# Ultrasound-guided oblique subcostal transversus abdominis plane block versus erector spinae plane block as pre-emptive analgesia for open umbilical hernia repair: a comparative, randomized, double-blinded clinical trial

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**Background and aim**
Ultrasound (US) oblique subcostal transversus abdominis plane (OSTAP) block provides excellent pain relief following open umbilical hernia repair. The erector spinae (ES) plane block has recently received a great deal of attention as it is simple to operate. Our research compares US-guided bilateral ES block with bilateral oblique OSTAP block as pre-emptive analgesia.
**Patients and methods**
This clinical trial included 70 participants of both sexes who were prepared for optional open umbilical hernia repair. Before beginning of the surgical procedure, they received either bilateral US-guided ES block (group E) or bilateral ultrasonic-guided OSTAP block (group T). The primary outcome of our trial was the total morphine intake during the first 24 h postoperatively.
**Results**
The total amount of morphine consumed (mg) within the first 24 h following the procedure was statistically substantially less in group E than in group T ($P$<0.001). The time it took for the first morphine request in group E (7.4 ± 1.79 h) was statistically insignificantly longer than group T (6.6 ± 1.97). In comparison with group T, there was no significant decrease in intraoperative fentanyl usage in group E ($P$>0.1). Regarding verbal numerical rating scores when compared between the two groups at rest and cough, it was statistically significant lower at 30 min, 2 h, and 4 h ($P$<0.05) in group E than group T. There was no statistical difference between them in the following periods.
**Conclusion**
Bilateral US-guided ES block offers a powerful analgesia after open umbilical hernia surgery.

**Keywords:**
erector spinae plane block, pain control, transversus abdominis plane block, umbilical hernia

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## Introduction

Effective pain control is critical to improve clinical outcomes and allow patients to mobilize faster after surgery [1]. Conventional opioid-based pain control is associated with many undesirable events such as increased drowsiness, nausea, and vomiting after surgery. Multimodal analgesic techniques using multiple anodyne or local anesthetics can improve pain management and prevent unfavorable postoperative effects [2].

Blocking the transversus abdominis plane (TAP) plays a crucial role in pain control following abdominal surgical procedures [3]. Local anesthetic injected into the transversus abdominis fascia plane can cause sensory block along the anterior wall of the abdomen from T7 to L1. Many clinical studies have shown beneficial effects of TAP, but most of them are related to lower abdominal surgery [3,4].

Ultrasonic-guided oblique subcostal transversus abdominis plane (OSTAP), first published by Hebbard *et al*. [5], is a modification of TAP that successfully solves the issue of inconsistent distribution of supraumbilical blocks. The erector spinae (ES) block is a paraspinal regional anesthesia maneuver that permits local anesthesia dispersion in the fascial plane between the ES muscle and the transverse process achieving the paravertebral regional spread of three vertebral levels caudally and cranially respectively to cover dorsal and ventral rami suppressing somatic and visceral pain [6].

Therefore, we performed a randomized, prospective comparative study under the assumption that ES block was as good as or better than OSTAP block in patients prepared for elective umbilical hernia surgery under general anesthesia.

Our study aimed to compare the perioperative analgesic effect of ES block and OSTAP block in patients scheduled for elective umbilical hernia repair under general anesthesia, with the primary outcome comparing the total analgesic requirement up to 24 h, and the secondary outcomes included fentanyl consumption used intraoperatively and the time it took for the first analgesic request, the degree of pain at rest and cough, any intraoperative or postoperative problems up to 24 h postoperatively.

## Patients and methods

This trial was intended as a prospective, double-blinded, randomized comparative study. The ethics committee of our Faculty of Medicine gave the approval of the study, with protocol number 'RC/2/6/2021.' The study was previously recorded in clinicaltrials.gov, which gave the study number 'NCT04941170'. Following authorization, the experiment was performed at our university hospital from June 2021 through December 2021 on 70 patients with ASA levels I and II of both sexes with the age range between 18 and 65 years scheduled for elective open umbilical hernia repair surgery under general anesthesia. Patients who declined to take part in this study; ASA levels III or IV patients; patients with coagulopathy; patients who are proven to be hypersensitive to one of the used medications; patients with a BMI greater than 35; patients with respiratory, myocardial, kidney, or liver diseases; and chronic drug users were excluded. Eligible patients were determined at the pre-anesthetic clinic visit. The recruited patients' informed written consent was then obtained the night before the surgery. The patients were instructed how to use a verbal number rating method (VNRS), which ranges from 0 to 10 (with 0 referring to no pain and 10 referring to excruciating agony). Using a computer-created stratified random table, patients were randomly allocated to one of the two groups (each containing 35 participants). A set of sealed dark envelopes were used to conceal the patients' allocations and case number information. The anesthetic crew prepared the drugs and opened the envelope accordingly. Neither the participant nor the investigator in charge of gathering the required data was aware of the patient group designations. An intravenous cannula was placed in the patient before the surgery, and premedications (midazolam 0.02 mg/kg and ranitidine 50 mg) were given intravenously. On the patient's arrival to the operating room, basic monitors (ECG, pulse oximetry, and noninvasive arterial blood pressure) were fixed. Preoxygenation with 100% oxygen was done for 3 min. General anesthesia was established with propofol 2 mg/kg, fentanyl 1–2 μg/kg, and cisatracurium 0.15 mg/kg to ease endotracheal intubation. Isoflurane and cisatracurium were used to maintain anesthesia. Ventilation parameters were adjusted to maintain tidal volume of 6–8 ml/kg and end-tidal $CO_2$ between 30 and 35 mmHg.

Either bilateral ultrasonic-guided OSTAP block in the group (T) or bilateral ultrasonic-guided ES block for patients at the level of T7 in the group (E) was conducted after induction of anesthesia and before surgical intervention. The hemodynamic goal was to maintain systolic blood pressure within 20% of the baseline. Persistent intraoperative elevations above this point would trigger intravenous fentanyl additive dose. As the surgery is completed, extubation was done after appropriate muscle relaxant reversal with 0.02 mg/kg atropine with 0.05 mg/kg neostigmine. All patients were transferred to the postanesthesia care unit after surgery, where they received 1 g of intravenous paracetamol soon following admission and every 6 h thereafter. If the numerical rating scale was 3, rescue analgesia in 3-mg morphine intravenous increments was provided. The first call for rescue analgesia was registered. The participant, the operating surgeon, and the anesthesiologist who collected data postoperatively were all blinded to the assignment. The primary outcome of our study was comparing the total analgesic requirement up to 24 h, and the secondary outcomes included fentanyl consumption used intraoperatively and the time it took for the first analgesic request. The degree of pain was assessed by VNRS at postanesthesia care unit admission, 30 min, 2, 4, 8, 12, 18, and 24 h postoperatively at rest and cough. Any intraoperative or postoperative problems up to 24 h postoperatively such as vomiting, bradycardia (HR<50 beats/min), and hypotension (defined as a drop in the mean arterial blood pressure of >20% below the preoperative level) were managed with ephedrine 5 and 0.4 mg atropine intravenously, respectively. Hematoma and pneumothorax were all noted.

### Description of the techniques

#### *The technique of ultrasonic-guided erector spinae block*

In the lateral position, under complete aseptic condition, an ultrasonic-guided ES block was performed by palpating the spinous processes beginning from the C7 downward till the T7 spinous process. A low-frequency curved array ultrasonic transducer (General Electric; GE, Florida, USA 'LOGIQ P5') was covered by a sterile sleeve. The ultrasound (US) probe was then

used for identification of the T7 transverse process tip, which was inserted in a transverse position. The ultrasonic probe was then positioned 2–3 cm lateral from the midline in a longitudinal direction for locating the transverse process hyperechoic line and its corresponding sonic shadow. By rotating the probe to a longitudinal direction, a parasagittal view observed transverse processes covered with skin, subcutaneous tissue, and ES muscle. The T5–T6 vertebral level is the site of the inferior margin of the rhomboid major muscle, and its absence was used to confirm visibility of the T7 transverse process. We placed the block needle (8 cm, 22 G) in a craniocaudal direction (Perifix.B.BRAUN Melsungen AG, Germany) until it contacts with the transverse process of T7, in the interfacial plane beneath the ES muscle. The ES muscle was observed, detaching from the transverse process, after a little dose of local anesthetic was administered by the block needle. The needle position is confirmed by this divergence from the transverse process. Administration of 20 ml 0.25% bupivacaine into the interfacial plane is done, deeper to the ES muscle. The same procedure was repeated on the opposite side [7].

#### *Technique of oblique subcostal transversus abdominis plane block*

In supine position under stringent aseptic conditions, US-guided OSTAP block was performed. We sterilized the exposed skin before the procedure and put a sterilized cover on the probe. We put a linear high-frequency ultrasonic probe 6–13-MHz (General Electric; GE, 'LOGIQ_P5') obliquely near the coastal edge and xiphoid process and defined the rectus abdominis muscle (RA), TAP, and transversus abdominis muscle (TA). An 8-cm 22 G block needle (Perifix.B.BRAUN AG, Germany) was then placed on the plane along the oblique subcostal border and laid between the RA and TA. The place of insertion is beneath the xiphoid process. Injection of 1 ml of 0.25% bupivacaine was done to hydro-dissect the fascia between the RA and TA once the needle was confirmed to be in the appropriate target region. The remaining 19 ml of 0.25% bupivacaine was injected inferolaterally along the subcostal border after separating the TA muscle fascia pattern. A similar technique was performed on the opposite side of the abdomen [5].

### Statistical analysis

According to a study done by Wahdan *et al.* [7], the sample size was determined by the primary result (morphine intake for 24 h). Anticipating a 15% decrease in analgesic intake in group E using the power of at least 80% and an estimate of 15% decrease in analgesic intake in group E, the two-sided alpha error level was 5% and the estimated effect size was 0.717. G*Power software, version 3.1.9.4 yielded 32 patients per group (Universitat Keil, Germany). To compensate for dropouts, 35 patients were included in each group.

Data evaluation was made using SPSS, version 25 (IBM, Armonk, New York, USA). Quantitative parametric data were expressed as mean±SD and assessed by unpaired Student *t* test. Qualitative data were expressed as numbers and percentages. Data evaluation was done by the $\chi^2$ test. Quantitative nonparametric data were expressed as medians and interquartile ranges and assessed by Mann–Whitney *U* test. Statistical significance was considered if the *P* values were mostly less than 0.05.

## Results

Tables 1–5.

## Discussion

Multimodal opioid-sparing analgesia has emerged as a viable option to opioid-based analgesia during the last two decades. A successful multimodal strategy incorporates truncal blocks and peripheral nerve blocks [8].

A TAP block is an abdominal field block that affects the anterior abdominal wall's myocutaneous nerve supply. The subcostal technique is appropriate for procedures with a supraumbilical incision as it blocks higher sensory nerves ranging from T6 to T10 [9]. Another method is to use ES block, which involves blocking the posterior and anterior branches of the spinal nerves, besides the communication branches that contribute to sympathetic block and visceral analgesia [10].

The primary goal of the trial showed decreased analgesic consumption with ES block as there were 14 (40%) patients in group E who received postoperative

**Table 1 Demographic data of all groups**

| | Group E | Group T | *P* value |
|---|---|---|---|
| Age (years) | 41.31 ± 10.98 | 39.6 ± 10.8 | 0.51 |
| Weight (kg) | 83.43 ± 9.6 | 82.4 ± 9.22 | 0.64 |
| Sex [*n* (%)] | | | |
| ♂ | 20 (57.1) | 22 (62.8) | 0.62 |
| ♀ | 15 (42.9) | 13 (37.2) | |
| ASA [*n* (%)] | | | |
| I | 28 (80) | 23 (65.7) | 0.17 |
| II | 7 (20) | 12 (34.3) | |
| Duration of surgery (min) | 95.14 ± 11.99 | 94.11 ± 10.94 | 0.709 |

Values are presented as mean±SD and were compared with unpaired Student *t* test. No significant differences were seen among the two groups (*P*>0.05). Ultrasound-guided ES block (group E) or bilateral ultrasonic-guided oblique subcostal transversus abdominis plane block (group T).

**Table 2 Total morphine consumption (mg) in 24 h postoperatively and intraoperative fentanyl (mcg) time to 1st analgesic request (h)**

| | Group E | Group T | *P* value |
|---|---|---|---|
| Number of patients received IV morphine | 14 (40) | 22 (62.8) | 0.0557 |
| Total morphine consumption in 24 h (mg) | 9 ± 2.72 | 12 ± 1.85 | <0.001* |
| Intraoperative Fentanyl (mcg) | 51.85 ± 18.6 | 58.85 ± 19.93 | 0.13 |
| Time to 1st analgesic request (h) | 7.4 ± 1.79 | 6.6 ± 1.97 | 0.08 |

Values are presented as mean±SD and were compared with unpaired Student *t* test. No significant differences were seen among the two groups regarding the number of patients received IV morphine time to 1st analgesic request (h), and intraoperative fentanyl (mcg) (*P*>0.05)). There was a significant difference between the two groups regarding total morphine consumption in 24 h (mg *P* value less than 0.001. Ultrasound-guided ES block (group E) or bilateral ultrasonic-guided oblique subcostal transversus abdominis plane block (group T).

**Table 3 Comparison between the two studied groups according to verbal number rating scale at rest**

| VNRS at rest | Group (E) (*n*=35) | Group (T) (*n*=35) | *P* |
|---|---|---|---|
| On admission | 3 (2–3.5) | 3 (2–4) | 0.366 |
| 30 min | 4 (3–5) | 6 (4–6) | 0.020* |
| 2 h | 4 (3–4.5) | 4 (3–6) | 0.042* |
| 4 h | 3 (2–4) | 4 (3–4.5) | 0.028* |
| 8 h | 3 (2–4) | 3 (3–4) | 0.294 |
| 12 h | 2 (2–3) | 2 (2–3) | 0.505 |
| 18 h | 2 (1–2) | 2 (2–2.5) | 0.185 |
| 24 h | 1 (1–2) | 2 (1–2) | 0.562 |

Data were expressed as medians and interquartile ranges (IQR). VNRS, verbal number rating scale. Regarding VNRS at rest, there was a significant difference between the two groups at 30 min (*P*=0.020), 2 h (*P*=0.042), and 4 h (*P*=0.028), with no significant difference between the two groups at other times of observation (*P*>0.05). Ultrasound-guided ES block (group E) or bilateral ultrasonic-guided oblique subcostal transversus abdominis plane block (group T).

morphine versus 22 (62.8%) patients in group T, with a nonsignificant difference. Regarding total postoperative morphine intake (mg) during 24 h postoperatively, group E showed a statistically significant reduction compared with group T (9 ± 2.7 and 12 ± 1.8 mg, respectively; *P*<0.001). As per secondary outcomes, both regional anesthetic treatments provided good postoperative analgesia. The ES block, on the contrary, provided significantly prolonged analgesia with latency to rescue analgesia need of 7.4 ± 1.79 h compared with 6.6 ± 1.97 h with the TAP block. At each observation time, there was a considerable improvement in VNRS.

Malawat *et al*. [11] performed a study comparing TAP block and ES block for pain control postoperatively for cesarean delivery patients. The overall postoperative morphine intake in the ES group was significantly less than that in the TAP group (*P*<0.001). In addition, visual analog scale

**Table 4 Comparison between the two studied groups according to verbal number rating scale at cough**

| VNRS at cough | Group E (*n*=35) | Group T (*n*=35) | *P* |
|---|---|---|---|
| On admission | 3 (2–4) | 3 (2–4) | 0.514 |
| 30 min | 5 (3–6) | 6 (4–6) | 0.025* |
| 2 h | 4 (3–5) | 4 (4–5) | 0.028* |
| 4 h | 3 (2.5–4) | 4 (3–4.5) | 0.045* |
| 8 h | 3 (2–4) | 3 (3–4) | 0.294 |
| 12 h | 2 (1–2.5) | 2 (2–3) | 0.340 |
| 18 h | 2 (1–2) | 2 (1.5–2.5) | 0.345 |
| 24 h | 1 (1–2) | 2 (1–2) | 0.562 |

Data were expressed as medians and interquartile ranges (IQR). VNRS, verbal number rating scale. Regarding VNRS at cough, there was a significant difference between the two groups at 30 min (*P*=0.025), 2 h (*P*=0.028), and 4 h (*P*=0.045), with no significant difference between the two groups at other times of observation (*P*>0.05). Ultrasound-guided ES block (group E) or bilateral ultrasonic-guided oblique subcostal transversus abdominis plane block (group T).

**Table 5 Intraopertive and postoperative complications**

| Complications | Group E [*n* (%)] | Group T [*n* (%)] | *P* value |
|---|---|---|---|
| Nausea | 4 (11.4) | 8 (22.9) | 0.2 |
| Vomiting | 2 (5.7) | 3 (8.6) | 0.64 |
| Bradycardia | 1 (2.9) | 3 (8.6) | 0.3 |
| Hypotension | 1 (2.9) | 2 (5.7) | 0.55 |
| Hematoma and pneumothorax | 0 | 0 | – |

Data evaluation was made by the $\chi^2$ test. No significant differences were seen among the two groups regarding nausea, vomiting, bradycardia, hypotension, hemothorax, and pneumothorax *(P* value more than 0.05). Ultrasound-guided ES block (group E) or bilateral ultrasonic-guided oblique subcostal transversus abdominis plane block (group T).

scores were much lower at cough and rest. These findings were similar to those of our research.

Our findings are in line with those of Boules and colleagues, who investigated the effect of analgesia of TAP block and ES block after elective cesarean delivery (CS) and noticed that the median (interquartile range) period of the block was lower in the TAP group than in ES group [8 h (8–8) vs. 12 h (10–14); *P*<0.001). The mean visual analog scores at rest in the ES group were 0.32 U less than that in the TAP group in the first 24 h. The TAP group used considerably more tramadol in the first 24 h than the ES group [125 mg (100, 150)] vs. 100 mg (75, 100); *P*=0.003] [12].

In our trial, the time to rescue analgesia requirement in the TAP block group was 6.6 ± 1.97 h, whereas in the ES block group, it was 7.4 ± 1.79 h. Our trial is equivalent to that of Mohamed and colleagues. Using US guidance, ES block was investigated as an analgesic in patients who underwent open abdominal wall hernia repair. In the ES block group, the pain score was lower at 2 h postoperatively than in the control group and was still lower 12 h after surgery (*P*<0.001). Four patients

in the ES block group needed fentanyl intraoperatively, compared with 27 patients in the control group. In the ES group, the median (interquartile) intake of fentanyl intraoperatively was significantly less [94*g* (74–130 μg)]. In the ES block group, 10 patients needed meperidine after surgery, compared with 25 in the control group. In the ES block group, the median (interquartile) postoperative emergency doloretine use was significantly less [0 mg (0–33 mg)] than that in the control group [83 mg (64–109 mg)]. When comparing the ES block group with the control group, the first analgesic request time was considerably more in the ES block group ($P$<0.001) [13].

The study done by Mankikar *et al.* [14] is consistent with our findings. They studied the analgesic effect of TAP block following cesarean surgery and discovered that it took 9.53 h to get rescue analgesia.

On the contrary, a study conducted in patients undergoing CS using 40 ml of ropivacaine 0.375% for TAP block for postoperative analgesia showed that the pain scores and opioid consumption were similar between the two groups. The groups consisted of one that received TAP block with ropivacaine ($n$=50) and the other placebo ($n$=50). The mean (SD) VAS on movement at 24 h in the ropivacaine and placebo groups was 3.4 (2.4) and 3.2 (2.2) cm, respectively, with $P$=0.47 [15].

McKeen *et al.* [16] conducted a similar study using TAP block and observed no significant difference in opioid consumption ($P$=0.2) and VAS ($P$=0.61).

Our study groups showed nonsignificant differences regarding perioperative problems such as nausea, vomiting, bradycardia, hypotension, hematoma, and pneumothorax ($P$>0.1). Similar results were documented by van den Broek and colleagues. They investigated the effect of combining the ES block with normal anesthesia care in patients who underwent posterior lumbar interbody fusion surgery and observed a reduction in nausea and vomiting after surgery [17].

Fang and colleagues reported that after US-guided preoperative single-dose ES block that delivers equivalent postthoracotomy analgesia through the thoracic paravertebral block, there were nonsignificant differences in nausea and vomiting after surgery. There were a considerable reduction in blood pressure. (6.7% vs. 21.7%, $P$ = 0.04), hematoma (0 vs. 10.9%, $P$ = 0.02), better success rate of single puncture (82.2% vs. 54.3%, $P$ < 0.001), and bradycardia (0 vs. 8.7%, $P$ = 0.04), in the ESPB group [18]. The ES block promises to give extended craniocaudal distribution, including three to four vertebral levels of paravertebral space caudally and cranially, providing for considerable somatic and visceral analgesic and an impact profile similar to retrolaminar and paravertebral blocks [19]. The ultrasonic target represents the transverse process which is another advantage of the ES block, that can be effortlessly seen; a musculofascial plane as the injection site being a musculofascial plane that's a long way from the major vascular systems, pleura and neuroaxis, making it a relatively safe, easy, and dependable surrogate to pain control [20]. As this ES muscle is made up of tendons and muscles that reach the lumbar, thoracic, and cervical regions, a single injection of 30 ml in adults causes several dermatomes to be anesthetized [21].

Our trial has various limitations, one of which is that the effect of local anesthetic diffusion through the nonosseous gaps into the paravertebral region between adjacent vertebrae should be explored further. We did not assess the block's dermatomal levels in this investigation because we were focused on analgesic intake and requirements. Because the block proved difficult to conduct on obese patients, they were excluded. Because both blocks were conducted under general anesthetic, sensory evaluation of the patients was not undertaken; however, this did not alter the outcome. As a result, we urge more research needs to be done comparing the two blocks.

In conclusion, ES plane block is more effective in perioperative analgesia for open umbilical hernia repair when compared with OSTAP block, with no difference in incidence of postoperative complications in patients in both groups.

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#### Conflicts of interest

There are no conflicts of interest.

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