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The impact of external oblique intercostal block on early postoperative pain and recovery in patients undergoing J-shaped incisions for upper abdominal surgery: a single-center prospective randomized controlled study

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Abstract

Background The aim of this study was to investigate the effects of external oblique intercostal nerve block (EOIB) on early postoperative pain and recovery in patients undergoing J-shaped incision surgery in the upper abdomen.

Methods Patients aged 18–85 years, classified as ASA I-III, undergoing elective open upper abdominal J-shaped incision surgery under general anesthesia were included in this study. Patients were randomized into two groups: the external oblique intercostal nerve block group (Group E) and the control group (Group C). Following induction of general anesthesia, Group E received 30 ml of 0.375% ropivacaine and 4 mg dexamethasone for ultrasound-guided EOIB on the surgical side, while Group C received no nerve block. Postoperatively, both groups utilized fentanyl patient-controlled intravenous analgesia. The primary outcome of the study was the 24-hour fentanyl consumption recorded for both groups. Patients with a Numeric Rating Scale (NRS) score > 4 were administered 40 mg parecoxib sodium as rescue analgesia.

Results Postoperative fentanyl consumption at 24 h was significantly lower in Group E compared to Group C (832.92 ± 66.42 μg vs. 1021.25 ± 76.63 μg, $p = 0.001$). Group E demonstrated lower NRS scores at rest and during movement at 0, 2, 4, 12, and 24 h postoperatively compared to Group C, but similar scores at 48 h. The time to first ambulation (49.92 ± 4.21 h vs. 58.38 ± 2.95 h, $p = 0.001$) and time to first flatus (59.79 ± 2.49 h vs. 67.83 ± 2.48 h, $p = 0.001$) were both shorter in Group E than in Group C, with higher Quality of Recovery-15 (QoR-15) scores in Group E (108.00 ± 3.80 vs. 97.00 ± 5.13, $p = 0.001$).

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Conclusion EOIB significantly enhances postoperative analgesia in patients undergoing upper abdominal J-shaped incision surgery, reducing opioid consumption and analgesic requirements, and improving the quality of recovery. It may be considered as part of a multimodal analgesic regimen following upper abdominal surgery.

Trial registration This study was registered in the Chinese Clinical Trial Testing Center (ID: ChiCTR2300076653, 10.13.2023).

Keywords Ultrasound-guided, External oblique intercostal plane block, General surgery, Postoperative analgesia

Introduction

The J-shaped incision remains a common approach for hepatopancreatectomy procedures [1, 2]. The extensive nature of this incision and intraoperative traction can result in severe pain. The mechanisms of pain include peripheral nociceptor stimulation (subcostal incision, rib retraction, diaphragmatic irritation, etc.) and sympathetically transmitted visceral pain. Current evidence suggests that only 20–45% of patients undergoing major abdominal surgery achieve adequate postoperative pain relief [3]. However, patients undergoing hepatic and splenic resection may experience perioperative coagulopathy, significant intraoperative blood loss, and postoperative pain-induced respiratory complications [4], which could limit the use of opioids and epidural analgesia.

Regional block techniques such as transversus abdominis plane block (TAPB), erector spinae plane block (ESPB), and quadratus lumborum block (QLB) as part of a multimodal postoperative analgesic regimen can reduce perioperative opioid use [5, 6]. However, these techniques still present challenges for patients undergoing upper abdominal surgery, including positioning difficulties, technical challenges, and incomplete blockade. The external oblique intercostal plane block (EOIB) is a novel modified block technique; Hamilton first identified staining of the lateral cutaneous branches of the intercostal nerves between T6-T10 in cadavers [7]; subsequent studies by Elsharkawy et al. on EOIB in cadavers and volunteers found staining of both the anterior and lateral cutaneous branches of the intercostal nerves from T7-T10, and consistent skin sensory blockade from T6-T10 in the anterior axillary line and from T6-T9 in the midaxillary line [8]. Compared to the aforementioned block techniques, EOIB is more superficial, further from the surgical incision, and can be performed or catheterized for continuous analgesia in the supine position.

There is a lack of research on the efficacy of EOIB in open upper abdominal surgery. The primary aim of this study is to investigate the impact of EOIB on perioperative opioid consumption and recovery in patients undergoing upper abdominal J-shaped incision surgery. We hypothesize that EOIB can reduce opioid consumption during the perioperative period and improve recovery quality in patients undergoing upper abdominal J-shaped incision surgery.

Methods

Study design

This prospective randomized study was approved by the Ethics Committee of The Second Affiliated Hospital of Xuzhou Medical University ([2023]052334) (05.23.2023), registered at the Chinese Clinical Trial Registry (ChiCTR2300076653) (10.13.2023), and conducted in accordance with the principles of the Declaration of Helsinki [9]. Written informed consent was obtained from all participants. The report of this study adheres to the Consolidated Standards of Reporting Trials (CONSORT) guidelines [10].

Patients aged 18–85 years, classified as American Society of Anesthesiologists (ASA) physical status I-III, undergoing open upper abdominal J-shaped incision surgery (Partial hepatectomy, Splenectomy, Choledocholithotomy) under general anesthesia at The Second Affiliated Hospital of Xuzhou Medical University from December 5, 2023 to October 2024 were included in the study. Exclusion criteria included: Body Mass Index (BMI) > 30 kg/m^2, women in pregnancy and lactation, allergy to study drugs, severe cardiopulmonary dysfunction, severe hepatic or renal insufficiency, history of pain syndrome, opioid dependence, long-term analgesic use, contraindications to nerve block, severe mental illness, inability to communicate, coagulation disorders, or use of anticoagulant drugs, and participation in other trials. Patients were randomly assigned to Group E or Group C in a 1:1 ratio using random sequences generated by the StatBox system.

The computerized randomization was conducted by an independent third party, with group assignments stored in sealed, opaque envelopes. Anesthesiologists performing EOIB were not blinded, but did not participate in data collection and assessment processes. Neither patients nor the anesthesiologists managing perioperative care nor the surgeons conducting the operations were aware of group assignments until the study's completion. EOIB was performed after anesthesia induction to ensure blinding of patients and researchers responsible for data collection. Outcome assessors involved in data collection were unaware of group assignments until after data analysis was complete. A designated anesthesiologist from the study team instructed patients on using the Numerical Rating Scale (NRS) for pain assessment and

patient-controlled intravenous analgesia (PCIA) for postoperative pain relief before postoperative follow-up.

Anesthesia management

All patients received standardized general anesthesia. Upon arrival in the operating room, patients were routinely administered oxygen via facemask, an intravenous line was established, and monitoring was initiated for electrocardiogram (ECG), invasive blood pressure (IBP), pulse oximetry (SpO2), and bispectral index (BIS). Intravenous injections of fentanyl 2 μg/kg, propofol 1.5–2 mg/kg, and rocuronium 0.6 mg/kg were administered sequentially, and endotracheal intubation was performed when the patient's BIS value was less than 50. After intubation, the ventilator settings were adjusted to a tidal volume of 6–8 ml/kg and a respiratory rate of 12–15 breaths per minute, maintaining end-tidal carbon dioxide ($EtCO_2$) between 35 and 45 mmHg and BIS values between 40 and 60. Anesthesia was maintained with sevoflurane, remifentanil, and propofol. Rocuronium was administered as needed to maintain muscle relaxation. No additional rocuronium was given 30 min before the end of surgery, and ondansetron 4 mg was administered to prevent postoperative nausea and vomiting, while nalbuphine 5 mg and ketorolac tromethamine 30 mg were used for postoperative analgesia. At the conclusion of surgery, sugammadex 2–4 mg/kg was used to reverse the effects of rocuronium. Patients were extubated and transferred to the post-anesthesia care unit (PACU).

Ultrasound-guided external oblique intercostal block (EOIB)

Group E received an ultrasound-guided EOIB by an experienced anesthesiologist following induction of general anesthesia, with the anesthesiologist not involved in the collection of trial data. The block was performed according to the method described by Elsharkawy et al. [8]. Patients were positioned supine with the ipsilateral arm abducted. A high-frequency linear array transducer was placed in the sagittal plane between the midclavicular line and the anterior axillary line, with the marker directed towards the head, to identify the sixth and seventh ribs (approximately at the level of the xiphoid process). The transducer was slightly rotated clockwise for a clearer view. Using an in-plane technique, a nerve block needle was advanced from the cephalic direction until the tip was positioned between the sixth and seventh ribs, in the plane between the external oblique muscle and the intercostal muscles. After hydrodissection with 2–3 ml of 0.9% saline to confirm the needle tip position, a mixture containing 30 ml of 0.375% ropivacaine and 4 mg dexamethasone was injected into the plane (Fig. 1).

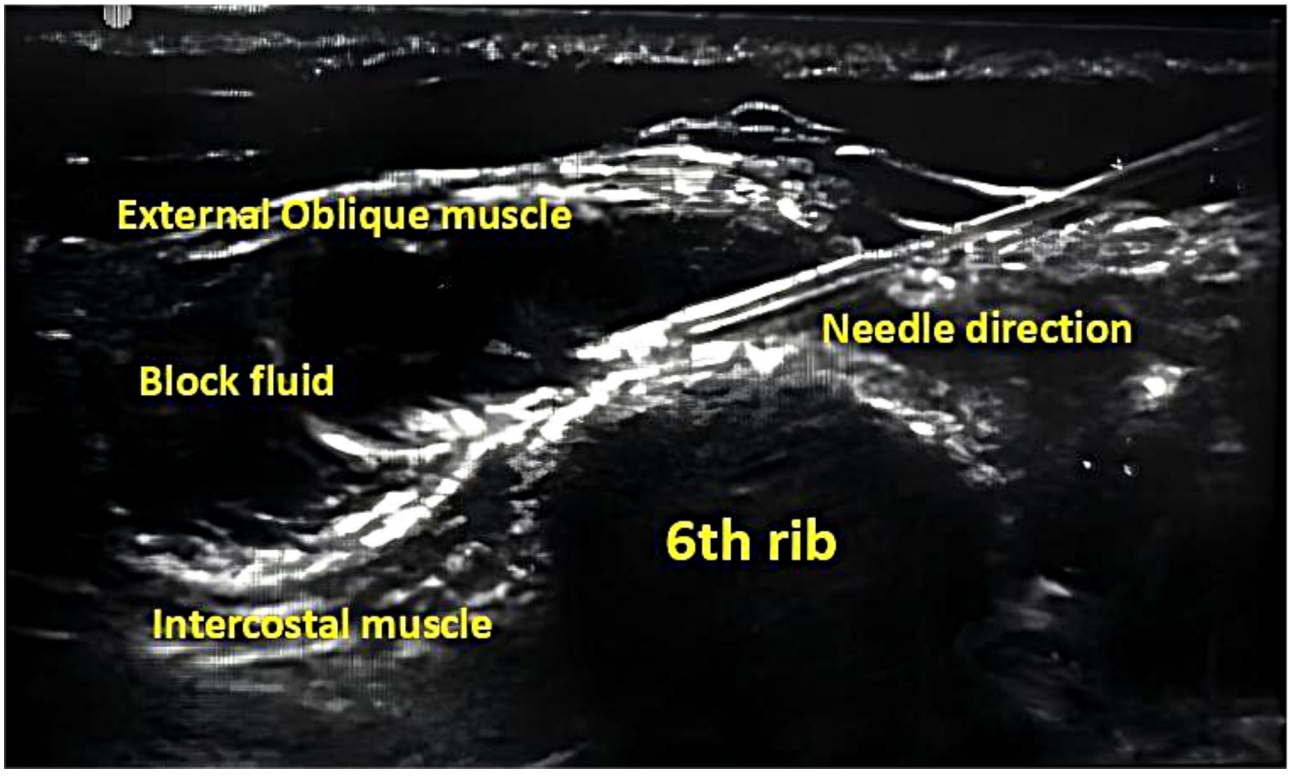

Fig. 1 Ultrasound images of EOIB
(Displaying the needle direction and the area of drug administration.)

Postoperative pain management

Upon completion of surgery, all patients were connected to PCIA, which contained fentanyl at a concentration of 10 μg/ml without a background infusion. The PCIA was programmed to deliver a 10 μg bolus of fentanyl upon patient demand, with a lockout interval of 10 min and a 1-hour limit of 60 μg. Upon arrival at the post-anesthesia care unit (PACU), postoperative pain was assessed using a NRS score from 0 (no pain) to 10 (worst possible pain). If the NRS score>4, patients were instructed to use the PCIA. Transfer to the ward was initiated when the Aldrete score reached 9 or above. In cases where NRS scores remained>4 despite the maximum PCIA dosage, patients received an intravenous rescue analgesic dose of parecoxib sodium 40 mg. Resting and dynamic NRS scores were evaluated by independent researchers at 0, 2, 4, 12, 24, and 48 h postoperatively, either in the PACU or on the ward.

Outcome measures

The primary outcome measure of this study was the consumption of fentanyl within the first 24 h postoperatively. Secondary outcomes included resting and movement NRS scores at 0, 2, 4, 12, 24, and 48 h postoperatively; cumulative fentanyl consumption at 2, 4, 12, 24, and 48 h postoperatively; time to first use of the analgesic pump; number of rescue analgesic administrations; opioid-related adverse effects (postoperative nausea and vomiting (PONV), sedation, pruritus, urinary retention); time to first ambulation and first flatus postoperatively; and postoperative Quality of Recovery-15 (QOR-15) scores [11].

Statistical analysis

Sample size calculation was performed using PASS 2021 software and the sample size calculation formula for comparing the means of two independent samples is utilized, with postoperative fentanyl consumption within 24 h as the primary outcome measure. Based on preliminary results from a small sample of 10 cases, Group C and Group E had fentanyl consumptions of (1041.0 ± 178.6 μg) and (854.0 ± 141.5 μg), respectively, at 24 h postoperatively. With a significance level $\alpha = 0.05$ and a power of 90%, it was determined that 21 cases per group would be required. Accounting for a 10% dropout rate, the total sample size was calculated to be 48 cases, with 24 patients included in each group.

Data analysis was performed using IBM SPSS Statistics 26.0 (IBM, Armonk, NY, USA). The Shapiro-Wilk test was employed to assess the normality of data distribution. Data that were normally distributed are presented as mean ± standard deviation (mean ± SD), while data that were not normally distributed are shown as median and interquartile range (IQR). Student's t-test was utilized for normally distributed variables, and the Mann-Whitney U test was applied for non-normally distributed variables to compare the mean differences between the two groups. Categorical variables are expressed as the number of patients (n) and percentage (%), with chi-square tests or Fisher's exact tests used for categorical data analysis. Repeated measures ANOVA and generalized estimating equations were applied to examine differences across various time points. The Kaplan-Meier survival analysis was applied to compare the time to first use of PCIA between the two groups. The first use of PCIA was considered as "death", and the interval from the connection of PCIA to its first use was defined as "survival time." The survival rate was calculated as the proportion of patients who had not used PCIA at each time point relative to the total number of patients in each group ($n = 24$). The resulting survival curve had time on the x-axis and survival rate on the y-axis. The Log-Rank test was used to evaluate the significance of differences between the groups and the hazard ratio (HR) was used to measure the relative difference in the risk of an event occurring between two groups. The significance level was set at $\alpha = 0.05$, and all analyses were conducted as two-tailed tests, with $p < 0.05$ indicating statistical significance.

Results

A total of 60 patients met the study eligibility criteria. Five patients declined to participate, and seven were excluded based on the inclusion criteria, resulting in 48 patients enrolled in the study. All enrolled cases completed the surgery and data collection according to the study protocol (Fig. 2).

There were no statistically significant differences in the baseline characteristics between the two groups (Table 1). There were no significant differences in the types of surgery, duration of surgery and anesthesia, and intraoperative fluid balance between the groups. Compared to Group C, Group E had lower intraoperative remifentanil consumption (385.8 ± 30.78 μg vs. 420.8 ± 18.16 μg, $p = 0.001$) (Table 2). The 24-hour fentanyl consumption was lower in Group E compared to Group C (832.92 ± 66.42 μg vs. 1021.25 ± 76.63 μg, $p = 0.001$), with significant differences at all other time points (2, 4, 12, 48 h) ($p = 0.01$) (Table 3).

The resting NRS scores at 0, 2, 4, 12, and 24 h were significantly lower in Group E compared to Group C ($p = 0.001$). There was no significant difference in NRS scores at 48 h between the two groups ($p = 0.227$) (Fig. 3A). Group E also had significantly lower movement NRS scores at 24 h postoperatively ($p = 0.001$), with no significant difference at 48 h ($p = 0.124$) (Fig. 3B).

The Kaplan-Meier curves for the time to first use of PCIA showed significant differences between the two groups (Log-rank test, $p < 0.001$) (Fig. 4), with no missing

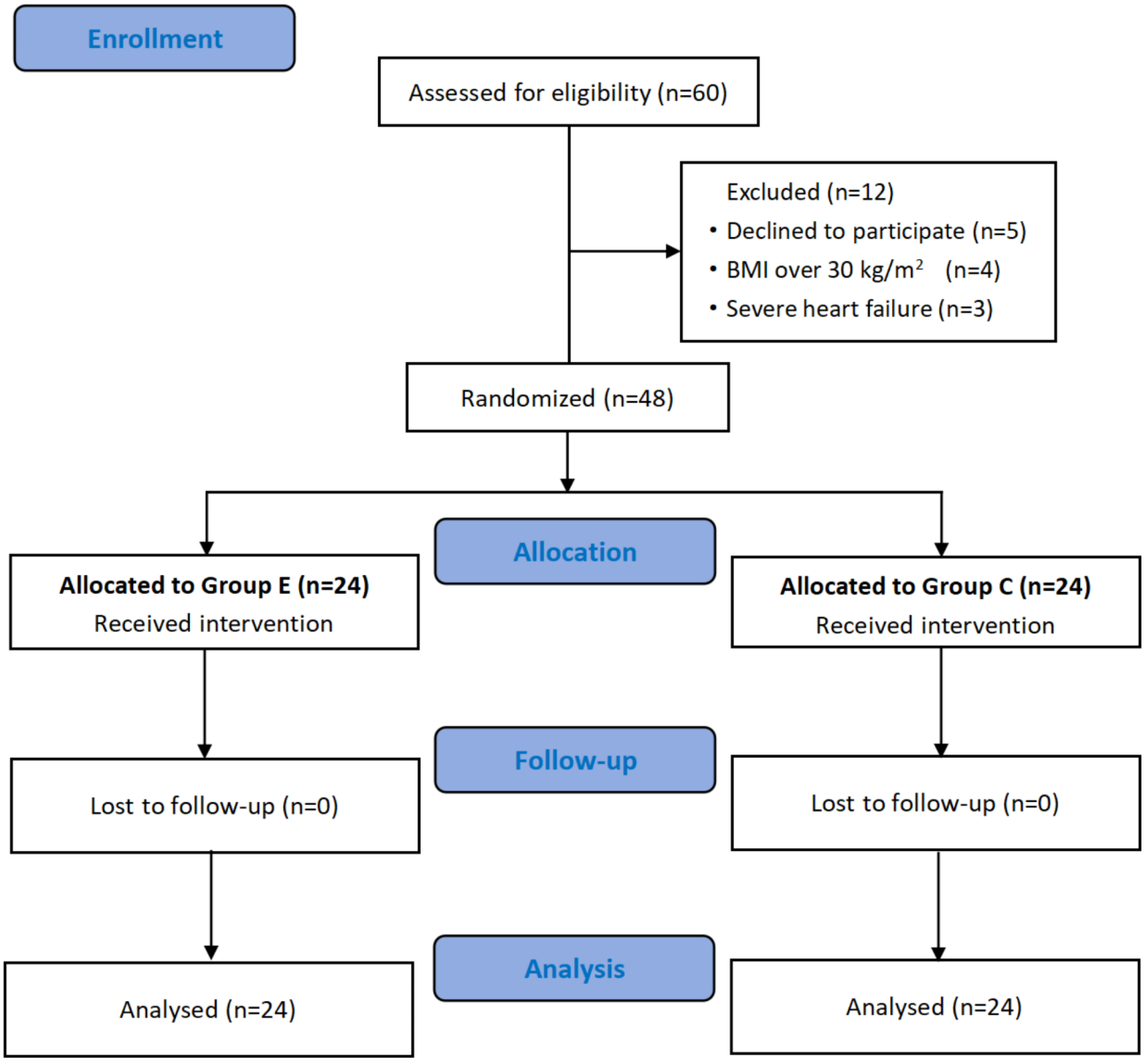

Fig. 2 CONSORT flow diagram of study

values. The curves diverged distinctly, with the curve for group C descending more rapidly, indicating a higher frequency of PCIA use and a lower survival rate. In contrast, group E had a longer median survival time than group C and the HR value for Group E was 0.07.

The incidence of postoperative nausea and vomiting and sedation was lower in Group E compared to Group C ($p = 0.035$, $p = 0.014$), while there were no significant differences in postoperative pruritus and urinary retention between the two groups ($p = 0.267$, $p = 0.637$). Compared to Group C, Group E had shorter times to first ambulation (49.92 ± 4.21 h vs. 58.38 ± 2.95 h, $p = 0.001$) and first flatus (59.79 ± 2.49 h vs. 67.83 ± 2.48 h, $p = 0.001$), and higher postoperative QoR-15 scores (108.00 ± 3.80 vs. 97.00 ± 5.13, $p = 0.001$) (Table 4). No patient experienced complications related to nerve block, such as pneumothorax, bleeding, or local anesthetic systemic toxicity.

Discussion

The results of this randomized controlled trial demonstrate that EOIB significantly reduces postoperative NRS scores and fentanyl consumption in patients undergoing upper abdominal J-shaped incision surgery. Compared to patients who did not receive any block, the average cumulative fentanyl consumption in Group E was reduced by 18.4% over 24 h; during the first 24 h postoperatively, both resting and movement NRS scores were significantly lower in Group E than in Group C, with a

Table 1 Patient characteristics

Characteristic	Group C($n=24$)	Group E($n=24$)	*P*-value
Age(yr); (mean ± SD)	65.83 ± 3.1	65.58 ± 4.37	0.82
Female/ Male (n/n)	12/12	13/11	0.773
BMI($kg{\cdot}m^{-2}$);(mean ± SD)	23.28 ± 0.93	23.79 ± 1.26	0.113
ASA physical status; II/ III (n/n)	12/12	10/14	0.562
Basic disease			
Hypertension; n (%)	15(62.5)	16(66.7)	0.763
Diabetes; n (%)	17(70.83)	16(66.7)	0.755
Tachycardia; n (%)	2(8.33)	0(0.0)	0.149
Bradycardia; n (%)	0(0.0)	3(12.5)	0.074
Laboratory examination			
Albumin ($g\ L^{-1}$);(mean ± SD)	42.17 ± 2.05	42.42 ± 1.52	0.634
Total bilirubin ($\mu mol\ L^{-1}$);(mean ± SD)	15.50 ± 3.41	15.79 ± 1.62	0.787
RBC($10^{12}L^{-1}$);(mean ± SD)	4.22 ± 0.36	4.17 ± 0.43	0.698
HCT(%);(mean ± SD)	41.57 ± 1.67	41.26 ± 3.33	0.689
HB($g\ dl^{-1}$);(mean ± SD)	12.78 ± 1.62	13.17 ± 1.71	0.421

Data are presented as mean ± SD, number (%) or number

Abbreviations: SD Standard deviation, IQR Interquartile range, BMI Body mass index, ASA American Society of Anesthesiologists; RBC Red Blood Cells; HCT Hematocrit; HB Hemoglobin. $P<0.05$ was considered statistically signifcant

Table 2 Intraoperative data

Characteristic	Group C ($n=24$)	Group E ($n=24$)	*P*-value
Partialhepatectomy/SplenectomyCholedocholithotomy(n/n/n)	12/8/4	15/5/4	0.599
Duration of surgery (min); (mean ± SD)	125.0 ± 6.73	124.4 ± 6.94	0.785
Duration of anaesthesia (min); (mean ± SD)	146.0 ± 8.46	145.1 ± 8.16	0.796
Duration of extubation (min); (mean ± SD)	21.0 ± 3.54	20.7 ± 3.63	0.873
Crystalloid infusion (ml); (mean ± SD)	1516.7 ± 160.61	1529.2 ± 157.36	0.787
Colloid infusion (ml); median (IQR)	0(0,500)	0(0,500)	0.921
Amount of bleeding (ml); (mean ± SD)	258.3 ± 58.36	247.9 ± 54.13	0.525
Urine volume (ml); (mean ± SD)	354.2 ± 62.40	360.4 ± 60.76	0.727
Intraoperative remifentanil consumption (μg); (mean ± SD)	420.8 ± 18.16	385.8 ± 30.78	0.001
Intraoperative propofol consumption (mg); (mean ± SD)	389.2 ± 28.27	364.2 ± 39.11	0.015

Data are presented as mean ± SD, median (IQR) or number

Abbreviations: SD Standard deviation, IQR Interquartile range. $P<0.05$ was considered statistically signifcant

Table 3 Cumulative Fentanyl consumption at different time points

Group	Postoperative Time					F	*P*
	2 h	4 h	12 h	24 h	48 h		
Group E ($n=24$)	72.29 ± 19.78	188.96 ± 28.44	512.50 ± 49.45	832.92 ± 66.43	948.33 ± 98.63	1254.56	0.01
Group C ($n=24$)	91.25 ± 12.27	215.83 ± 26.03	601.67 ± 22.97	1021.25 ± 76.63	1138.75 ± 86.60	2483.31	0.01
t	3.99	3,42	8.01	9.10	7.11		
P	0.01	0.01	0.01	0.01	0.01		

Data are presented as (μg); mean ± SD. $P<0.05$ was considered statistically signifcant

median NRS score difference of 2 points at 0 h. These findings preliminarily establish the analgesic effect of EOIB following upper abdominal J-shaped incision surgery.

Previous studies have reported that regional block techniques, such as neuraxial analgesia and peripheral nerve blocks, can reduce perioperative pain and opioid consumption in upper abdominal surgery, accelerating patient recovery [12]. A review suggests that epidural and intrathecal analgesia provide high-quality analgesia and reduce cardiovascular and respiratory complications, but coagulopathy-induced epidural infections and hematomas in liver surgery remain clinical challenges [13]; a study indicates that transversus abdominis plane (TAP) catheter analgesia can reduce opioid requirements after subcostal incision hepatectomy [14], but the catheter insertion site is close to the surgical incision and the block coverage is difficult to extend to the upper lateral

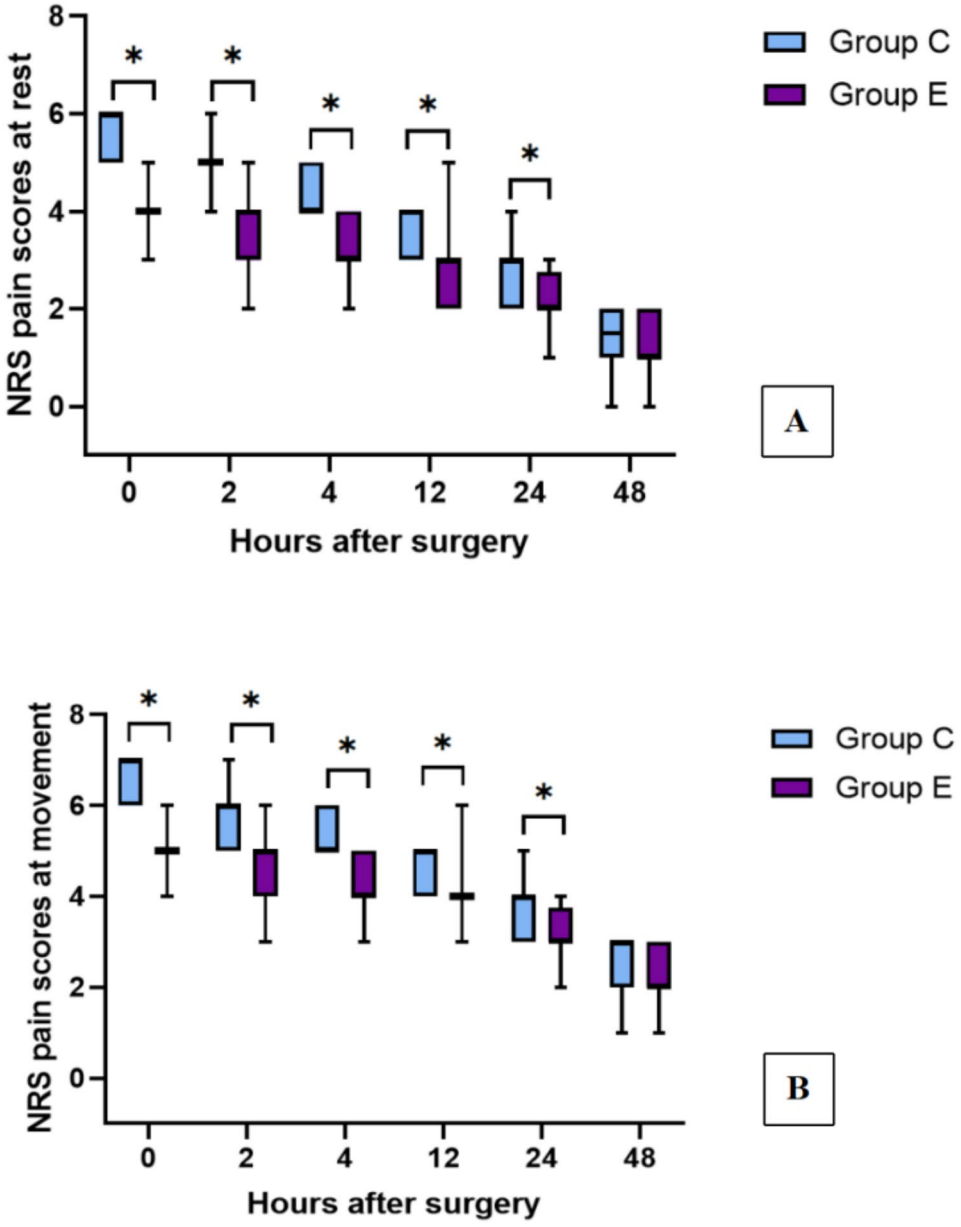

Fig. 3 Postoperative pain scores in both groups. **A**, NRS scores at rest. **B**, NRS scores during movement. Box plots represent median (interquartile range), with the whiskers representing minimum and maximum values. *$p < 0.05$

abdominal wall [15]; additionally, studies by Huang and Zhu et al. have elucidated the analgesic and opioid-sparing effects of QLB and ESPB in hepatectomy [16, 17], but both blocks are deeper and cannot be performed in the supine position, with the ESPB's block range being unpredictable [18]. The aforementioned methods have certain technical and hospital consumable requirements for anesthesiologists and may also pose risks of tissue hematoma, infection, or insufficient analgesia. EOIB is a superficial block targeting the plane between the external oblique muscle and the intercostal muscles, which can be easily identified by ultrasound even in obese patients [19, 20]. Compared with QLB and ESPB, EOIB has more recognizable injection targets and a more superficial puncture point, which will not injure deep tissues and visceral organs. It has a low incidence of complications such as hematoma and infection. The procedure is simpler and can be performed without the patient being in a special position. Transversus abdominis plane block has no effect on the upper abdominal sensation, while the block range of EOIB involves the upper abdomen, which meets the analgesic requirements of the J-shaped incision. The puncture point is far from the surgical incision and vascular bed [21], facilitating the surgical operation.

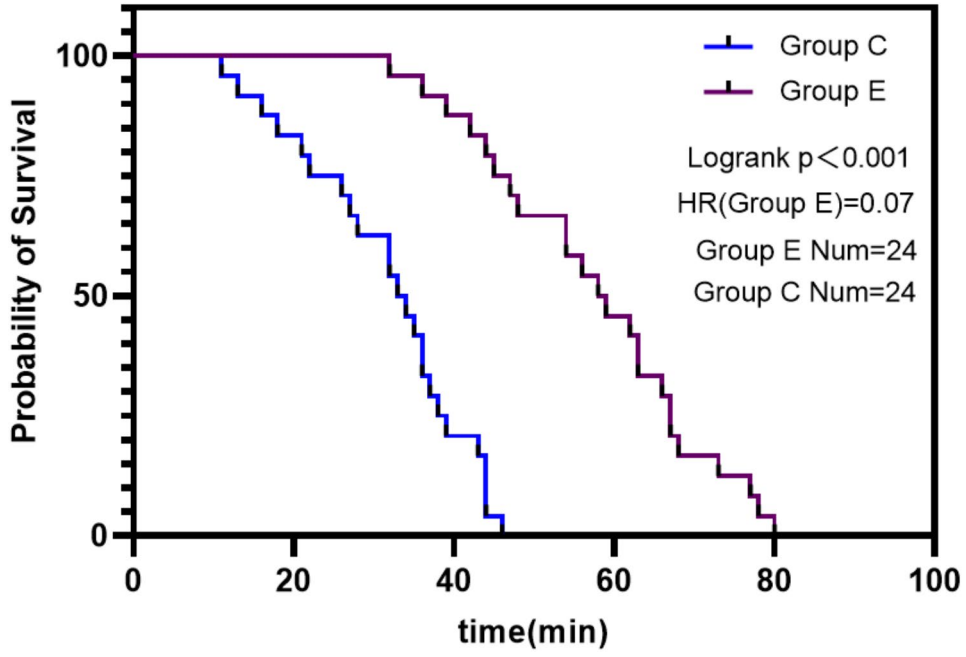

Fig. 4 Two groups of patients' first-time use of PCIA Kaplan-Meier curves (no missing values)

Table 4 Secondary outcomes between groups

Characteristic	Group C($n=24$)	Group E($n=24$)	*P*-value
Postoperative adverse reactions			
PONV; n (%)	12(50.0)	5(20.8)	0.035
Lethargy; n (%)	12(50.0)	4(16.7)	0.014
Pruritus; n (%)	6(25.0)	3(12.5)	0.267
Uroschesis; n (%)	3(12.5)	2(8.3)	0.637
Postoperative flatulence time (h); (mean ± SD)	67.83 ± 2.48	59.79 ± 2.49	0.001
Postoperative ambulation time (h); (mean ± SD)	58.38 ± 2.95	49.92 ± 4.21	0.001
Time to first use PCIA (h); median (IQR)/(mean ± SD)	30(20, 33.75)	52.17 ± 13.89	0.001
Rescue analgesia (in 48 h); median (IQR)	2.5(2,3)	1.0(0,2)	0.001
The QoR-15 score; (mean ± SD)	97.00 ± 5.13	108.00 ± 3.80	0.001

Data are presented as mean ± SD, median (IQR) or number (%)

Abbreviations: SD Standard deviation, IQR Interquartile range, PONV Postoperative Nausea and Vomiting, PCIA patient-controlled intravenous analgesia, QoR-15 Quality of Recovery-15. $P<0.05$ was considered statistically signifcant

Current evidence on the postoperative efficacy of EOIB in upper abdominal surgery is primarily based on case reports and laparoscopic surgery [22–24]. In a case report following open liver surgery, researchers placed an EOI plane catheter in the right recovery area postoperatively for analgesia, and with supplemental injections of 0.375% ropivacaine 20 ml and clonidine 75 μg every 12 h, the patient's NRS score was reduced to 0 within 15 min, with no need for any acetaminophen or other analgesics until discharge [25]. Studies on laparoscopic cholecystectomy and sleeve gastrectomy also concluded that EOIB reduced postoperative pain and analgesic use [26, 27]. In this study, both Group E and Group C received postoperative PCIA. The Kaplan-Meier curve indicated that the risk of using PCIA was lower in Group E than in Group C, suggesting that EIOB can prolong the duration of analgesia in upper abdominal J-shaped incision surgery. However, due to the lack of prospective studies comparing the two groups without PCIA, it is challenging to comment on the consistency of the trial results. Nevertheless, the significant reduction in fentanyl consumption and the NRS score difference greater than 2 points at 0 h postoperatively still support the evidence of EOIB's effectiveness in pain management after upper abdominal J-shaped incision surgery. Currently, the application of EIOB in upper abdominal surgery is limited. It has demonstrated satisfactory analgesic efficacy in laparoscopic surgeries. The case reports and the findings of this study suggest that EIOB also provides effective analgesia in open upper abdominal surgeries and is worthy of further clinical application.

EOIB is a novel fascial plane block that provides analgesia to the anterior and lateral walls of the upper abdomen [7]. Elsharkawy discovered the potential mechanism of EOIB through a study on cadavers and volunteers, finding that a single EOIB dyed the anterior and lateral cutaneous branches of the intercostal nerves from T6/7 to T10/11. The upper abdominal wall is innervated by the intercostal nerves T6-T10 [8], and the J-shaped incision is precisely within the nerve distribution that can be covered by EOIB. In this study, to maintain blinding and alleviate patient anxiety, EOIB was performed after general anesthesia induction, hence no assessment of sensory levels was conducted.

The time to first use of PCIA in this study was significantly shorter than that in laparoscopic surgery patients who also received unilateral EOIB postoperatively, and the NRS score at 0 h was higher than that in contemporary laparoscopic surgery patients, which may be related to the degree of pain caused by incision size. The limitation of EOIB is that it cannot affect visceral pain; some scholars believe that the blocking effect of EOIB on the anterior cutaneous branches of T6-T10 intercostal nerves is insufficient, requiring bilateral blocks to prevent insufficient analgesia [28]. This study did not report any nerve block-related complications, but EOIB still carries potential risks such as pneumothorax, infection at the puncture site, and systemic toxicity from local anesthetic absorption. Most studies use 0.25% bupivacaine for EOIB blocks, with a volume of about 30-40 ml and bilateral blocks; this study used a unilateral 30 ml of 0.375% ropivacaine without causing systemic local anesthetic toxicity, suggesting a higher safety profile for EOIB. Dexamethasone, used as an adjuvant in local anesthetic agents, can provide anti-inflammatory and analgesic effects and prolong the duration of action of EIOB. The incidence of nausea and vomiting was significantly different between the two groups, which may be related to the lower use of opioids in Group E and the effects of dexamethasone after systemic absorption. There was a significant difference in the time to first ambulation, first flatus, and QoR-15 scores between the two groups. Postoperative acute pain can lead to postoperative insomnia, anxiety, and systemic stress and inflammatory responses; studies have indicated that adherence to early activity is key to successful enhancement of recovery after hepatectomy [29]. The results of this study suggest that EOIB can alleviate postoperative pain, reduce systemic stress and inflammatory responses, allow for early mobilization, and promote postoperative recovery.

The study has limitations. Firstly, as a single-center study, the results may be subject to regional biases, and further multicenter studies with larger sample sizes are required for validation. Secondly, EOIB was performed in Group E after anesthesia induction, without assessment of the sensory block range, which could have led to block failure in some patients. Thirdly, the study involved a single-shot EOIB, and the metabolism of local anesthetics might have influenced the final outcomes, suggesting that continuous catheter-based blocks may be necessary for future studies. Fourthly, the surgical procedures were not standardized. Although the surgical spectrum was similar between the two groups and all patients underwent surgery via a J-shaped incision, the sources and degrees of pain caused by different surgeries varied. Moreover, the retraction time, retraction distance, and extent of tissue manipulation for the same type of surgery were not consistent. These factors could influence postoperative pain and opioid consumption. Lastly, the study utilized a single concentration and volume of local anesthetic for EOIB, and the optimal concentration and volume require further investigation.

Conclusion

The findings of this study indicate that EOIB provides significant postoperative analgesic effects in patients undergoing upper abdominal J-shaped incision surgery, reducing opioid consumption and analgesic requirements, and enhancing the quality of recovery. It may become part of a multimodal analgesic regimen following upper abdominal surgery.

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Author contributions

Yi S participated in the study conception, proposal writing, data analysis, and the article draft and manuscript revision. Zhang XL contributed to implementation of the intervention measures and the final draft. Song YH contributed to the article draft and data collection. Wang XH contributed to the proposal writing, editing, and article draft. Gao H participated in study design and data analysis. Yuan Z participated in study design and final draft. Kong MJ participated in study design, manuscript revision and fnal draft. All authors read and approved the final manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study conformed to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of The Second Afliated Hospital of Xuzhou Medical University ([2023]052334), and this study was registered with the Chinese Clinical Trial Testing Center (ID: ChiCTR2300076653). All participants gave written informed consent.

All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and that

all authors are in agreement with the manuscript. Written informed consent was taken from all the patients. This study was registered in the Chinese Clinical Trial Testing Center (ID: ChiCTR2300076653, 10.13.2023).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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