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# Ultrasound-Guided External Oblique Intercostal Fascial Plane Block for Postoperative Analgesia

**Maged Salah Mohamed, Ahmed Abd Elmohsen Bedewy, Ahmed Mohamed Zain *, Moataz Salah Khalil**
Anesthesia, ICU and Pain management Department, Faculty of Medicine, Helwan University, Egypt.
***Corresponding author: Ahmed Mohamed Zain, Mobile**: (+20) 1155114580 E-mail**:** Ahmed_younis@med.helwan.edu.eg

## ABSTRACT

**Background:** After abdominal wall surgery, improved recovery largely depends on effective postoperative analgesia. Currently, there is no clinical data to support the clinical efficacy of ultrasound-guided external oblique intercostal fascial plane block (EOIPB), a novel regional anesthesia technique that provides anterior and lateral abdominal wall analgesia.

**Objectives:** This study aimed to evaluate the analgesic efficacy and safety of ultrasound-guided EOIPB in patients undergoing paraumbilical hernioplasty.

**Patients and Methods:** This prospective single-arm study included 30 adult patients (ASA physical status I–II) scheduled for elective paraumbilical hernioplasty under general anesthesia. All patients received bilateral ultrasound-guided EOIPB with 20 mL of local anesthetic on each side (10mL 0.5% bupivacaine, 5mL 2% lidocaine, and 5 mL of normal saline). Postoperative analgesia consisted of paracetamol and ketorolac, with morphine administered if the Numeric Rating Scale (NRS score) exceeded 3. The primary outcomes included 24-hour morphine consumption; secondary outcomes were serial NRS pain scores at rest and during coughing, hemodynamic parameters, and the incidence of postoperative nausea and vomiting (PONV).

**Results:** Patients maintained low pain scores at rest and during coughing with significant improvement over time. The mean cumulative morphine requirement was 10.3 ± 4.0 mg in the first 24 hours, while intraoperative fentanyl consumption averaged 48.0±20.6 µg. Hemodynamic parameters demonstrated significant but clinically acceptable variability, with transient reductions in heart rate and mean arterial pressure observed during the early postoperative period. PONV occurred in 5 patients (16.7%), all of whom were managed successfully with antiemetics.

**Conclusion:** Ultrasound-guided EOIPB is a safe and effective technique for postoperative analgesia following paraumbilical hernioplasty. It provides sustained pain relief, reduces opioid consumption, maintains hemodynamic stability, and is associated with a low incidence of complications.

**Keywords:** External Oblique Intercostal Fascial Plane Block; Paraumbilical hernioplasty; Postoperative analgesia; Opioid consumption

## INTRODUCTION

Effective postoperative analgesia is still a key component of improved recovery protocols in the field of abdominal surgery. Abdominal field blocks have been employed for more than a century, initially described by Schleich in 1899 [(1)]. These techniques have evolved from multiple landmark-based injections in the 1980s [(2)], to simplified single-injection approaches in the 1990s [(3)], and more recently to ultrasound-guided methods with catheter placement for continuous analgesia since 2007 [(4)]. Ultrasound guidance in regional anesthesia provides several advantages, including higher success rates, faster onset, reduced local anesthetic requirements, and fewer complications [(5)]. It also allows real-time visualization of needle trajectory and anesthetic spread, improving both safety and efficacy. This has increased clinical use of new fascial plane blocks, especially the Rectus Sheath Block and the External Oblique Intercostal (EOI) Fascial Plane Block [(6)].

In order to consistently produce sensory blockage spanning T6–T10 at the anterior axillary line and T6–T9 at the midline, the EOI fascial plane block seeks to anesthetize the lateral and anterior cutaneous branches of the intercostal nerves from T7 to T10 [(7)]. As a novel superficial plane technique for upper abdominal surgery, it offers favorable safety compared to neuraxial or deep plane blocks. It is particularly advantageous in anticoagulated and obese patients, and in those unable to tolerate complex positioning [(8,9)]. Its superficial, compressible location away from major vascular structures also makes it suitable for catheter-based continuous analgesia.

The purpose of this study was to assess the safety and analgesic effectiveness of external oblique fascial plane block guided by ultrasonography for postoperative pain management after paraumbilical hernioplasty.

## PATIENTS AND METHODS

This prospective single-arm study included 30 adult patients (ASA physical status I–II) scheduled for elective paraumbilical hernioplasty under general anesthesia, attending at Helwan University Hospitals between May 2023 and April 2024.

### Sample Size

A convenience sample of 30 patients was recruited to provide preliminary estimates of the efficacy and safety of ultrasound-guided external oblique intercostal (EOIPB) fascial plane block in the context of postoperative pain management. This sample size was considered adequate for exploratory analysis



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and hypothesis generation for future larger-scale studies.

**Inclusion criteria:** Patients scheduled for elective paraumbilical hernioplasty, classified as American Society of Anesthesiologists (ASA) physical status I or II, and aged 18 to 65 years were included.

**Exclusion criteria:** Patients with known allergies to local anesthetics, chronic opioid use, pregnancy, infection at the intended injection site, and coagulopathy (defined as any disorder of hemostasis associated with abnormal bleeding or thrombosis).

**Anesthetic Technique**

All patients underwent standardized general anesthesia. Non-invasive blood pressure monitoring, electrocardiography, capnography, and pulse oximetry were all used. In accordance with institutional procedure, premedication included intravenous midazolam (1–2 mg) and antimicrobial prophylaxis. Propofol (2–3 mg/kg), fentanyl (1–2 μg/kg), and atracurium (0.6 mg/kg) were used to induce induction. Sevoflurane was administered for maintenance at a minimum alveolar concentration of 2%. If the mean arterial pressure or heart rate rose more than 20% from the baseline, more fentanyl (0.5 μg/kg) was given intraoperatively. There was no local infiltration at the operative site.

**External Oblique Intercostal Fascial Plane Block**

Approximately fifteen minutes before the surgical incision, patients received bilateral ultrasound-guided EOI fascial plane blocks after induction of general anesthesia. Along the anterior midaxillary line, a high-frequency linear ultrasound probe was positioned longitudinally at the sixth intercostal space. Using an in-plane approach, a 10-cm, 21-gauge needle deep into the fascial plane to the external oblique muscle. Following negative aspiration, each side received an injection of 20 mL of a local anesthetic solution, which included 10 mL of 0.5% bupivacaine, 5 mL of 2% lidocaine, and 5 mL of normal saline. The process was carried out in the contralateral direction.

**Postoperative Analgesia Protocol**

Intravenous paracetamol (1 g) and ketorolac (30 mg) were administered to all patients prior to surgery. Intravenous morphine (0.03–0.15 mg/kg) was given after surgery if the NRS pain score exceeded 3/10. with a maximum bolus dose of 15 mg and a maximum daily dose of 120 mg. Paracetamol 1 g every 8 hours was continued unless the NRS was <2 or the patient declined further doses.

**Pain and Hemodynamic Assessment**

The 11-point NRS (0 = no pain, 10 = worst imaginable pain) was used to measure the level of pain during rest and coughing at 20 and 40 minutes after surgery, as well as at 1, 3, 6, 9, 12, 18, and 24 hours. Hemodynamic factors, such as mean arterial pressure and heart rate were recorded at baseline, intraoperatively at 15-minute intervals, and postoperatively at the same predefined time points up to 24 hours.

**Outcome Measures**

- **Primary outcome:** Total amount of morphine administered intravenously (mg) during the first 24 hours following surgery.
- **Secondary outcomes:**
  - NRS pain ratings during rest and coughing at predetermined intervals.
  - Hemodynamic stability (mean arterial pressure and heart rate).
  - Postoperative nausea and vomiting (PONV) incidence and severity, measured on a 4-point scale (none, mild, moderate, severe).
  - Occurrence of shoulder pain.
  - Requirement for antiemetic therapy (ondansetron).

***Ethical Consideration*:**

**This study was ethically approved by Helwan University's Medical Ethics Committee. Written informed consent was obtained from all participants. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human subjects.**

***Statistical analysis***

SPSS version 22 (IBM Corp., Armonk, NY, USA) was used to analyze the data. Quantitative variables were expressed as mean ± standard deviation (SD) for normally distributed data or median (range) for non-normally distributed data, while qualitative variables were displayed as numbers and percentages. The Shapiro-Wilk test was used to check for normality. Within the EOI block group, changes in mean arterial pressure, heart rate, and pain levels over time were evaluated using repeated-measures ANOVA; a p-value $\leq 0.05$ was deemed statistically significant.

**RESULTS**

Table 1 demonstrates the baseline characteristics of enrolled patients. The cohort included both male and female participants with a mean age of 47 years and BMI in the overweight range.

**Table 1. Demographic and anthropometric characteristics of patients (n = 30)**

| Variable | Mean ± SD / n (%) |
|---|---|
| Age (years) | 47.0 ± 11.0 |
| Sex Male | 13 (43.3%) |
| Female | 17 (56.7%) |
| Weight (kg) | 79.73± 10.326 |
| Height (cm) | 166.5 ± 6.42 |
| BMI (kg/m²) | 28.82 ± 3.73 |

Table 2 shows that pain scores at rest remained consistently low during the first 24 hours postoperatively. Repeated measures analysis indicated a statistically significant overall change across time points ($p = 0.04$).

**Table 2. NRS pain scores at rest following surgery**

| Time point | Mean ± SD | p-value (RM-ANOVA) |
|---|---|---|
| 1 hour | 1.9 ± 1.0 | |
| 2 hours | 1.5 ± 0.9 | |
| 4 hours | 1.9 ± 1.0 | |
| 8 hours | 1.9 ± 1.2 | |
| 16 hours | 2.3 ± 1.4 | |
| 24 hours | 1.5 ± 0.9 | 0.04 (S) |

Table 3 shows that pain scores during coughing were higher compared with rest, particularly in the early postoperative hours, but progressively decreased by 24 hours. The decline over time reached statistical significance ($p < 0.05$).

**Table 3. NRS pain scores during coughing following surgery**

| Time point | Mean ± SD | p-value (RM-ANOVA) |
|---|---|---|
| 1 hour | 3.5 ± 1.8 | |
| 2 hours | 2.3 ± 1.4 | |
| 4 hours | 2.9 ± 1.4 | |
| 8 hours | 3.0 ± 1.5 | |
| 16 hours | 3.1 ± 1.5 | |
| 24 hours | 1.6 ± 1.5 | <0.05 (S) |

Table 4 shows that the effectiveness of the block in lowering the need for analgesics was demonstrated by the patients' comparatively low overall morphine consumption during the first 24 hours and their moderate intraoperative fentanyl use.

**Table 4. Postoperative opioid consumption (n = 30)**

| Variable | Mean ± SD |
|---|---|
| Total morphine consumption (mg/24h) | 10.3 ± 4.0 |
| Intraoperative fentanyl (µg) | 48.0 ± 20.6 |

Table 5 shows that a low incidence of PONV (16.7%) was observed, with most cases being mild to moderate and responsive to standard antiemetic therapy.

**Table 5. Postoperative nausea and vomiting (PONV) within 24h (n = 30)**

| PONV | n (%) |
|---|---|
| No | 25 (83.3%) |
| Yes | 5 (16.7%) |

Figure 1 illustrates the temporal trends of pain intensity over the first 24 hours. Patients reported consistently low scores at rest, while coughing was associated with higher but progressively declining pain scores.

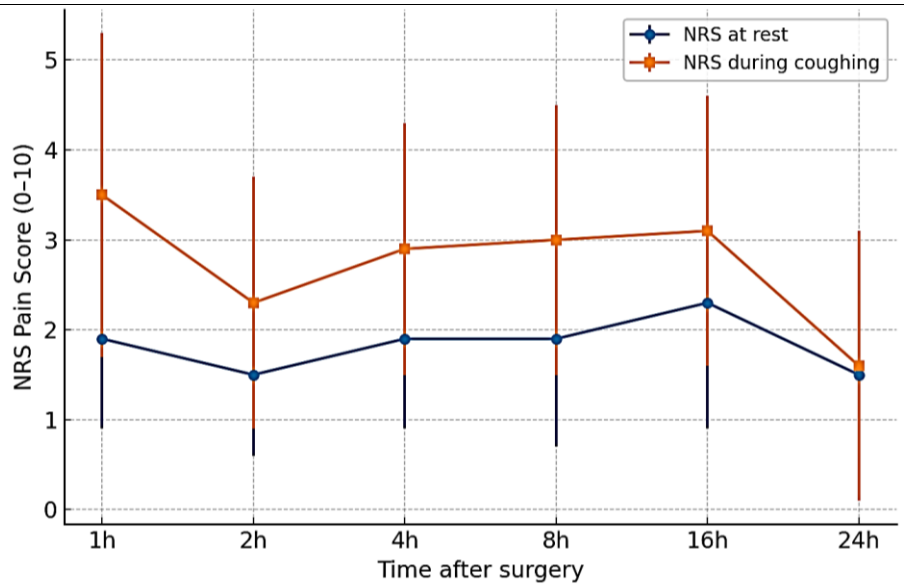


**Figure 1. Postoperative NRS pain scores at rest and during coughing**

This line graph shows perioperative heart rate fluctuations. A significant decline was observed during the first few postoperative hours, with stabilization thereafter as shown in figure 2.

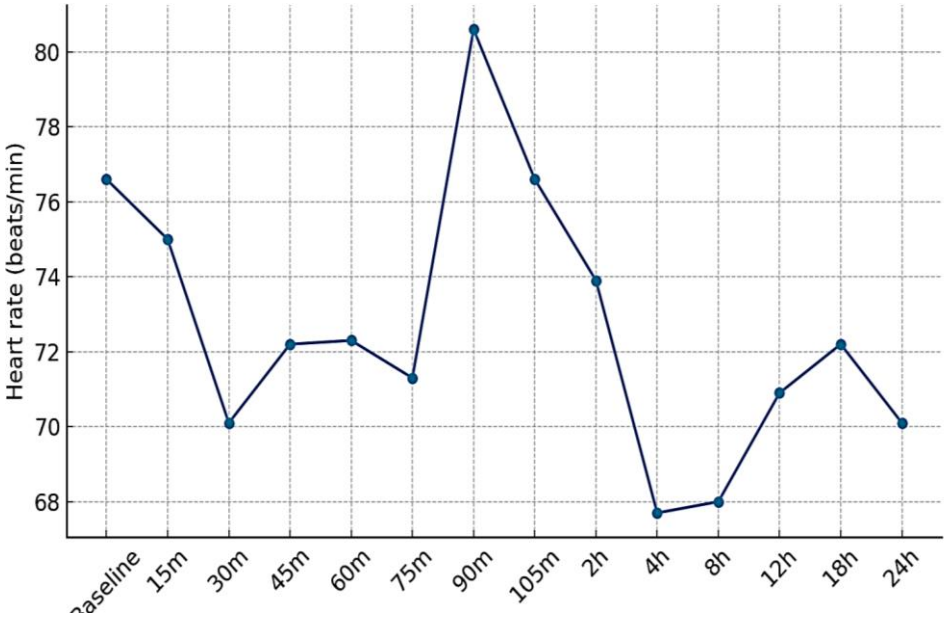


**Figure 2. Heart rate changes over time following EOI block**

Figure 3 depicts MAP trends during the perioperative period, demonstrating transient elevations early after surgery followed by gradual reduction, with statistically significant overall variability.

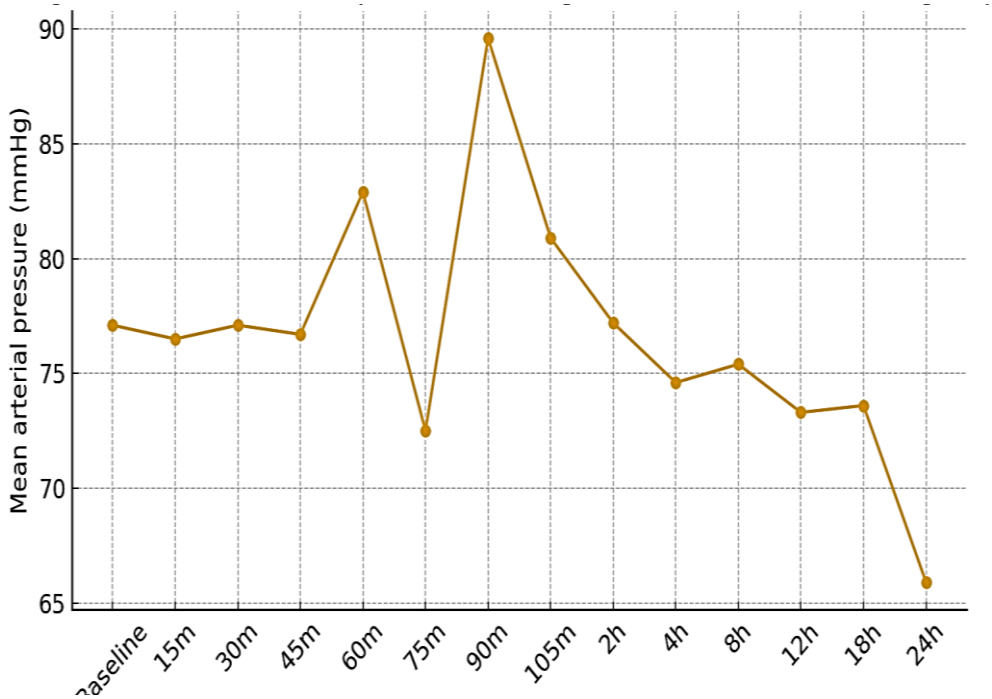


**Figure 3. Mean arterial pressure (MAP) changes over time following EOI block.**

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## DISCUSSION

In this prospective single-arm study, patients undergoing paraumbilical hernioplasty achieve effective postoperative analgesia following ultrasound-guided external oblique intercostal fascial plane block (EOIPB). Pain scores at rest remained consistently low during the first 24 hours, and although pain scores during coughing were higher, they showed a progressive decline over time, indicating sustained analgesic efficacy. Morphine consumption within the first 24 hours was modest (10.3 mg on average), intraoperative fentanyl requirements were low, and the incidence of postoperative nausea and vomiting (16.7%) was minimal and manageable with standard antiemetics. Hemodynamic parameters demonstrated significant changes at certain intervals but remained within clinically acceptable ranges, supporting both the efficacy and safety of the block.

Our findings were consistent with previous studies that confirmed the analgesic potential of EOIPB in abdominal surgery. **Gad *et al.* [10]** demonstrated that EOIPB resulted in lower morphine requirements compared with rectus sheath block in patients undergoing supra-umbilical surgical incisions. **Korkusuz *et al.* [11]** reported similar benefits in laparoscopic cholecystectomy patients, where EOIPB reduced pain scores and tramadol consumption compared to controls. **Petiz *et al.* [12]** successfully applied EOIPB in living donor nephrectomy, reporting low pain scores and suggesting that it may serve as an alternative to epidural analgesia in high-risk cases. Likewise, **White *et al.* [13]** described its utility in obese patients undergoing major abdominal procedures and emphasized its favorable safety profile.

The superiority of EOIPB was explained by its anatomical coverage. Unlike rectus sheath block, which primarily targets anterior branches of T7–T11 nerves, EOIPB blocks both anterior and lateral cutaneous branches of the intercostal nerves (T7–T10). **Elsharkawy *et al.* [14]** confirmed this through cadaveric staining studies, demonstrating broader dermatomal spread. This makes EOIPB particularly useful for transverse paraumbilical incisions, which extend beyond the rectus sheath and involve both anterior and lateral nerve branches. Such anatomical considerations explained the lower pain scores and reduced opioid consumption observed in this study. Similar observations were reported with transversus abdominis plane block, which has shown superiority to rectus sheath block in cesarean delivery incisions **[15].**

Hemodynamic stability observed in our study also reflected the block's efficacy in blunting the surgical stress response. **Amin *et al.* [16]** reported that patients receiving EOIPB demonstrated significantly lower MAP and HR compared with controls, while **Gad *et al.* [10]** confirmed reduced intraoperative fentanyl use, both findings consistent with our results.

The opioid-sparing effect observed in this study was of particular clinical importance. By reducing morphine and fentanyl requirements, EOIPB decreased opioid-related side effects such as nausea, vomiting, and respiratory depression, thereby improving recovery profiles. Similar outcomes were reported by **Gad *et al.* [10], Amin *et al.* [16],** and **Korkusuz *et al.* [11],** highlighting the role of EOIPB within multimodal analgesia protocols. In terms of PONV, the incidence in our study was low, consistent with **Amin *et al.* [16]** and **Kavakli *et al.* [17],** who found no significant increase in PONV with EOIPB compared to control groups.

The clinical implications of our findings were noteworthy. EOIPB was a superficial, compressible, and relatively safe block, making it advantageous in obese and anticoagulated patients, or when neuraxial anesthesia was contraindicated. Its ability to provide reliable coverage of the anterior and lateral abdominal walls made it particularly suitable for paraumbilical hernia repair and other upper abdominal surgeries.

## LIMITATIONS

This study's single-arm design without a concurrent control group, limited sample size, and single-center setting were some of its limitations that could restrict its generalizability. Pain assessment was limited to the first 24 hours, and longer-term outcomes such as chronic pain or functional recovery were not evaluated. Future research should focus on larger randomized controlled trials directly comparing EOIPB with other regional techniques such as rectus sheath block and transversus abdominis plane block. Studies assessing catheter-based continuous EOIPB for prolonged analgesia, as well as investigations in high-risk populations (e.g., obese or anticoagulated patients), are also warranted.

## CONCLUSION

Patients undergoing paraumbilical hernioplasty experienced safe and effective postoperative analgesia thanks to ultrasound-guided external oblique intercostal fascial plane block. The block is associated with low pain scores at rest and during coughing, reduced opioid consumption, stable hemodynamic parameters, and a low incidence of postoperative nausea and vomiting. These findings support the inclusion of EOIPB as an effective component of multimodal analgesia strategies for abdominal wall surgery. Further large-scale randomized controlled trials are needed to validate these results and explore their broader clinical applications.

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