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Original article

Analgesic Contribution of External Oblique Intercostal Block in Major Abdominal Surgeries: A Randomized Clinical Trial

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Abstract

Background: Despite advances in surgical techniques and anesthesia management, postoperative pain remains an important issue. TAP block provides an excellent postoperative analgesia, decreases opioid requirement, and is conducive to favorable respiratory mechanics. **This study aimed to** compare between analgesic contribution of external oblique intercostal block versus general anesthesia alone in major abdominal surgeries (abdominal exploration, open cholecystectomy and nephrectomy). **Methods:** This randomized open label clinical trial was conducted on 46 patients in Benha University Hospitals during the period from February 2023 to December 2023 . Patients were randomly allocated in two equal groups, group A included 23 patients who underwent GA + EOI plane block and group B included 23 patients who underwent GA only. Preoperative assessment including full history taking, clinical examination and routine laboratory investigations was performed. The design of trial and pain score was clarified for participants during the preoperative anesthesia visit. **Results**: Intraoperative fentanyl consumption was significantly lower in group A than group B (P<0.001). Intraoperative hemodynamics (MAP and HR) were significantly lower in group A than group B according (P<0.001, 0.005 respectively). There was a statistically significant difference between the two study regarding postoperative pain assessment using NRS at first 48 hours postoperative, being lower in group A than group B. **Conclusion:** The External Oblique Intercostal Block is an effective anesthetic technique that can be used in major upper abdominal surgeries to reduce post-operative pain including delayed time of 1st rescue analgesia and decreased total opioid consumption.

Keywords: Analgesic; External Oblique Intercostal Block; Major Abdominal Surgeries; Pain

Introduction

Despite advances in surgical techniques and anesthesia management, postoperative pain remains an important issue. Pain that develops after surgical intervention is multifactorial, the severity of which varies according to factors including the extent of surgical trauma, anesthesia technique, plus the physiological, psychological, emotional, and sociocultural characteristics of the patient (1).

Regional anesthesia of the trunk and abdominal wall is usually centered on epidural analgesia. Although epidural analgesia remains the gold standard for major abdominal surgery, in the context of multimodal analgesia and enhanced recovery protocols, epidural analgesia may not always offer clinically important differences in pain control and is associated with hypotension and other serious risks (2).

Interfascial plane blocks - regional anesthetic techniques first described with anatomical landmarks - have become safer and easier to perform with the use of ultrasonography. Ultrasound guidance and anatomic studies have led to the description of many new interfacial plane blocks (3). While there are now many regional anesthetic techniques for use in thoracic and abdominal procedures, very few of these techniques are appropriate for postoperative analgesia in abdominal surgeries, which lead to somatic pain from the abdominal area and also visceral pain due to surgical manipulation (4).

Use of ultrasonography for regional blocks offers direct visualization of the anatomical plane, needle placement, and the pattern of local anesthetic spread resulting in increased safety margin and optimal block quality. The successful use of US-guided block has been reported in several other surgical procedures (5). The popularity of abdominal wall blocks has increased dramatically in recent years. These are frequently used due to the use of blocks that are highly effective, such as the Transversus abdominis plane (TAP) block and the widespread use of ultrasound (US) imaging (6).

Transversus abdominal plane (TAP) block is one of the several modalities used for pain relief in the postoperative period. It involves deposition of local anesthetic into the fascial plane superficial to the transversus abdominis muscle, where nerves supplying the anterolateral abdominal wall traverse (7). TAP block provides an excellent postoperative analgesia, decreases opioid requirement, and is conducive to favorable respiratory mechanics. These facilitate early mobilization and discharge, significantly improving the patient's quality of life up to 6 months postoperatively (8).

The purpose of this study was to compare between analgesic contribution of external oblique intercostal block versus general anesthesia alone in major abdominal surgeries (abdominal exploration, open cholecystectomy and nephrectomy).

Patients and methods

This randomized open label clinical trial was conducted on 46 patients in Benha University Hospitals during the period from February 2023 to December 2023 .

The study was presented to the research Ethics Committee of faculty of medicine- Benha University and approved with approval code MS 37-2-2023). Informed consent was obtained from the patients before participating in this study.

Inclusion criteria were all patients aged >18 years old, both sex, and scheduled for abdominal exploration surgery, open cholecystectomy and nephrectomy.

Exclusion criteria were patient refusal, body mass index (BMI) > 35 Kg/m^2 (morbidly obese patients), patients who had sensitivity toward general anesthesia, who are unable to describe their satisfaction, with known local anesthetics and opioid allergy, with major respiratory, cardiac, renal or hepatic disorders (ASA III&IV) and operations lasting more than 4 hours (lengthy operations).

Grouping: Patients were randomly allocated in two equal groups, group A including 23 patients who underwent GA + EOI plane block and group B including 23 patients who underwent GA only.

All studied cases were subjected to the following: preoperative assessment including full history taking (age, sex, BMI, comorbidities), clinical examination (heart rate, systolic blood pressure, diastolic blood pressure, temperature) and routine laboratory investigations. The design of trial and pain score was clarified for participant during the preoperative anesthesia visit. **Intraoperative management**: After cannula insertion, all patients were premedicated with intravenous (IV) midazolam 2 mg + fentanyl 1ug / kg, For all case, the standard technique of general anesthesia was used. We used the standard monitoring (pulse oximetry, temperature probe, noninvasive blood pressure, 5 lead ECG, and capnography). Induction of general anesthesia was done by IV propofol 2-2.5 mg / kg. After IV atracurium 0.15 mg / kg, endotracheal intubation was done. Maintenance of anesthesia was isoflurane (1-1.5%) with 50% oxygen. Incremental doses of IV atracurium 0.03mg/Kg was given. Then, patients were mechanically ventilated to maintain end-tidal CO_2 30—35 mmHg (respiratory rate=12 breath / min, tidal volume = 7 ml/kg, inspiratory-to-expiratory ratio 1: 2, positive end expiratory pressure = 5 cm H_2O). Patients in group A received US-guided EOI block for each side consisted of 20 mL of 0.25% bupivacaine from the sixth rib level between the external oblique and intercostal muscles after induction of general anesthesia. Additional bolus doses of fentanyl 1 Mg/kg IV will be given if the mean arterial blood pressure (MAP) or heart rate (HR) rises above 20% of baseline levels. Patients in group B underwent GA only, where induction of general anesthesia was done by IV propofol 2-2.5 mg / kg. After IV atracurium 0.15 mg / kg, endotracheal intubation was done. Maintenance of anesthesia was done by isoflurane (1-1.5%) with 50% oxygen. **Postoperative care**: At the end, all anesthetics were stopped. Extubation was performed when spontaneous breathing is adequate and following prompt reversal. Patients were transferred to the post anesthesia care unit (PACU). Following that, the patients were transferred to a ward and given 1 g of acetaminophen IV every 8 hours. Pain was assessed by NRS, if NRS > 3, patients received Pethidine 50 mg as rescue analgesia. All data were collected by an intraoperative anesthesiologist and postoperative assessor every 4 h for 48 h.

Measurements: All the following data was collected; Demographic data **including** age in (years), BMI (Kg/m_2), duration of surgery in (minutes) was recorded. Intraoperative fentanyl consumption (Mg) was recorded. Intraoperative hemodynamic parameters: [MAP (in mmHg) and HR (beats /minute)] were recorded. Postoperative pain (using NRS) at rest and at movement was measured at PACU and every 4 h for 48 h postoperative. Rescue analgesia in the form of IV pethidine (50mg) boluses if NRS >3. Time to the 1st rescue analgesic request was recorded. Total amount of rescue analgesic in 1st 48hrs postoperative .Recording of adverse events was done [e.g., nausea, vomiting, hypotension (MAP < 20% of baseline value) and bradycardia (HR < 60).

The primary outcome was time of 1st rescue analgesia and total opioid consumption. **The secondary outcomes** was Intraoperative heart rate and blood pressure and intraoperative fentanyl consumption

Statistical analysis:

Statistical analysis was done by SPSS v27 (IBM©, Armonk, NY, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (SD) and were analysed by unpaired student t-test. Quantitative non-parametric data were presented as the median and interquartile range (IQR) and were analysed by Mann Whitney-test. Qualitative variables were presented as frequency and percentage (%) and analysed using the Chi-square test or Fisher's exact test when appropriate. A two-tailed P value < 0.05 was considered statistically significant.

Results

There was no statistically significant difference between the two study groups regarding demographic data (sex, age & BMI), type of operation and duration of surgery. **Table 1**

Intraoperative fentanyl consumption was significantly lower in group A than group B ($P<0.001$). Intraoperative hemodynamics (MAP and HR) were significantly lower in group A than group B according ($P<0.001$, 0.005 respectively). **Table 2**

There was a statistically significant difference between the two study groups regarding postoperative pain assessment using NRS at PACU lower in group A than group B ($P<0.001$). And there was a statistically significant difference between the two study groups regarding post-operative pain at 4,8,12,16,20,24,28,32,36,40 hours being lower in group A than group B ($P<0.001$). And at 44 hours there was no statistically significant difference between two groups regarding NRS with p- value =0.898 Finally at 48 hours there was a statistically significant difference between the two study groups regarding post-operative pain being lower in group B than group A ($P<0.001$). Overall, there was a statistically significant difference between the two study regarding postoperative pain assessment using NRS at first 48 hours postoperative, being lower in group A than group B. **Table 3-Figure 1**

There was a statistically significant difference between the two study groups regarding first rescue analgesia. It was early postoperative in group B than group A ($P<0.001$). **Table 4**

There was no statistically significant difference between the two study groups regarding adverse events such as nausea & hypotension. **Table 5**

Table 1: Demographic, clinical date operation and duration of surgery of the studied groups

	Group A (n = 23)		**Group B (n = 23)**		**Test of sig.**	**p**
	No.	**%**	**No.**	**%**		
Sex						
Male	11	47.8	11	47.8	χ^2=	1.000
Female	12	52.2	12	52.2	0.00	
Age (years)						
Mean ± SD	39.22 ± 15.08		46.17 ± 10.80		t=	0.080
Median (Min-Max)	42.0 (19.0-64.0)		45.0 (30.0- 69.0)		1.799	
BMI (kg/m^2)						
Mean ± SD	30.0 ± 5.28		31.61 ± 6.25		t=	0.351
Median (Min-Max)	30.0 (20.0-40.0)		32.0 (22.0-46.0)		0.943	
Operation						
Open cholecystectomy	7		30.4		χ^2=	
Nephrectomy	7		30.4		0.125	0.939
Exploration	9		39.1			
Duration of surgery (min)					t=	
Mean ± SD	129.74 ± 27.82		135.87 ± 24.29s		0.796	0.430
Median (Min - Max)	130.0 (85.0-180.0)		140.0 (90.0 -180.0)			

c2: Chi square test, t: Student t-test ,SD: Standard deviation , p: p value for comparing between the two studied group

Table 2: Comparison between the two studied groups according to intraoperative fentanyl consumption

		Group A (n = 23)	Group B (n = 23)	Test	p
Intraoperative fentanyl consumption (mic)	**Min-Max**	0.0 - 50.0	50.0 - 200.0	U=4.500*	<0.001*
	Mean ± SD	19.57 ± 24.95	141.30 ± 44.34		
	Median (IQR)	0.0 (0.0 - 50.0)	150.0 (100.0-175.0)		
Intraoperative hemodynamics					
MAP (mmHg)	**Mean ± SD**	77.91 ± 6.88	86.09 ± 8.82	t=3.504*	**0.001***
	Median (Min- Max)	79.0 (65.0-90.0)	88.0 (65.0-98.0)		
HR (beats/minute)	**Mean ± SD**	78.91 ± 9.44	88.0 ± 11.15	2.984*	**0.005***
	Median (Min- Max)	79.0 (65.0-94.0)	88.0 (65.0-110.0)		

MAP: mean arterial pressure, HR: heart rate, IQR: Inter quartile range, U: Mann Whitney test, SD: Standard deviation, p: p value for comparing between the two studied groups, t: Student t-test, SD: Standard deviation ,p: p value for comparing between the two studied groups *: Statistically significant at p ≤ 0.05

Table 3: Comparison between the two studied groups according to NRS

	Group A (n = 23)	p_0	Group B (n = 23)	p_0	U	p
At PACU					68.50*	<0.001*
Min — Max	0.0 - 2.0		0.0 - 4.0			
Mean ± SD	0.35 ± 0.57		2.0 ± 1.24			
Median (IQR)	0.0 (0.0 - 1.0)		2.0 (1.0 - 3.0)			
First 4 hours		0.776		0.427		**<0.001***
Mean ± SD	0.61 ± 0.66		2.78 ± 1.20		38.00*	
Min - Max	0.0 - 2.0		1.0 - 5.0			
Median (IQR)	1.0 (0.0 - 1.0)		3.0 (2.0 - 4.0)			
8 hours		0.289		**0.043***		**<0.001***
Mean ± SD	1.04 ± 0.71		3.96 ± 0.71		0.00*	
Min –Max	0.0 - 2.0		3.0 -5.0			
Median (IQR)	1.0 (1.0 -1.50)		4.0 (3.50- 4.0)			
12 hours		**0.024***		**0.001***		**<0.001***
Mean ± SD	1.70 ± 0.63		4.65 ± 0.71		0.00*	
Min – Max	1.0 — 3.0		4.0 - 6.0			
Median (IQR)	2.0 (1.0 — 2.0)		5.0 (4.0 -5.0)			
16 hours		**0.005***		**<0.001 ***		**<0.001***
Mean ± SD	2.04 ± 0.64		6.04 ± 0.93		0.00*	
Min –Max	1.0 — 3.0		4.0 — 8.0			
Median (IQR)	2.0 (2.0 — 2.0)		6.0 (5.50 -7.0)			
20 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	2.61 ± 0.72		6.09 ± 0.85		0.00*	
Min - Max Median	2.0 — 4.0		5.0 -8.0			
(IQR)	2.0 (2.0 — 3.0)		6.0 (5.50 -7.0)			
24 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	3.04 ± 0.71		6.0 ± 1.17		15.00*	
Min –Max	2.0 - 4.0		3.0 - 8.0			
Median (IQR)	3.0 (3.0 - 3.50)		6.0 (5.50 - 7.0)			
28 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	3.17 ± 0.49		6.43 ± 0.90		0.00*	
Min- Max	2.0 - 4.0		5.0 -8.0			
Median (IQR)	3.0 (3.0 - 3.0)		6.0 (6.0 - 7.0)			
32 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	3.57 ± 0.51		6.65 ± 0.88		0.00*	
Min - Max.	3.0 - 4.0		5.0 - 8.0			
Median (IQR)	4.0 (3.0 - 4.0)		7.0 (6.0 - 7.0)			
36 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	4.39 ± 0.50		6.43 ± 1.41		31.500*	
Min - Max	4.0 - 5.0		5.0 - 9.0			
Median (IQR)	4.0 (4.0 - 5.0)		6.0 (5.0 - 7.50)			
40 hours		**<0.001 ***		**<0.001 ***		**<0.001***
Mean ± SD	4.96 ± 0.71		6.48 ± 0.85		53.00*	

Min - Max	4.0 - 6.0		5.0 - 8.0			
Median (IQR)	5.0 (4.50 - 5.0)		7.0 (6.0 - 7.0)			
44 hours		**<0.001***	5.65 ± 1.34	**<0.001***	259.00	0.898
Mean ± SD	5.39 ± 0.66		4.0 — 8.0			
Min - Max	4.0 - 6.0		5.0 (5.0 — 7.0)			
Median (IQR)	5.0 (5.0 - 6.0)					
48 hours		**<0.001***		**0.004***		**<0.001***
Mean ± SD	6.17 ± 0.72		4.43 ± 1.16		464.00*	
Min - Max.	5.0 - 7.0		3.0 - 7.0			
Median (IQR)	6.0 (6.0 - 7.0)		4.0 (4.0 - 5.0)			

U: Mann Whitney test ,SD: Standard deviation ,IQR: Inter quartile range. p: p value for comparing between the two studied groups p_0: p value for Post Hoc Test (Dunn's) for Friedman test for comparing between At PACU and each other period . *: Statistically significant at $p \leq 0.05$

Table 4: Comparison between the two studied groups according to rescue analgesia (hours)

Rescue analgesia (hours)	Group A (n = 23)	Group B (n = 23)	U	p
Min -Max	24.0 - 36.0	4.0 - 12.0		
Mean ± SD	31.57 ± 4.35	7.24 ± 2.72	0.00*	<0.001*
Median (IQR)	32.0 (28.0 - 36.0)	8.0 (4.0 - 8.0)		

U: Mann Whitney test, SD: Standard deviation, IQR: Inter quartile range, p: p value for comparing between the two studied groups *: Statistically significant at $p \leq 0.05$

Table 5: Comparison between the two studied groups according to adverse events

Adverse events	Group A (n = 23)		Group B (n = 23)		χ^2	p
	No.	%	No.	%		
Nausea	7	30.4	6	26.1	0.107	0.743
Hypotension	8	34.8	7	30.4	0.099	0.753

c2: Chi square test p: p value for comparing between the two studied groups

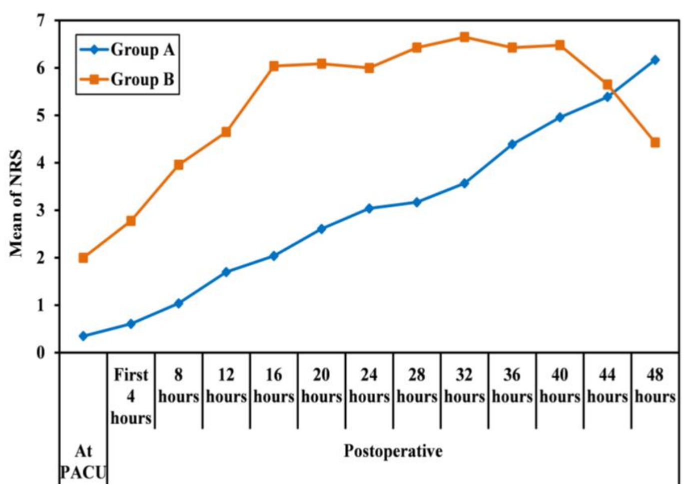

Figure 1: Comparison between the two studied groups according to NRS

Discussion

The EOI block represents an important modification and iterative advancement of fascial plane block techniques that may consistently cover the upper lateral abdominal wall. The EOI block has easily identifiable sonographic landmarks, can be performed with the patient in the supine position, and has needle/catheter insertion sites that are more distant from the site of surgery than those used in previously described techniques (9).

In the current study, there was no statistically significant difference between the two study groups regarding sex, age, BMI, type of operation & duration of surgery.

In alignment, Korkusuz et al., (10) performed a randomized controlled trial to investigate tramadol intake in the first 24 hours post-surgery, pain scores, and quality of recovery after bilateral external oblique intercostal plane block (EOIPB) in patients undergoing laparoscopic cholecystectomy. They found no statistically significant difference between the two study groups regarding sex, age, BMI, and duration of surgery.

There was a statistically significant difference between the two study groups regarding intraoperative fentanyl consumption, which was significantly lower in EOI plane block group than control group (P<0.001). Moreover, there was a statistically significant difference between the two study groups regarding intraoperative hemodynamics, MAP and HR were significantly lower in group A than group B, P<0.001 and P<0.005, respectively.

Randomized controlled prospective comparative study reported that intraoperative HR showed significant difference at T3 (end of surgery) only, while intraoperative MAP at T2 (20 minutes after doing the block) and T3 (end of surgery) only, in which EOI plane block group had lower measurements. Also, they noted that EOI plane block group had significantly lower total intraoperative fentanyl consumption (11).

Furthermore, there was a statistically significant difference between the two study groups regarding postoperative pain assessment using NRS at PACU, that was lower in group A than group B (P<0.001). And there was a statistically significant difference between the two study groups regarding post-operative pain. Overall, there was a statistically significant difference between the two studies regarding postoperative pain assessment using Numeric rating scale at first 48 hours postoperative, being lower in group A than group B.

In coherence with our results, a previous randomized controlled prospective comparative study by Yahya et al., (11) stated that postoperative pain (VAS-10) in the first 12 hours was highly significantly lower in EOI plane block group compared to pre-incisional local infiltration group.

Another recent a prospective, randomized, controlled, patient and observer-blinded study tested whether EOI block would reduce IV morphine consumption within 24 h after laparoscopic sleeve gastrectomy. They found that NRS scores at rest and during movement were lower in the EOI block group than in the control group at 2, 6, and 12 h but were similar at 24 h (12).

Our results showed a statistically significant difference between the two study groups regarding first rescue analgesia. It was early postoperative in group B than group A (P<0.001). Regarding adverse events in the present study, there was no statistically significant difference between the two study groups regarding adverse events such as nausea & hypotension.

A randomized controlled prospective comparative study found that total postoperative 12-hour morphine consumption (mg/kg) was statistically significantly higher in pre-incisional local infiltration group than EOI plane block group. In addition, intraoperative and postoperative side effects showed no statistically significant difference between the two groups (11).

Our results can be illustrated by the mechanism of EOI plane block itself as conducted previous cadaveric study and retrospective cohort study assessing the potential analgesic effect of the EOI block. The authors demonstrate the potential mechanism of this technique with a cadaveric study that shows consistent staining of both lateral and anterior branches of intercostal nerves T7– T10. Patients who received this block exhibited consistent dermatomal sensory blockade of T6–T10 at the anterior axillary line and T6–T9 at the midline. So, they concluded that this block can be used in multiple clinical settings for upper abdominal wall analgesia (13).

Efficacy of EOI plane block was further supported by a pilot study in ten healthy volunteers their results indicated that novel external oblique muscle plane blocks involving local anesthetic injection superficial to the external oblique muscle efficiently anesthetize the lateral cutaneous branches of the thoracoabdominal nerves. Their study shows that it may be anatomically plausible for the combined use of these blocks to anesthetize the entire abdominal wall (14).

Conclusion

The External Oblique Intercostal Block is an effective anesthetic technique that can be used in major upper abdominal surgeries to reduce post-operative pain including delayed time of 1st rescue analgesia and decreased total opioid consumption.

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