EGYPTIAN JOURNAL OF ANAESTHESIA
2023, VOL. 39, NO. 1, 846–855
https://doi.org/10.1080/11101849.2023.2277094

Ultrasound guided erector spinae plane block versus intrathecal morphine for analgesia following major hepatopancreaticobiliary surgery

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ABSTRACT

Background: Intrathecal morphine (ITM) has been evidenced to provide efficient analgesia for hepatopancreaticobiliary surgery (HPB) in the postoperative period. Despite its benefits, ITM carries certain risks, such as pruritus, postoperative nausea and vomiting, and of utmost importance, the possibility of delayed respiratory depression. We conducted this study to compare the effectiveness of bilateral erector spinae plane block (ESPB) and ITM for analgesia following major HPB surgery. Our hypothesis was that bilateral ESPB would lead to a significant reduction in opioid consumption within the first 24 hours following surgery, with a lower incidence of side effects.

Methods: Forty patients with scheduled major HPB surgery were randomly allocated to receive either bilateral ESPB ($n = 20$) or ITM ($n = 20$) before general anesthesia induction. The primary outcome was cumulative postoperative nalbuphine consumption in the first 24 hours.

Results: Cumulative nalbuphine consumption at 24 hours after surgery was significantly lower in the ITM group compared to ESPB (3.05 ± 0.38 versus 6.56 ± 0.88 respectively). However, the ESPB group demonstrated effective pain control as indicated by pain scores of ≤2 at rest and ≤3 when coughing throughout all measured time points. Moreover, ESPB significantly reduced the incidence of postoperative nausea, vomiting ($p = 0.03$), and pruritus ($p = 0.003$) within the first 24 hours postoperatively compared to ITM.

Conclusions: Although bilateral ESPB resulted in higher opioid consumption than ITM in the first 24 hours after major HPB surgery, the adverse effects were less with minimal or no risk of hemodynamic instability.

ARTICLE HISTORY
Received 9 September 2023
Revised 22 September 2023
Accepted 25 October 2023

KEYWORDS
Erector spinae plane block; Intrathecal morphine; hepatopancreaticobiliary surgery; postoperative analgesia

1. Introduction

Major hepatopancreaticobiliary (HPB) surgery usually requires large abdominal incisions for surgical access with special difficulties in managing postoperative pain, which comprises both visceral and somatic components, the coeliac plexus provides nerve supply to the majority of HPB structures, whereas the intercostal nerves primarily supply the somatic component [1].

Providing sufficient analgesia in these patients is crucial to reduce the potential for respiratory complications and the onset of chronic pain after surgery [2,3].

Opioid use can worsen postoperative ileus, which is already prevalent in these patients, and the return of gastrointestinal function is related to the dose and duration of opioids administered [4]. Given the increasing frequency of hepatic and pancreatic surgeries, it is important to assess and compare alternative analgesic techniques for this patient population.

Intrathecal morphine (ITM) has been evidenced to provide efficient analgesia in the postoperative period [5]. The risks, however, are postoperative nausea and vomiting, pruritus, and of utmost importance, the possibility of delayed respiratory depression [6].

The emergence of innovative regional anesthesia techniques offers the possibility of utilizing lower-risk methods as an alternative to ITM that can provide good-quality analgesia, improve patient outcomes, and produce fewer adverse effects [7]. One such technique is the Erector Spinae Plane Block (ESPB), which has been previously described by Forero et al. [8] for control of chronic thoracic pain. This block has been used in diverse acute pain conditions, such as fractured ribs [9] and bariatric surgery [10]. Studies propose that administering the block to the lower thoracic level (T7-T9) can offer a combined visceral and somatic analgesia for upper abdominal surgery [10,11].

Performing ESPB on patients is relatively simple, and it can be carried out with little or no sedation in the preoperative holding area. The in-plane ultrasound-guided technique is the most commonly used method for performing the ESPB. This block involves insertion of a needle in the facial plane between the erector spinae muscles and the thoracic transverse

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processes where the local anesthetic is administered. The local anesthetic extends in both caudal and cephalic directions blocking the dorsal and ventral rami of the thoracic and abdominal spinal nerves. This results in a sensory block that spans multiple dermatomes of the anterior, posterior, and lateral thoracic and abdominal walls [9].

The aim of the current study is to compare the analgesic efficacy of USG bilateral ESPB and ITM following major HPB surgery. We hypothesized that bilateral ESPB would significantly decrease opioid consumption within the first 24 h after surgery with lower incidence of side effects.

2. Methods

After acquiring approval from the Assiut University Hospital Ethical Committee in Egypt, where the study was conducted, under number 17101512, this study was registered in advance at "http://www.clinicaltrial.gov" under number NCT04635644.

All participants provided written consent after being informed, and we included in the study adult patients with an American Society of Anaesthesiologists (ASA) physical status I-II, aged between 18 and 65 years, who were scheduled for elective major HPB surgery related to benign or malignant disease; Surgery is considered major if it is expected to last for more than 1 hour or involves a blood loss of more than 500 ml. In all surgeries included, the extended right subcostal incision was utilized. We excluded from the trial patients who declined to be a part of the study, or those who had any of the following: known drug allergies, coagulopathy, infection at the injection site, chronic opioid use, chronic pain syndromes, psychiatric disorders, and severely co-morbid patients. The study was conducted at Assiut University Hospitals in Egypt between November 2021 and March 2023.

A web-based randomizer (http://www.randomizer.org) in a 1:1 ratio was used to allocate enrolled patients to an ITM group ($n = 20$) or an ESPB group ($n = 20$). All healthcare professionals responsible for the care of patients during and after the surgery, including anesthesiologists not involved in the study intervention, surgeons, nursing staff, and outcome assessors, were kept blinded to group allocation.

Before surgery, study participants were taught how to use an 11-point numerical rating scale (NRS) for assessing their acute postoperative pain, which ranged from 0 to 10, with 0 indicating the absence of pain and 10 indicating the most intense pain [12].

After securing an intravenous (iv) line in the holding area and shifting to the operating room, standard ASA monitoring and supplemental oxygen via a simple face mask were applied. Intravenous midazolam 1–2 mg and antibiotic prophylaxis were administered. The antibiotic was ensured to be given half an hour before the start of surgery. Either ITM or ESPB was performed before general anesthesia induction.

For the ESPB group, patients were positioned in a prone posture, and a high-frequency linear ultrasound probe (linear 6–13 MHz, SonoSite M-Turbo®, Bothell, DC, USA) was placed longitudinally in a parasagittal orientation, 2.5–3 cm lateral to the T8 spinous process with sterile technique. The erector spinae muscles were detected above the tip of the T8 transverse process. A 21 G 10 cm needle was placed using an in-plane technique in a cephalic to caudal direction to reach the T8 transverse process after skin sterilization and local infiltration of the needle entry point with 2–3 ml of 2% lidocaine. The needle tip's location was determined by using 2 mL of 2% lidocaine to hydrodissect and observing a linear fluid spread that lifted the erector spinae muscle off the bony shadow of the transverse process on ultrasound imaging. Subsequently, a volume of 20 mL of 0.25% Bupivacaine was injected at that site. The same steps were repeated for the other side.

For the ITM group, patients were positioned on their right side and administered an intrathecal injection of morphine 200 µg (0.2 mL of morphine sulfate 1 mg/mL) mixed in 1.8 mL of normal saline at the L3-L4 or L4-L5 level using a 25 G Whitacre spinal needle with adherence to the standard aseptic techniques.

After ESPB blocks or ITM administration, patients were placed back in the supine position and induction of general anesthesia was done by administering IV fentanyl 1 µg/kg, propofol 2 mg/kg, and rocuronium bromide 0.6 mg/kg following which endotracheal intubation was performed. Anesthesia was maintained with isoflurane in a 1:1 oxygen: air mixture, infusion of fentanyl at a rate of 1 µg/kg/h, and an infusion of rocuronium at a rate of 0.01–0.012 mg/kg/min. A tidal volume of 6 to 8 mL/kg was used to control mechanical ventilation, and a ventilator rate (8 to 12/min) was adjusted to keep the end-tidal CO2 level between 35 and 40 mmHg. Intraoperative normothermia was achieved through the use of warm intravenous fluids, warm blanket, and humidifier. A nasogastric tube was placed, a central venous catheter was inserted via the right internal jugular vein using aseptic technique with maximal sterile barriers, the radial artery was cannulated by a 20-gauge angiocatheter after conducting modified Allen's test prior to anesthesia induction, and a Foley's catheter was also inserted utilizing a sterile technique.

The heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were documented before performing ITM or ESPB as a baseline, then at 15 min and 30 min after anesthesia induction, and every 30 min till the end of operation. Both fluid input including crystalloids, colloids, packed red blood cells, and fresh-frozen plasma,

as well as fluid output such as urine output (UOP) and blood loss were recorded. At the end of surgery, Train of Four (TOF) was used to guide reversal of neuromuscular blockade by neostigmine and atropine. Following extubation, patients were transferred to the post-anesthesia care unit (PACU) for careful observation.

After surgery, all patients were given paracetamol 1 g intravenous infusion at 8-hour intervals. For breakthrough pain (NRS ≥ 4 or the patient complained of pain), the first and second-line rescue analgesics administered were an intravenous bolus of nalbuphine at a dose of 0.05 mg/kg and an intravenous infusion of ketorolac at a dose of 30 mg, respectively. NRS for pain at rest and when coughing was assessed serially at 1, 2, 4, 8, 12, 24, 48, and 72 h after surgery. Both the time for first analgesic request and NRS at that time were recorded. Nalbuphine 0.05 mg/kg bolus as first-line rescue analgesics was repeated only 2 hours after the last bolus if needed. Cumulative consumption of rescue analgesics at 8, 24, 48, and 72 hours postoperatively were recorded. The presence of postoperative nausea, vomiting, or pruritus within 24 hours after surgery was noted. Postoperative nausea or vomiting was treated with 0.1 mg/kg of ondansetron. Metoclopramide 10 mg IV was administered in case of no response to ondansetron. Occurrence of any procedure-related complications such as hematoma, pneumothorax, local anesthetic systemic toxicity, post-dural puncture headache, allergic reactions, hypotension (MAP <60 mm Hg), and respiratory depression (respiratory rate <8 breaths per minute or oxygen saturation <90%) within the first 24 hours postoperatively was also observed.

The primary outcome was cumulative Nalbuphine consumption in mg equivalent to morphine dose at 24 hours after surgery. Secondary outcomes included Nalbuphine consumption at 8, 24–48, and 48–72 hours postoperatively, non-opioid analgesic consumption in mg at 8, 24, 24–48, and 48–72 hours postoperatively, NRS score, hemodynamic changes, and procedure-related complications during and after the procedure till 24 hours postoperatively.

Sample Size Calculation: In a previous study [13] for use of intrathecal morphine versus epidural analgesia for postoperative pain relief after liver resection, the mean (standard deviation [SD]) total 24 h postoperative morphine requirement in the Intrathecal Morphine group was 17.2 (3.6) mg. To attain a 50% decrease in the consumption of opioids with an alpha error of 0.05 and power of 85%, a sample size of 18 was required in each group. Considering dropouts, we decided to enroll 20 patients per group.

Statistical analysis was established using software package SPSS® version 24.0 (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was used to check whether the data distribution was normal. Parametric data were expressed as a mean ± standard deviation, while non-parametric data were presented as median (range). Ratios and percentages were used as appropriate.

Student t-test was employed to compare continuous data with a normal distribution, while the Mann-Whitney U test was used to analyze non-normally distributed data. Changes over time in analgesic consumption, HR, and MAP between the study groups were analyzed by repeated-measures ANOVA followed by a post hoc Bonferroni test to identify significant differences. Either the chi-square test or Fisher's exact test was utilized to examine the association between qualitative variables. P-value >0.05 was considered statistically significant.

3. Results

In the present study, 42 participants scheduled for major HPB surgery were assessed for eligibility between November 2021 and March 2023, two individuals were excluded before being enrolled and randomized, one due to patient's choice to withdraw their consent and one due to surgical cancellation. Consequently, the study was completed with 40 participants, with each group consisting of 20 individuals, as demonstrated in the CONSORT flow-chart (Figure 1).

The demographic data and surgical characteristics of both groups were similar at baseline (Table 1).

Nalbuphine and Ketorolac consumption over time were significantly different between subjects in both groups [F (1,38) = 25.5 for nalbuphine & 63.5 for ketorolac, P < 0.001]. A significant decrease in Nalbuphine and Ketorolac consumption was observed in the ITM group when compared to the ESPB group at 0–24 postoperatively. However, there was no statistically significant difference observed between the two groups in the postoperative period at 24–48 hours and 48–72 hours (Table 2).

For most follow-up time points, there were no significant differences observed between the two groups with respect to pain scores at rest and during coughing. However, pain scores at rest and during coughing were significantly lower in the ITM group compared to the ESPB group at 12 hours, but higher at 48 hours after surgery (Figure 2).

In contrast to the ITM group, the ESPB group exhibited a significantly shorter time for the first analgesic request (p < 0.001) with a significantly higher NRS score at the time of the first analgesic request (p = 0.02) (Table 3).

Regarding hemodynamic data, the current study demonstrated no significant difference between groups in heart rate measurements over time [F (1,38) = 1.7, $P = 0.2$] except for a significant increase in the ESPB group compared to the ITM group at 1 hour after surgery (Figure 3). The ESPB group exhibited a statistically significant increase in MAP compared to the ITM group at 1 and 6 hours postoperatively; however, there was no significant

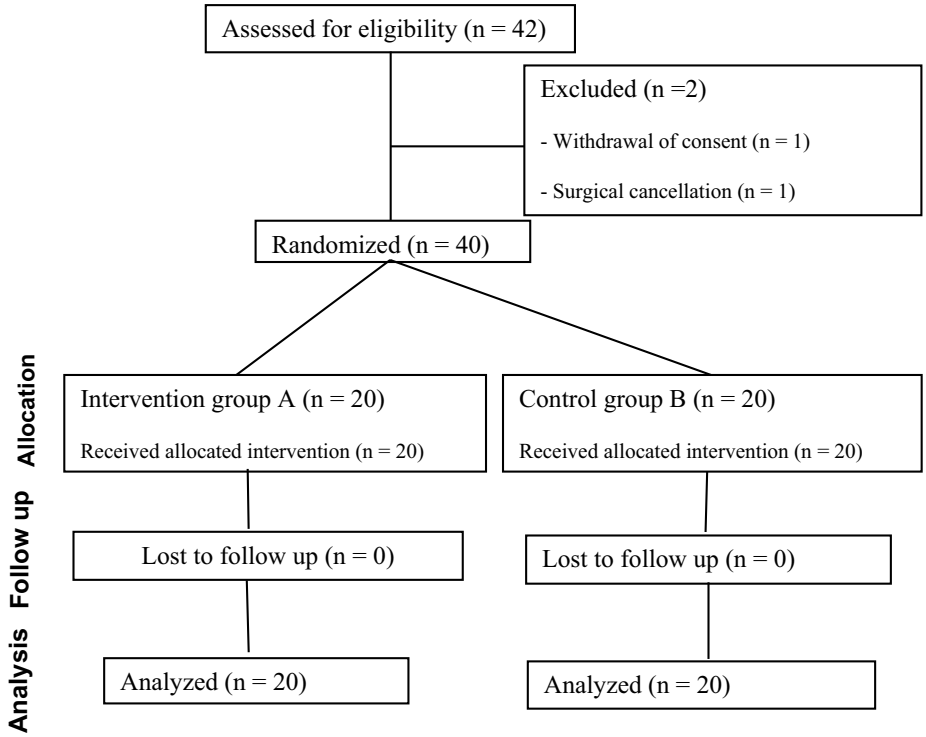

Figure 1. The CONSORT flow diagram. CONSORT indicates consolidated standards of reporting trials.

Table 1. Patient's demographic and surgery data.

	Group ESPB (*n* = 20)	Group ITM (*n* = 20)	P Value
Age (years)	55.0 ±12.29	59.15 ± 8.70	0.23
Gender (male/female)	13/7	12/8	1.00
BMI (Kg/m^2)	24.54 ± 2.39	23.30 ± 2.60	0.13
ASA N (%)			
I	10 (50%)	9 (45%)	1.00
II	10 (50%)	11 (55%)	
Type of surgery N (%)			
Whipple operation	8 (40%)	10 (50%)	0.92
CBD Exploration	5 (25%)	4 (20%)	
Liver resection	4 (20%)	3 (15%)	
Hepatic cyst	3 (15%)	3 (15%)	
Operative duration (hours)	3.93 ± 1.46	4.28 ± 1.58	0.47
Crystalloids (ml)	2775 (1800–4000)	2850 (1450 – 4300)	0.88
Colloids (ml)	0 (0–500)	0 (0–500)	0.29
PRBCs (units)	0 (0–2)	0.5 (0–2)	0.93
FFP (units)	2 (0–3)	2 (0–3)	0.98
UOP (ml)	775 (250–2000)	1000 (300–1800)	0.99
Blood loss (ml)	700 (100–1600)	575 (100–1250)	0.66

Data are presented as mean ± SD, median (range). or as number (%). BMI Body mass index, ASA American society of anesthesiologists, PRBCs Packed Red Blood Cells. FFP fresh frozen plasma. UOP Urine Output, ESPB Erector Spinae Plane Block, ITM Intrathecal Morphine. P-value < 0.05 was considered statistically significant.

Table 2. Postoperative analgesic consumption.

Postoperative analgesic Consumption	ESPB (*n*=20)	ITM (*n*=20)	P. value
Nalbuphine (mg)			
T0–8	1.7 ± 0.8	1.55 ± 0.6	0.51
T0–24	6.56 ± 0.88	3.05 ± 0.38	<0.001*
T24–48	9.85 ± 2.17	8.33 ± 3	0.06
T48–72	2.05 ± 1	2.15 ± 1.04	0.76
Ketorolac (mg)			
T0–8	0 (0–0)	0 (0–0)	1.00
T0–24	60 (60–90)	30 (30–30)	<0.001*
T24–48	30 (0–30)	30 (0–30)	0.17
T48–72	0 (0–0)	0 (0–0)	1.00

Data are presented as mean ± SD or median (range). ESPB Erector Spinae Plane Block, ITM Intrathecal Morphine. P-value < 0.05 was considered statistically significant.

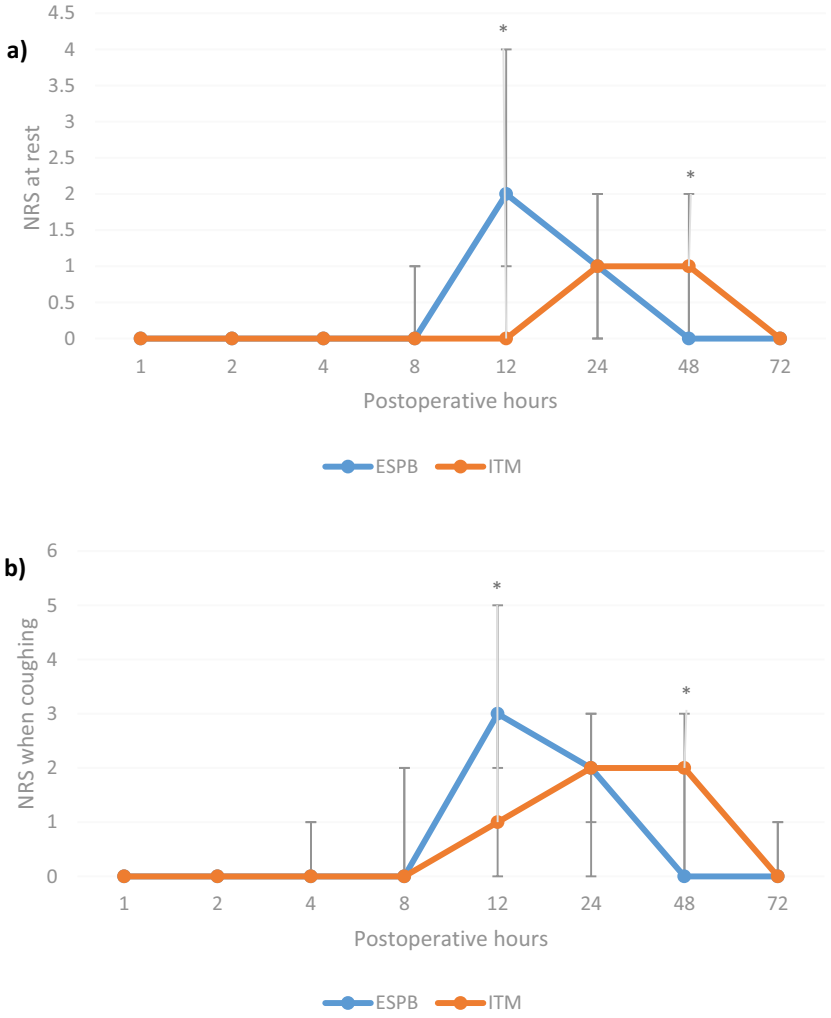

Figure 2. NRS, numerical rating scale a) at rest and b) when coughing (median (range)) [y axis]. Time in hours [x axis]. ESPB, erector spinae plane block; ITM, intrathecal morphine. $P<0.05$ was considered statistically significant. * statistically significant.

Table 3. Comparison between groups according to analgesic request and time to first flatus.

	ESPB (n=20)	ITM (n=20)	P. value
Time for first analgesic request (hours)	11.6±1.57	19.45 ±1.32	<0.001*
NRS at first analgesic request	5 (4–6)	4 (4–5)	0.02*
Time to first Flatus (hours)	1 (1–2)	2 (1–2)	0.06

Data are presented as mean ± SD or median (range). ESPB Erector Spinae Plane Block, ITM Intrathecal Morphine. P-value < 0.05 was considered statistically significant.

difference between the groups at other measurement times (Figure 4) with no significant difference between subjects over time in both groups [F (1,38) = 0.54, $P = 0.47$]. The time to the first flatus did not show a statistically significant difference between the groups, as indicated by a p-value of 0.06 (Table 3).

ESPB resulted in a significant reduction in the incidence of postoperative nausea, vomiting, and pruritus compared to ITM. No significant difference was detected between the two groups with regard to the number of patients who developed hypotension, respiratory depression, or required ICU stay (Figure 5).

4. Discussion

The main aim of this study was to compare the analgesic efficacy of USG-bilateral ESPB and ITM after major HPB surgery. Our findings indicate that the ITM group exhibited reduced opioid consumption in the first 24 hours after surgery coupled with a longer duration for the first analgesic request. However, the ESPB group was accompanied by a lower incidence of postoperative nausea, vomiting, and pruritus compared to ITM.

We used ITM in this trial despite epidural catheterization is widely accepted as the gold standard of care for managing pain in major abdominal surgery [14], as epidural catheter placement has a number of limitations in HPB surgery, particularly in extensive liver resection. The removal of epidural catheters from patients after high volume liver resection can be challenging because postoperative synthetic hepatic dysfunction results in a coagulopathy that is exacerbated by significant intraoperative blood loss. Preoperatively, neither the extent of the necessary liver resection nor the amount of blood loss is completely foreseeable. The postoperative coagulopathy peak usually occurs

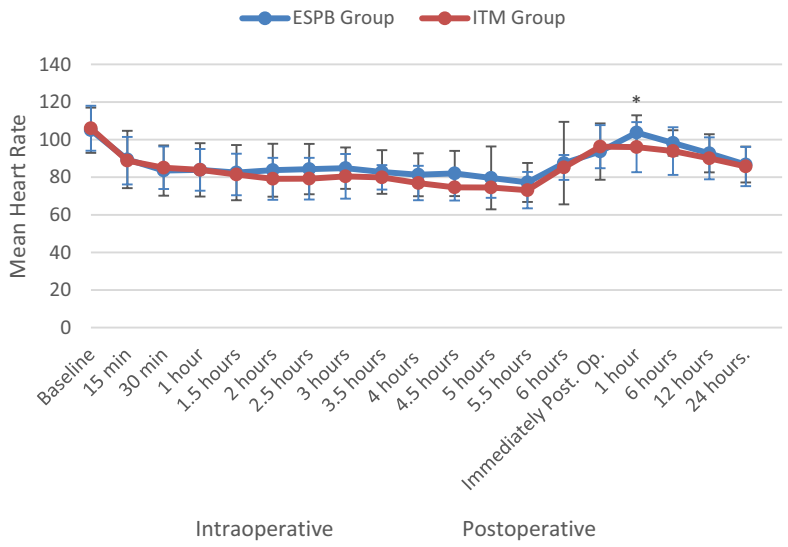

Figure 3. Heart rate (mean ± standard deviation) (y axis). Time (x axis). ESPB, erector spinae plane block; ITM, intrathecal morphine. $P<0.05$ was considered statistically significant. * statistically significant.

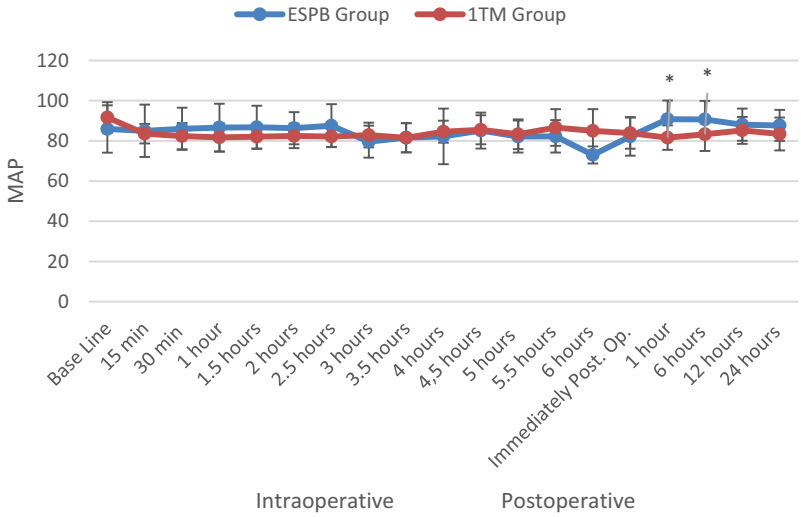

Figure 4. MAP, mean arterial blood pressure (mean ± standard deviation) (y axis). Time (x axis). ESPB, erector spinae plane block; ITM, intrathecal morphine. $P<0.05$ was considered statistically significant. *Statistically significant.

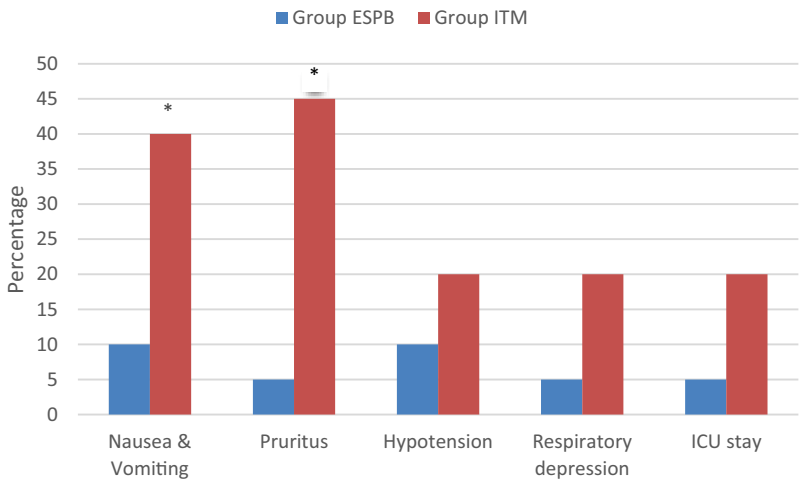

Figure 5. Comparison between two groups as regard to patient's outcome. ESPB, erector spinae plane block; ITM, intrathecal morphine. $P<0.05$ was considered statistically significant. *Statistically significant.

between days 2 and 3 after surgery, and it commonly does not return to its normal level until the seventh day [15,16]. Waiting for epidural catheter removal on day 7 increases the chance of infection [17]. Furthermore, to attain adequate pain control following major abdominal surgeries, thoracic epidural catheterization is necessary, while intrathecal morphine (ITM) can offer analgesia at the lumbar level with a higher success rate and lower risk of epidural-related complications such as perioperative hypotension and epidural hematoma.

In terms of pain scores in the first 48 hours following major liver resection, De Pietri et al. [13] found that combining ITM with opioid-based patient-controlled analgesia (PCA) was comparable to thoracic epidural analgesia, despite the ITM group consumed more intravenous opioid PCA during the first 12 hours. The authors concluded that ITM is a suitable method of pain management in major hepatic resections. The results were corroborated by the study conducted by Sakowska et al. [18], which involved 160 patients who had undergone hepatic or pancreatic resections, they also found no significant difference in the postoperative pain scores between ITM and epidural analgesia.

The optimal dose of ITM for abdominal surgery ranges from 100 µg to 500 µg or more [19]. We hypothesized that 200 µg ITM would provide effective pain relief without any opioid-related complications, thereby improving Enhanced Recovery After Surgery (ERAS) outcomes.

Studies have shown that abdominal wall blocks could be a promising alternative to invasive methods for pain relief following major HPB surgery [20,21]. The ESPB, which was initially introduced by Forero et al. in 2016 [8], involves injecting a local anesthetic under ultrasound guidance into the facial plane between the erector spinae muscles and the transverse process. The distribution of the local anesthetic within this plane can provide pain relief across multiple thoracic vertebral levels, depending on the location of the block. Initially, it was hypothesized that the analgesic effect resulted from the blockage of the dorsal and ventral rami of the nerve roots, as well as the anterior spread of the local anesthetic into the paravertebral space. However, a recent study involving the injection of dye into cadavers did not reveal any anterior dye spread to the paravertebral space. Instead, the dye stained the dorsal ramus as it exited the costotransverse foramen near the injection site and extended to the lateral cutaneous branches of the intercostal nerves located lateral to the angle of the ribs [22]. While the ESBP was initially introduced at the T5 level to provide thoracic analgesia, successful upper abdominal surgical analgesia has been achieved through insertion at the T7 level [10,11].

In our study, cumulative nalbuphine consumption in mg equivalent to morphine dose at 24 hours postoperatively as a primary outcome was significantly lower in ITM group compared to ESPB (3.05 ± 0.38 vs 6.56 ± 0.88 respectively). Ketorolac consumption was also significantly lower in the ITM group compared to the ESPB group at 24 hours postoperatively, but no statistically significant differences were noted in nalbuphine and ketorolac consumption between the two groups at 24–48 and 48–72 hours postoperatively. Median pain scores at rest and while coughing were also lower in the ITM group at 12 hours and became higher in the ITM group at 48 hours during the postoperative period. The time for the first analgesic request was significantly longer in the ITM group compared to the ESPB group (19.45 ± 1.32 versus 11.6 ± 1.57)

This data implies that ITM leads to decreased opioid usage during the early postoperative period. Nevertheless, this advantage started to disappear after 24 hours, which correlates with the duration of ITM. However, it is evident that pain was adequately managed in the ESPB group during this period, as demonstrated by NRS of 2 or less at rest and 3 or less when coughing at all time points.

Of greater importance, despite the increased opioid consumption during the initial 24-hour period in the ESPB group, we noted that ESPB significantly reduced the incidence of postoperative nausea, vomiting, and pruritus within the first 24 hours after surgery compared to ITM, with a smaller number of patients who developed respiratory depression although it did not attain statistically significant difference. The well-established respiratory depression that is dose dependent with ITM [23], while relatively infrequent, necessitates careful monitoring of patients for 24–48 hours following surgery.

Consistent with the present study Kang et al. [24], compared bilateral continuous ESPB using a programmed intermittent bolus regimen ESPB versus ITM for postoperative analgesia in living donor laparoscopic hepatectomy among 59 patients allocated into two well-matched groups and showed that at 8 and 24 hours following the surgical procedure, the ITM group exhibited a significant reduction in cumulative opioid use, with comparable opioid consumption over 48 hours between the ITM and ESPB groups. But unlike our study, we didn't find a statistically significant difference at 8 h postoperatively. Median resting pain scores in that study [24] were lower in the ESPB group after 24 hours, and this disparity achieved statistical significance at 48 and 72 hours after the surgery.

However, when Kang et al. [6], compared Bilateral single-injection ESPB versus ITM for analgesia following living donor laparoscopic hepatectomy among 54 patients allocated into two groups, they found that at 8 hours after surgery, the ITM group had significantly lower cumulative opioid consumption and pain scores

than ESPB group, but there was no notable difference in pain scores or opioid consumption between 24 and 72 hours after surgery.

In contrast with the current study, Hamed et al. [25] reported that the ITM group had consumed significantly more tramadol (101.71 ± 25.67 mg) than the ESPB group (44 ± 16.71 mg) within the initial 24 hours in patients who underwent cesarean section, but they used low dose of ITM (100 µg) which together with the difference in type of procedure may be important factors in obtaining such results.

Salazar et al. [26] and Elshafie et al. [27] showed that ESP blocks were associated with lower opiate consumption compared to standard analgesia in the major open hepatobiliary surgery. These studies despite difference in control groups indicate the effectiveness of ESPB in major open hepatobiliary surgery. Additionally, Fiorelli et al. [28] found that the overall amount of remifentanil used and the need for additional analgesics were lower in the ESPB group than in the intercostal nerve block (ICNB) group ($p < 0.05$).

Regarding hemodynamic data, the present study revealed no statistically significant differences between the groups in terms of HR and MAP measurements except at 1 hour for HR and at 1 and 6 hours for MAP postoperatively where they were significantly higher in ESPB group compared to ITM group. However, the differences in some hemodynamic data were significant, but these differences were transient and clinically non-significant as all were in the normal range. Consequently, the use of ESPB was safe as the standard ITM.

In line with the current study, Tulgar et al. [29] and Singh et al. [30] showed that the ultrasound guided ESPB has minimal adverse effects with little to no risk of hemodynamic instability. In addition, Ali et al. [31] demonstrated that performing a bilateral ESPB resulted in superior intraoperative and postoperative maintenance of heart rate and blood pressure, as well as increased patient satisfaction in individuals undergoing emergency laparotomy.

In agreement with the current study, Kang et al. [6] showed that bilateral single injection ESPB significantly reduced incidence of postoperative vomiting and pruritus compared to ITM. However, Kang et al. [24] showed that the occurrence of postoperative hypotension was significantly greater in the ITM group (31%) compared to the ESPB group (6.7%, $p = 0.021$). Also, Elshafie et al. [27] showed the ESPB group had a reduced number of patients who experienced postoperative nausea and vomiting compared to the conventional group (0/20 vs. 10/20; $p < 0.001$). In agreement with our study, Kang et al. [6,24] showed no significant difference between groups regarding time to first flatus.

Collectively our results were in contrast with a systematic review and meta-analysis of 24 randomized trials including 1502 patients by Gao et al. [32] showed that ESPB had a significant impact on reducing pain scores at 6 hours (SMD −1.25; 95% CI −1.79 to −0.71), 12 hours (SMD −0.85; 95% CI −1.33 to −0.37), and 24 hours (SMD −0.84; 95% CI −1.30 to −0.37) post-surgery, as well as 24-hour opioid consumption (SMD −0.62; 95% CI −1.19 to −0.06), when compared to placebo. ESPB also extended the time to initial rescue analgesia and decreased the incidence of PONV. In comparison to transversus abdominal plane block (TAPB), ESPB resulted in significantly lower pain scores at 6, 12, and 24 hours post-surgery, as well as reduced opioid consumption over 24 hours, and a longer duration until the first rescue analgesia was required. Additionally, the results of the subgroup analysis showed that ESPB significantly decreased pain scores at different time intervals and opioid consumption within the initial 24 hours following laparoscopic cholecystectomy, percutaneous nephrolithotomy, and bariatric surgery.

In our study, although ESPB was associated with higher opioid consumption in the first 24 hours after surgery, ESPB group exhibited effective pain management, with pain scores of ≤2 at rest and ≤3 when coughing at all measurement points throughout the study period, and minimal or no risk of hemodynamic instability as well as less incidence of side effects including postoperative nausea, vomiting, and pruritus compared to ITM. Moreover, we noted less incidence of respiratory depression, hypotension, and lower number of patients requiring ICU stay, although these did not attain statistically significant difference. In this regard, the ESPB can be a possible good analgesic option in patients who are at risk of postoperative coagulopathy complications such as those undergoing liver surgery. It may also be useful as a postoperative rescue therapy for patients who are experiencing significant pain despite other analgesic measures.

Our study had several limitations. First, we did not assess sensory coverage to confirm successful ESPB and detect patchy block or block failure. Second, patient-controlled analgesia (PCA) may be a better option as a postoperative analgesic regimen instead of that used in this study. Third, this study was conducted at a single canter with a limited sample size. Fourth, there are no collected data relevant to patient satisfaction. Finally, we did not add a control group with a standard systemic analgesia alone as a third group which may reveal the benefit of ESPB.

Increasing sample size, using a continuous catheter technique with flexible and kink-resistant material, or adding analgesic adjuncts may be bases for optimizing analgesic efficacy of ESPB in further research.

5. Conclusion

Although bilateral ESPB resulted in higher opioid consumption than ITM in the first 24 hours after major HPB surgery, the adverse effects were less with minimal or no risk of hemodynamic instability.

Abbreviations

ESPB	Erector Spinae Plane Block,
ITM	Intrathecal Morphine,
HPB	hepatopancreaticobiliary,
BMI	Body mass index,
ASA	American society of anesthesiologists,
NRS	Numerical Rating Scale,
HR	heart rate,
SBP	systolic blood pressure,
DBP	diastolic blood pressure,
MAP	mean arterial pressure,
PRBCs	Packed Red Blood Cells,
FFP	fresh frozen plasma,
UOP	Urine Output,
TOF	Train of four
PACU	post-anesthesia care unit,
TAPB	transversus abdominal plane block,
PCA	patient-controlled analgesia,
SPSS	Statistical Package for the Social Sciences,
CONSORT	Consolidated Standards of Reporting Trials.

Acknowledgments

The authors wish to thank the study participants for their involvement in the study. The authors like to thank the medical staff of the participating clinical service at Assiut University Hospitals, Egypt, for their support with data collection.

Disclosure statement

None of the authors have any personal, professional, or financial conflicts of interest to declare.

Funding

The authors state no funding was involved.

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