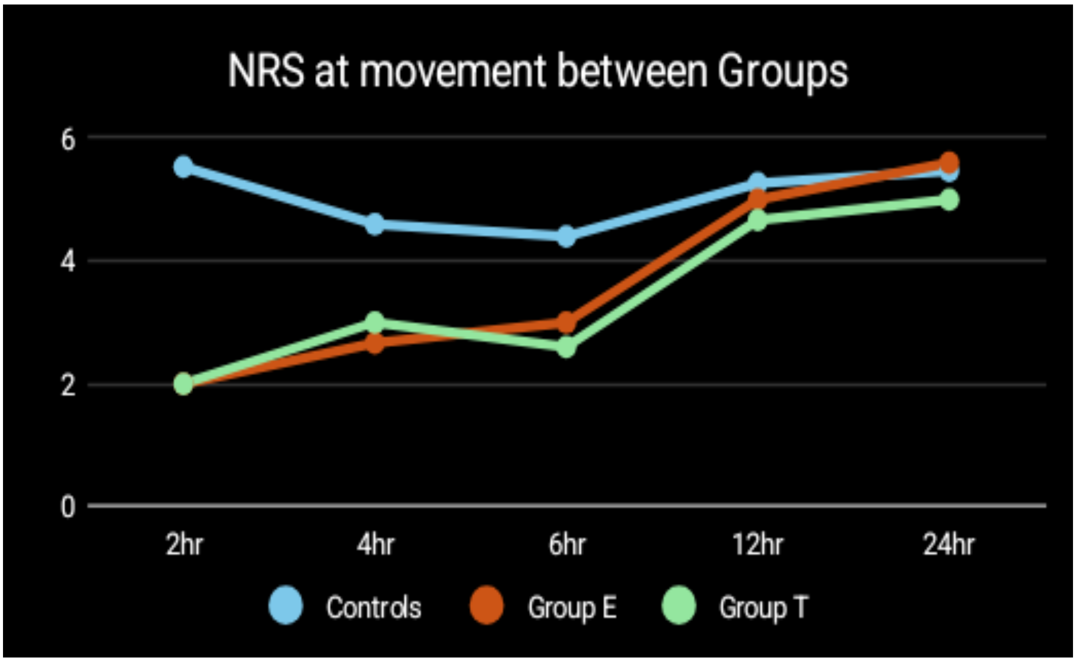

Figure 4: **Graphical representation of NRS during movement at determined time intervals**

Table 3: Comparison of Total Opioid and NSAID consumption in 24hrs

Dependent Variable			Mean Difference (I-J)	Std. Error	p- value	95% C.I	
						Lower Bound	Upper Bound
Opioids (mg)	Controls	Group E	226.6667*	20.0528	.0005	177.948	275.385
		Group T	213.3333*	20.0528	.0005	164.615	262.052
	Group E	Group T	-13.3333	20.0528	.785	-62.052	35.385
NSAIDs (mg)	Controls	Group E	1666.6667*	141.0467	.0005	1323.995	2009.339
		Group T	1733.3333*	141.0467	.0005	1390.661	2076.005
	Group E	Group T	66.6667	141.0467	.884	-276.005	409.339
*. The mean difference is significant at the 0.05 level.							

Table 4: Incidence of Side Effects

Side Effect	Control	Group E	Group T	p value
Nausea	6	4	3	0.41
Vomiting	2	0	0	0.29
None	7	11	12	

Chi-square test: No significant difference

Discussion

Effective postoperative analgesia following upper abdominal surgery remains a critical component of enhanced recovery protocols.

Regional anesthesia techniques targeting thoracoabdominal nerves have gained increasing attention due to their opioid-sparing effects and favorable safety profile. In the present study, we evaluated the analgesic efficacy of ultrasound-guided fascial plane block techniques for postoperative pain control following upper abdominal surgeries. Our findings demonstrated improved postoperative analgesia, reduced pain scores, and decreased rescue analgesic consumption in patients receiving the blocks compared with the control group. The external oblique intercostal plane (EOIP) block is a relatively novel regional anesthesia technique that targets the anterior and lateral branches of the thoracoabdominal nerves as they traverse the fascial plane between the external oblique and intercostal muscles. Anatomical investigations by Hossam Elsharkawy and colleagues demonstrated that local anesthetic spread within this plane can provide sensory blockade of dermatomes T6–T10, which correspond to the upper abdominal wall innervation relevant for laparoscopic cholecystectomy procedures [6]. Their cadaveric and clinical findings supported the feasibility of EOIP block as an effective analgesic strategy for upper abdominal surgery.

Our results align with the findings reported by A S Kavakli et al., who conducted a prospective randomized controlled trial evaluating EOIP block in patients undergoing laparoscopic sleeve gastrectomy [4]. The authors observed significantly lower postoperative pain scores and reduced opioid consumption in the EOIP block group compared with controls. Similar trends were observed in our study, where patients receiving the fascial plane block demonstrated lower numerical rating scale (NRS) scores in the early postoperative period and decreased requirement for rescue analgesia.

A randomized study by O Doymus et al. further compared EOIP block with port-site infiltration for laparoscopic sleeve gastrectomy [7]. The investigators reported that EOIP block provided superior analgesia and prolonged duration of postoperative pain relief. These results reinforce our findings that regional fascial plane blocks may offer better analgesic coverage compared with conventional local infiltration techniques.

More recently, comparative studies have evaluated different fascial plane blocks for upper abdominal surgery. A prospective randomized trial conducted by B Ciftci et al. compared the modified thoracoabdominal nerves block through perichondrial approach (M-TAPA) with EOIP block in laparoscopic cholecystectomy patients [2]. Their results demonstrated that both techniques provided effective postoperative analgesia, although subtle differences were noted in analgesic duration and dermatomal coverage. Similarly, the observational study by K Ökmen and colleagues also reported comparable analgesic efficacy between M-TAPA and EOIP blocks following laparoscopic cholecystectomy [1]. These findings suggest that multiple fascial plane blocks targeting thoracoabdominal nerves can be effective options for postoperative analgesia in upper abdominal procedures.

Our findings are also consistent with the randomized clinical study by S Shrey et al., which compared EOIP block with subcostal transversus abdominis plane (TAP) block in patients undergoing upper abdominal surgery [3]. The authors reported superior analgesia with EOIP block, likely due to more consistent spread to upper thoracoabdominal nerves. This supports the hypothesis that EOIP block may provide broader dermatomal coverage than conventional TAP block techniques.

The role of EOIP block in obese and high-risk patients has also been highlighted in clinical reports. L White and A Ji described successful use of EOIP block for upper abdominal surgery in obese patients, demonstrating its feasibility and safety even in technically challenging populations [9]. These findings are clinically relevant as laparoscopic cholecystectomy is frequently performed in overweight or obese individuals.

Case reports have also suggested the potential benefits of combining EOIP block with other regional techniques. For example, Y Ohgoshi and colleagues described the combined use of EOIP block with modified thoracoabdominal nerve block for abdominal surgery, achieving satisfactory postoperative analgesia [5]. Such multimodal regional strategies may further enhance postoperative pain control.

Traditional regional techniques such as thoracic paravertebral block and subcostal TAP block have been widely used for upper abdominal analgesia. However, these techniques have certain limitations, including risk of pleural puncture and variable dermatomal spread. Earlier work by G Kamhawy et al. comparing subcostal TAP block with thoracic paravertebral block demonstrated effective analgesia with both techniques, but highlighted procedural complexity associated with paravertebral approaches [8]. Fascial plane blocks such as EOIP offer a technically simpler and potentially safer alternative.

The opioid-sparing benefits observed in our study are also consistent with contemporary multimodal analgesia strategies. By reducing systemic opioid requirements, fascial plane blocks may decrease opioid-related adverse effects such as nausea, vomiting, and respiratory depression, thereby improving patient recovery and satisfaction.

Despite these encouraging findings, several limitations should be acknowledged. First, the sample size of the study may limit the generalizability of the results. Second, dermatomal sensory mapping was not performed to objectively confirm the extent of neural blockade. Third, the study evaluated only short-term postoperative outcomes, and long-term recovery parameters were not assessed.

Future multicenter randomized controlled trials with larger patient populations and standardized outcome measures are warranted to further validate these findings. Overall, the results of the present study contribute to the growing body of evidence supporting the use of ultrasound-guided fascial plane blocks for postoperative analgesia in upper abdominal surgery. The technique appears to provide effective pain relief, reduce opioid consumption, and enhance postoperative recovery.

Limitations: The limitations of the study are that the anaesthesiologist performing the procedure cannot be blinded due to the nature of the study. This was a Single Centre study with small sample size with shorter follow up period. Future multicentre studies with larger populations are required to validate these findings.

Conclusion

Ultrasound-guided External oblique intercostal plane (EOIP) block and Modified thoracoabdominal nerve block via the perichondrial approach (M-TAPA) blocks have emerged as effective techniques for managing postoperative pain in patients undergoing upper abdominal surgeries. These blocks provide multi-dermatomal analgesia, significantly reducing opioid consumption and contributing to improved patient outcomes. With minimal complications reported, EOIP and M-TAPA blocks can be safely incorporated into multimodal analgesia protocols, enhancing pain management strategies.

Clinically, M-TAPA block demonstrates better sensory dermatomal spread (T6-T12) compared to EOIP block, with slight increase in duration of analgesia suggesting a potential advantage in certain clinical scenarios. Hence I recommend M-TAPA block for better postoperative analgesia following upper abdominal surgeries. However, both techniques demonstrate comparable analgesic efficacy, making them valuable additions to pain management approaches for upper abdominal surgeries.

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