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Efficacy of Ultrasound-Guided External Oblique Intercostal Plane Block for Patients Undergoing Upper Abdominal Surgeries: A Randomized Controlled Trial

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ABSTRACT

Background: Myofascial plane block has recently replaced central neuraxial analgesia as the preferred method of effective, opioid-sparing pain treatment. The use of external oblique intercostal (EOI) nerve blocks to treat postoperative pain has increased recently because they can relieve pain in the upper midline and upper lateral abdominal wall.

Objectives: To evaluate the effect of external oblique intercostal plane block (EOIPB) on the postoperative pain that was evaluated by visual analogue pain scale (VAS) as a primary objective. Time to first rescue analgesia, 24 hours' postoperative consumption of analgesia, perioperative hemodynamics, postoperative anesthetic care unit (PACU) stay, patient satisfaction, and postoperative complications were the secondary objectives.

Patients and Methods: This prospective and randomized controlled study was conducted on fifty patients with ASA I and II, aged ≥ 20 to ≤ 70 years, scheduled for upper abdominal surgeries. Patients were divided equally into two groups, group (A) Patients received US-guided EOIB with 20 ml of 0.25% bupivacaine on each side after induction, and group (B) Patients received postoperative morphine on patient request.

Results: The EOIPB group showed a significantly lower VAS score than the control group at 0 time, 1h, 2h, 4h, 8h and 12h postoperatively ($p<0.001$), but there was no significant difference at postoperative 24h between the two groups ($p>0.05$). Postoperative 24-hour morphine consumption was significantly lower in the EOIPB group than in the control group (9.8±2.4 (6-15) mg vs. 19.4±2.7 (15-25) mg respectively, $P<0.001$). Similarly, the time until the first required analgesia was significantly longer in EOIPB group (8.1 ±0.8(7-9) vs. 4.1 ±0.8(3-5) in hours, respectively, $P<0.001$).

Conclusion: We concluded that EOIPB resulted in decreased postoperative pain, morphine, and fentanyl usage while increasing patient satisfaction.

Keywords: EOIPB, Postoperative pain, US-guided, VAS.

INTRODUCTION

Significant morbidity from discomfort after upper abdominal procedures results in inefficient coughing, which causes atelectasis [(1)].

The objectives of perioperative pain treatment are to reduce discomfort, facilitate early mobilization and discharge, and raise patient satisfaction. Opioid-based traditional pain therapy raises the risk of adverse events, including respiratory depression, oversedation, postoperative nausea and vomiting, and poor recovery outcomes. Consequently, in order to provide sufficient pain management with fewer opioid-related adverse effects, multimodal analgesia techniques are frequently used[(2)].

In order to provide sufficient postoperative analgesia, a variety of regional anesthetic and analgesia procedures are routinely used in ordinary practice under ultrasound supervision as part of multimodal analgesia[(3)]. Thanks to ultrasonography, interfascial plane blocks are now safer and simpler to execute. Numerous additional interfascial plane blocks have been described as a result of anatomic research and ultrasound guidance [(4)].

For upper midline and lateral abdominal wall analgesia, a published approach is the EOIPB [(5)]. In their cadaveric investigation, **Elsharkawy *et al.*** [(6)] provided consistent staining of the anterior and lateral branches of the intercostal nerves T7-T10, indicating the possible mechanism of this approach.

This work's objective was to evaluate the effect of EOIPB on postoperative pain after upper abdominal surgeries, evaluated by VAS score and 24 hours' postoperative morphine consumption.

PATIENTS AND METHODS

We conducted this prospective randomized controlled study at the Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine, Menoufia University.

The study was carried out in the operative theatres of Menoufia University Hospitals on 50 patients. They were randomized equally into two groups, group (A) external oblique intercostal plane block group in which patients received US-guided EOIPB with 20 ml of 0.25% bupivacaine on each side after general anesthesia and group (B) control group in which patients received only general anesthesia.

Inclusion criteria: Patients aged 20 to 70 years old with ASA physical status I or II; scheduled for upper abdominal operations.

Exclusion criteria: Refusal of the patients to give informed consent, history of allergy to local anesthetics, the presence of skin infection at the puncture site, preexisting coagulation disorders and history of alcohol or drug abuse.

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METHODS

Preoperative assessment: Every patient's preoperative evaluation involved a thorough history taking, a review of all test results, and a comprehensive clinical examination. Explanation of VAS and how to use to express pain severity after arousal from anesthesia was done.

Intraoperative assessment: On arriving in the operating room, a standard monitoring was linked to the patient (pulse oximetry, ECG, non-invasive arterial blood pressure, capnography) and various monitors depending on the circumstance.

Fentanyl 1 µg/kg (IV) was used to induce general anesthesia, followed by a sleeping dosage of propofol 2 mg/kg (IV) and atracurium 0.5 mg/kg. Tracheal intubation was completed. General anesthesia was maintained with mechanical breathing with O_2/air mixture with isoflurane (MAC 0.8:1.2).

During intraoperative anesthetic maintenance, if blood pressure or heart rate (HR) rose by more than 20% from baseline, intravenous morphine was administered to calm the patients' hemodynamics after ruling out other causes of sympathetic stimulation besides pain.

All patients got 1 g of intravenous paracetamol, 4 grams of ondansetron, and 8 mg of dexamethasone shortly after anesthesia induction.

EOI block technique:

The EOIP block was conducted after general anesthesia was administered and under standardized monitoring. **Elsharkawy *et al.*** [6] showed how to conduct the block with patients in a supine posture. Skin preparation was done with 10% povidone-iodine. The probe was protected with a sterile cover. A portable ultrasound equipment (SonoSite, superficial probe, 14-15 MHz, USA) was employed for block performance. The ultrasonic probe was positioned in a longitudinal parasagittal orientation at the 6th rib level, between the anterior axillary and midclavicular lines. The ribs, lungs, pleura, intercostal muscles, external oblique muscle, and subcutaneous tissue were seen in the image. A 22-G, 90-mm needle was inserted in an in-plane manner. The tip of the needle was inserted into the fascial plane on the deep aspect of the external oblique muscle. Following a negative aspiration, 20 milliliters of 0.25% bupivacaine were administered. The identical method was followed on the opposite side.

Recovery: At the end of the procedure, neuromuscular reversal was delivered by administering 0.05 mg/kg (IV) of neostigmine and 0.02 mg/kg (IV) of atropine. 100% oxygen was administered and tracheal extubation was done after fulfillment of the extubation criteria.

When the patient was completely aware and communicative, the pinprick approach was used to examine the dermatomal distribution of the extent of the blockade in order to determine the success or failure of the block. In case of failure, the patient was excluded from the study.

Measurements:

Preoperative: Demographic data such as age, gender, and BMI, hemodynamics (pulse-HR-mean BP) at baseline prior to anesthetic induction.

Intraoperative: Hemodynamics (HR - mean BP): These were recorded as soon as anesthesia was induced, then every 15 minutes until the procedure was completed, as well as the total amount of anesthetic and analgesic medication used throughout the procedure.

Postoperative: Hemodynamics (MAP and HR) were recorded after 15 min after extubation, then after 2, 4, 6, 12 and 24h of recovery time. Time of initial call for rescue analgesia, the VAS scores [7], during the following hours 0, 1, 2, 4, 8, 12, and 24 hours, PACU time, postoperative complications, total morphine consumption during the 24h postoperative period, time of first ambulation and patients' satisfaction with analgesia at the time of discharge was measured using a 5-point Likert scale as follows: (1=very dissatisfied, 2= dissatisfied, 3= mild satisfaction, 4= moderate satisfaction, 5= high satisfaction) [8].

Ethical approval:

This study was authorized by the Menoufia Medical Ethics Committee of the Menoufia Faculty of Medicine. All the participants signed written consent after being fully provided with all the necessary information regarding the study. The Helsinki Declaration was followed at every stage of the investigation.

Statistical analysis

Version 26.0 of the IBM SPSS software program was used to analyze the data statistically. Numbers and percentages were used to describe the qualitative data. The X^2-test and Fisher's exact test were employed to compare the qualitative data. Mean, standard deviation (SD), and range were used to describe the quantitative data. The quantitative data of normally distributed data was compared using the Student's t-test. The quantitative variables of non-normally distributed data were compared using the Mann-Whitney test. $P < 0.05$ was taken as the threshold for statistical significance.

RESULTS

The current study comprised fifty patients who were randomized evenly between the EOIPB and control groups. Both groups had comparable demographic characteristics and types of surgery (Table 1). Figure (1) revealed no significant difference between the EOIPB and control groups regarding type of operation ($p>0.05$).

Table (1): Demographic data and patients' clinical characteristics among the studied groups.

	Group A (n = 25)		Group B (n = 25)		Test of Significance	P
	No.	%	No.	%		
Gender: Male Female	 11 14	 44.0 56.0	 13 12	 52.0 48.0	χ^2= 0.32	0.571
ASA: I II	 12 13	 48.0 52.0	 14 11	 56.0 44.0	χ^2=0.32	0.571
Type of surgery: Lap cholecystectomy Sleeve Spleen	 19 5 1	 76.0 20.0 4.0	 17 6 2	 68.0 24.0 8.0	χ^2= 0.54	0.765
Age (years): Mean ± SD Range	51.7±16.5 23-70		51.4±14.8 23-70		t= 0.07	0.946
BMI (Kg/m^2): Mean ± SD Range	29.1±4.5 22-40		30.3±3.8 23-42		t= 1.00	0.324
Surgery duration (hours): Mean ± SD Range	1.21 ± 0.09 1-2		1.25 ± 0.07 1-2		t= 1.75	0.086

Group A: external oblique intercostal plane block group
Group B: control group

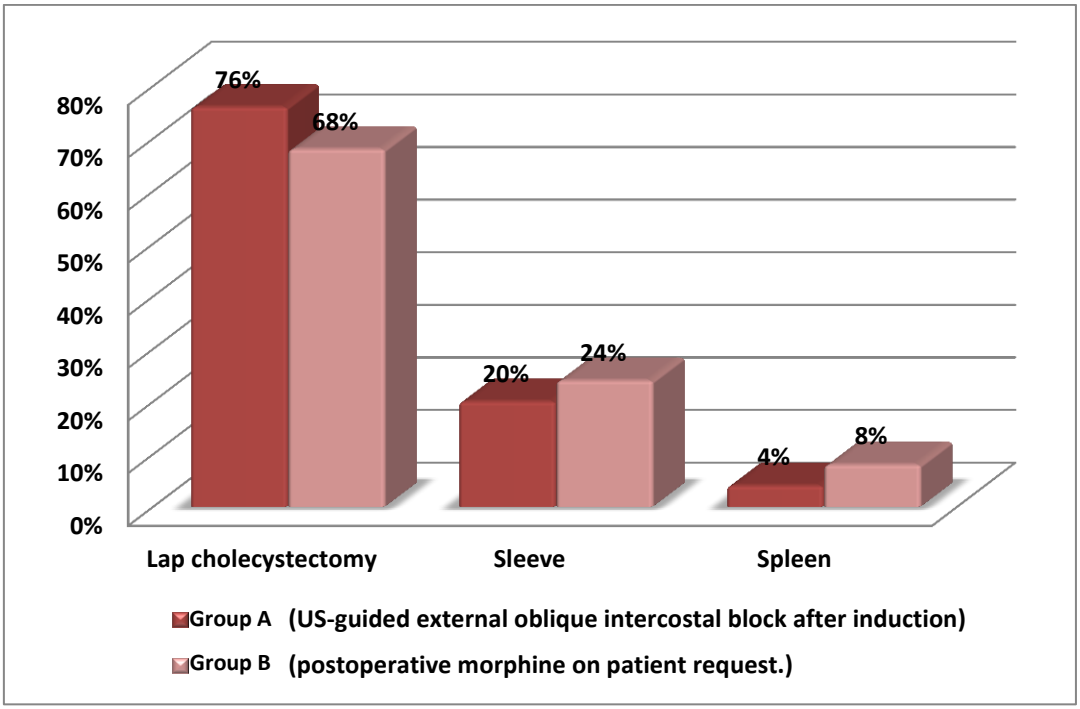

Figure (1): Type of surgery.

As regards our primary outcomes, the EOIPB group showed a significant lower VAS score than the control group at 0 time, 1h, 2h, 4h and 8h and 12 h postoperatively. But there was no significant difference at 24h between the two groups **(Table 2)**.

Table (2): Comparison between the studied groups regarding postoperative VAS score

	Group A (N=25)	**Group B (N=25)**	**Student t test**	**P-value**
	Mean ± SD Range	Mean ± SD Range		
Postoperative 0	1.6 ±0.7 1-2	2.0 ±0.5 1-3	**U** 2.32	**0.024***
Postoperative 1 hour	1.7 ±0.5 1-2	2.5 ±0.5 2-3	5.74	**<0.001***
Postoperative 2 hour	1.6 ±0.5 1-2	4.2 ±0.9 3-5	11.99	**<0.001***
Postoperative 4 hour	2.5 ±0.5 2-3	4.4 ±0.7 3-6	11.04	**<0.001***
Postoperative 8 hour	3.5 ±0.5 3-5	4.5 ±0.5 4-6	7.21	**<0.001***
Postoperative 12 hour	4.0 ±0.7 3-6	4.6 ±0.8 4-7	2.82	**0.007***
Postoperative 24 hour	4.3 ±0.8 4-7	4.7 ±0.7 5-7	1.88	0.066

* Significant
Group A: External oblique intercostal plane block group; Group B: Control group

The first call for rescue analgesia was significantly longer in EOIPB group in hours, while the postoperative 24h morphine consumption was significantly lower in EOIPB group than the control group **(Table 3)**.

Table (3): Comparison between the two studied groups regarding 1st 24 postoperative morphine consumption (mg) and first call for rescue analgesia (hours).

	Group A (N=25)	**Group B (N=25)**	**Student t test**	**P-value**
	Mean ± SD Range	**Mean ± SD Range**		
1st 24 hours postoperative morphine consumption (mg)	**9.8±2.4 6-15**	**19.4±2.7 15-25**	**13.22**	**<0.001***
First call for rescue analgesia (hours)	**8.1 ±0.8 7-9**	**4.1 ±0.8 3-5**	**17.57**	**<0.001***

* Significant
Group A: External oblique intercostal plane block group; Group B: Control group

There was a statistically significantly lower MAC and less fentanyl consumption in group A than group B **(Table 4)**.

Table (4): Comparison between the studied groups regarding anesthetic consumption

	Group A (N=25)	**Group B (N=25)**	**Student t test**	**P-value**
	Mean ± SD Range	Mean ± SD Range		
MAC	1.0 ±0.1 0.8-1.2	1.6 ±0.3 1.2-2.0	8.74	**<0.001***
Fentanyl consumption	110.0 ±20.4 100-150	165.0 ±27.9 125-200	7.95	**<0.001***

* Significant
Group A: External oblique intercostal plane block group; Group B: Control group

There was highly statistically significant more patient satisfaction in group A than group B (p-value <.001) **(Figure 2)**.

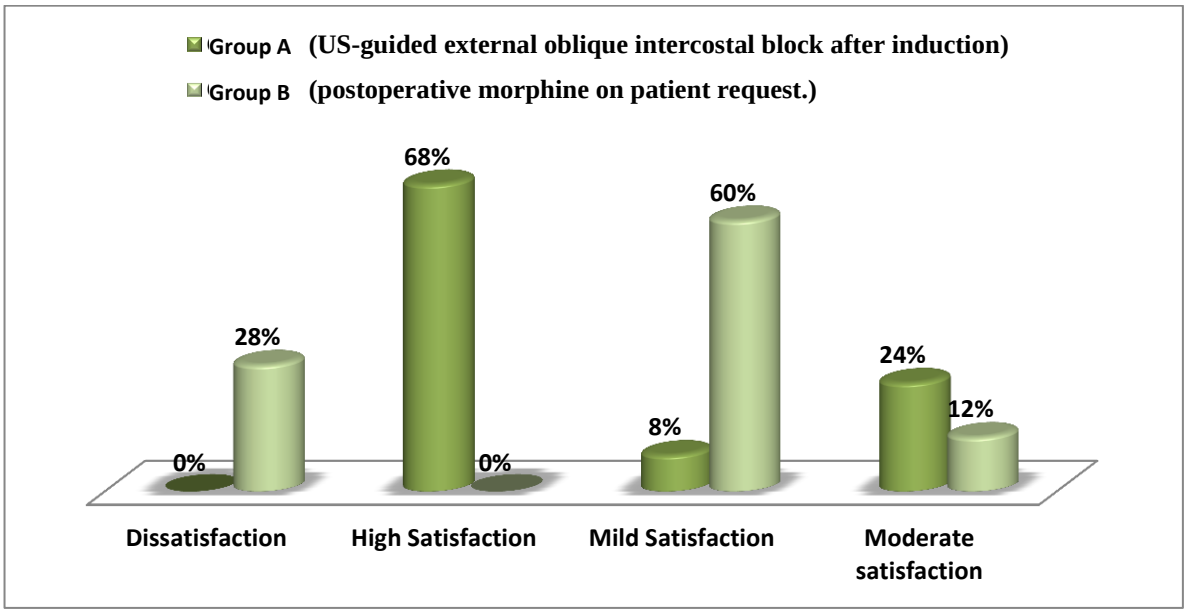

Figure (2): Patient satisfaction in the studied groups.

Our study revealed statistically significant difference between the two studied groups regarding postoperative nausea and vomiting **(Table 5)**. None of the patients experienced any block-related complications such as infection at the injection site, bleeding, nerve injury, pneumothorax, and local anesthetic toxicity.

Table (5): Comparison between the studied groups regarding complications

	Group A (N=25)		Group B (N=25)		Fisher's Exact test	P-value
	N	%	N	%		
Nausea:						
Yes	3	12.0	9	36.0	3.95	**0.047***
No	22	88.0	16	64.0		
Vomiting:						
Yes	-	-	6	24.0	6.82	**0.022***
No	25	100.0	19	76.0		
Hematoma:						
Yes	3	12.0	-	-	3.19	0.074
No	22	88.0	25	100.0		
itching:						
Yes	3	12.0	-	-	3.19	0.074
No	22	88.0	25	100.0		

*: Fisher's exact test was used for comparison
Group A: External oblique intercostal plane block group; Group B: Control group.

DISCUSSION

Large abdominal surgeries involving incisions in the upper abdomen result in excruciating pain in the abdomen, which, if left untreated, can have serious respiratory consequences such as hypoxia, hypoventilation, and basal lung atelectasis because of pain, secretion retention, and resistance to physical therapy. This causes a delay in recovery and raises the rate of postoperative morbidity. So adequate analgesia in upper abdominal surgeries carries more significance than patient comfort [1,9].

While multimodal analgesia and improved recovery protocols have made epidural analgesia less effective in controlling pain, it is still the preferred method for major abdominal surgery. However, epidural analgesia carries significant risks, including hypotension, and may not always provide meaningful differences in pain management [10–12].

As an alternative to neuraxial approaches, ultrasound-guided fascial plane blocks have been quickly adopted into regional anesthetic practice in recent years. These blocks include injection into a tissue plane to deliver analgesia in diverse anatomic locations [4,13]. Additionally, they are crucial in the opioid-sparing analgesia that follows abdominal surgery.

A unique block known as EOIPB has been characterized as a significant alteration to fascial plane

blocks that can reliably include the upper lateral abdominal walls [5–6]. For upper abdominal wall analgesia, **Hamilton *et al.*** [5] originally reported EOI block. They subsequently used dyes in a cadaveric investigation to assess drug diffusion following the EOIPB, supporting their theory. Since then, there are very few studies demonstrating and comparing its analgesic efficacy. Those studies are limited to case series and case reports.

Elsharkawy *et al.* [6] introduced EOIPB as a block that offers analgesia to the upper midline and lateral abdominal wall. Using the intercostal nerves T7–T10's anterior and lateral branches dyed, they were able to illustrate the likely cause of the block. Additionally, a dermatomal sensory block is provided by this block at the T6-T9 level in the midline and the T6-T10 level in the anterior axillary area.

White *et al.* [14] in 2022 in their case series of 2 obese patients undergoing upper abdominal surgeries administered bilateral EOI block using 0.2% ropivacaine 20 ml and found EOI provided effective analgesia.

Liotiri *et al.* [15] in 2023 in their case series of 3 patients undergoing liver surgeries administered bilateral EOI block using 0.375% ropivacaine 20 ml with 75 mcg clonidine and found reduced postoperative pain scores and opioid requirements.

Our study found that there was a statistically significant lower VAS score at different intervals in group A than group B (p value <0.001). Explaining the efficacy of EOIPB at pain management.

Also, in our study we noticed that group A had a lower analgesic demand for postoperative pain than group B. The 24 hours morphine consumption was significantly lower in the EOIP block group when compared to the control group (P value <0.001). It provided a significantly longer time for the first required analgesia compared to the control group (P value <0.001).

Our findings concurred with those of **Nagar and Palem** [16], whose study involved sixty patients scheduled for open cholecystectomy and divided into two groups at random to receive standard general anesthesia: Patients in Group E had unilateral EOIN block with 30 milliliters of 0.375% ropivacaine and 8 milligrams of dexamethasone. Patients in Group S had unilateral SAP block with 30 milliliters of 0.375% ropivacaine and 8 milligrams of dexamethasone. They noticed that group E had a lower VAS score than group S during the first, second, fourth, sixth, and twelfth hours following surgery. In comparison to group S, group E had a shorter initial rescue analgesia period and used fewer rescue analgesic doses [16].

As well **Korkusuz *et al.*** [17], who tramadol consumption during the first day following surgery was assessed. Eighty adult patients scheduled for laparoscopic cholecystectomy participated in the trial, and they were randomly assigned to one of two groups (with and without EOIPB). The study revealed that the EOIPB group consumed considerably less tramadol (0 [0, 50] mg) at 24 hours compared to the control group (50 [50, 100] mg) (median difference -50) (p<0.001). They also demonstrated that postoperative PACU pain scores of patients underwent EOI block from the 15th minute to the 24th hour was significantly lower than control group.

Similarly, our findings in line with **Coşarcan *et al.*** [18], who retrospectively compared patients undergoing bariatric surgery who got different fascial blocks against those who did not get any block. The rectus sheath block (TAP+RB), ESPB, and EOIPB were all shown to reduce morphine use in that trial, although TAP+RB and EOIPB appeared to be the most successful blocks. EOIPB was administered to 15 patients using 30 ml 0.25% bupivacaine.

In research by **Samtani *et al.*** [19]**,** 30 patients who were randomly assigned to two groups were asked to assess the analgesic effectiveness of EOIPB against erector spinae plane block for patients having laparoscopic cholecystectomy. Group I (EOI block, n=15) and Group II (ESP block, n=15). After administration of general anesthesia, ultrasound guided blocks were given bilaterally using 0.125% bupivacaine 50 ml with dexamethasone 4 mg (25 ml/side). They found EOI provided effective analgesia and reduced opioid analgesic requirements. It also provided benefits including technical simplicity and reduced time to perform the block in EOI group as compared to ESP group.

Other supportive results have been reported from the study of **Doymus *et al.*** [20]**,** which was done as comparison of EOIPB and local anesthetic infiltration of port site for postoperative analgesia in LSG. It was a prospective randomised controlled study conducted in patients undergoing LSG. The surgeon administered 5 ml of 0.25% bupivacaine at each port site to the patients in the PSI Group (n = 30), and 30 ml of US-guided EOIPB 0.25% bupivacaine to the patients in the EOI Group (n = 30). The EOI group's VAS ratings were significantly lower than the PSI group's at the PACU, 1, 2, 4, 8, and 12 hours after surgery (p<0.05). The EOI group consumed fentanyl at a lower rate than the PSI group throughout a 24-hour period (505.83±178.56 vs. 880.83±256.78 μg, respectively, p<0.001). The PSI group experienced more rescue analgesia than the EOI group (26/30 vs. 14/30, respectively, p=0.001).

Also, in a study of **Kavakli *et al.*** [21]**,** study enlisted 60 patients who were scheduled for LSG and found that the EOI block group (bilateral with a total of 40 ml 0.25% bupivacaine) used considerably less morphine over the course of 24 hours than the control group (7.5 [3.5 to 8.5] mg vs. 14 [12 to 20] mg, p=0.0001, respectively). At 2, 6, and 12 hours, the EOI

block group's numerical rating scale (NRS) ratings were lower than those of the control group at rest and during movement, but they were equivalent after 24 hours.

In a study by **Hammad *et al.*** [22], which compared the effectiveness of EOI block using bupivacaine to pre-incisional local infiltration with local anesthetic agent (bupivacaine and lidocaine) on the management of acute and intraoperative pain in adult bariatric surgery patients. A total of 72 patients were randomly assigned to two groups: group A and group B. Group A (n = 36) received 29 ml of 0,25% bupivacaine and 1% lidocaine and Group B (n=36) received pre-incisional local infiltration with a local anesthetic agent using mixture of (0.25% bupivacaine and 1% lidocaine). The authors documented a significant decrease in fentanyl consumption and reduced postoperative pain score (VAS) and morphine consumption in the first 12 hours after surgery in the EOIPB group compared to the preincisional local infiltration of wound sites.

On the other hand, when comparing the EOIP group with the control group in research by **Kusderci *et al.*** [23], it was discovered that the EOIP group had much greater cumulative tramadol intake at all time intervals, with the exception of the 1st hour ($p<0.001$).

Regarding MAP and HR at different follow-up periods, our research demonstrated that, with the exception of baseline HR and the immediate post-induction period after surgery, there was a statistically significant difference in HRs between the groups under investigation at various intervals.

It also shows that there was a statistically significant difference between studied groups regarding their MAPB at different intervals except at baseline, immediately after induction, 75 minutes intra-operatively.

Hammad *et al.* [22] reported a significantly lower intraoperative heart rate and MAP in the EOIPB group compared to group received pre-incisional local infiltration with a local-anesthetic agents.

Regarding complications and side effects, the results of the current investigation showed that there was a statistically significant difference in nausea and vomiting across the groups under examination. Because postoperative opioid usage raises the incidence of PONV in a dose-dependent way, it is possible that this increase in the number of patients with PONV in the control group is due to this factor. Opioids cause distension, induce vomiting, and delay stomach emptying by lowering muscular tone and peristaltic activity [24].

Kavakli *et al.* [21], documented that EOIPB decreased the postoperative nausea and vomiting compared to the control group but not to a significantly different level**.** This might be explained by employing a multimodal strategy in two groups that included antiemetic prophylaxis with a combination of dexamethasone and ondansetron [21].

None of the patients in our study experienced any block-related complications, such as infection at the injection site, bleeding, nerve injury, pneumothorax, or local anesthetic toxicity.

Consistent with our research, the research by **Kavakli *et al.*** [21], stated that no block-related problems were seen. EOI block is probably low-risk because it is a superficial plane block method. Like other peripheral blocks, the EOI block has some risk. These concerns include bleeding, infection, and hematoma at the injection site, as well as local anesthetic toxicity from systemic absorption of the local anesthetic. The possibility of pneumothorax should also not be disregarded because EOIB is in close proximity to the lungs [25].

Regarding patient satisfaction, our study shows that there was a statistically significant difference between the two studied groups regarding patient satisfaction which is more in Group A (p value <0.05).

Selim *et al.* [26] studied the efficacy of unilateral external oblique intercostal fascial plane block versus subcostal TAP Block in laparoscopic cholecystectomy. In this prospective randomised study, the patients were divided into two groups; external oblique intercostal nerve block (Group EOIB) and oblique subcostal transversus abdominis plane block (Group OSTAP). After surgery, EOIB or OSTAP block was administered with 20 mL of 25% bupivacaine.

They documented that EOIB and OSTAP blocks showed similar patient satisfaction scores.

Limitations of our study:

First, more meta-analysis is required because the sample size was limited. The fact that suggested local anesthetic volumes and dosages for EOIPB were still unknown constituted a second constraint. Therefore, each side received 20 milliliters (0.25%) of bupivacaine. Thirdly, the absence of visceral analgesic coverage of EOIPB, like other fascial blocks, is a restriction. This implies that the visceral component of postoperative pain may be the reason for EOIPB's inability to provide a minimally clinically meaningful change.

CONCLUSIONS

The present study examined the impact of EOIPB on postoperative pain as measured by visual VAS. We concluded that EOIPB resulted in decreased postoperative pain, morphine, and fentanyl usage while increasing patient satisfaction.

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