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Analgesic efficacy of erector spinae plane block versus rectus sheath block in adults undergoing open para-umbilical hernia repair

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***Abstract*---**Background: Rectus sheath block (RSB) is a popular technique for post-operative analgesia for patients undergoing abdominal surgeries with midline incisions. Ultrasound-guided erector spinae plane block (ESPB) is an interfacial plane block for the treatment of post-operative neuropathic pain. The aim of this study was to compare the analgesic efficacy of ESPB versus RSB in adult patients undergoing open para-umbilical hernia repair. Methods: This prospective randomized double-blinded study was carried out on seventy-four adult patients with ASA physical status I-II undergoing open paraumbilical hernia repair. Patients were divided into two equal groups: group I (ESPB): patients received bilateral ultrasound-guided ESPB using bupivacaine 0.25% (20 ml) on each side and group II (RSB): patients received bilateral ultrasound-guided RSB using bupivacaine 0.25% (20 ml) on each side. The following measurements was recorded: VAS score, intraoperative fentanyl consumption, the time to the first postoperative rescue analgesia administration, total dose of postoperative rescue analgesia (morphine) consumption, heart rate and mean arterial blood pressure. Results: The VAS scores at PACU admission, 1, 2, 4, 6, 12, 18 and 24 h postoperative,

intraoperative Fentanyl consumption, total amount of Fentanyl, time for the first postoperative rescue analgesia and postoperative morphine consumption were insignificantly different between ESPB and RSB groups. Conclusions: Ultrasound-guided ESPB is an alternative analgesic technique to RSB in adult patients undergoing open para-umbilical hernia repair. Both blocks were comparable regarding analgesic consumption, haemodynamic stability, and drug related adverse effects.

***Keywords*---**Erector Spinae Plane Block, Rectus Sheath Block, Open Para-Umbilical Hernia repair.

Introduction

Proper pain relief is a major concern and area of focus. Pre-operatively, one of the most common questions asked by patients pertains to the amount of pain they will experience after the surgery. Pain has closed ties with clinical outcome and acute postoperative patient well-being. Studies have indicated such negative clinical outcomes to include decreases in vital capacity and alveolar ventilation, pneumonia, tachycardia, hypertension, myocardial ischemia, myocardial infarction, transition to chronic pain, poor wound healing, and insomnia [1-3]. The advent of ultrasound guidance has helped to increase the feasibility and clinical applications for truncal block, allowing easier identification of the target anatomy structures and accurate visualization of the needle and local anesthetic spread [4].

Rectus sheath block (RSB) is a popular technique for post-operative analgesia for patients undergoing abdominal surgeries with midline incisions. A good analgesic effect has been reported for upper as well as lower abdominal midline incisions [5]. The anesthetic spread in the space behind the rectus abdominis muscle is the premise for an effective RSB as it spreads freely cephalad and caudal and to block the terminal branches of the intercostal nerves before they leave the rectus sheath [6].

Ultrasound-guided erector spinae plane block (ESPB) is an interfascial plane block described by Forero et al. [7] for the treatment of thoracic neuropathic pain. Although first described for use in chronic pain, it has later been used as a postoperative analgesia method in many surgical procedures [8, 9]. ESPB is performed at T7-8 to target the thoracoabdominal nerves for abdominal surgery and has been demonstrated to have a role in simplifying complex analgesia protocols in surgeries that require multiple procedures and incisions [10]. The aim of this study was to compare the analgesic efficacy of ESPB versus RSB in adult patients undergoing open para-umbilical hernia repair.

Patients and Methods

This prospective randomized double-blinded study was carried out on seventy-four adult patients aged (21-70) years old with ASA physical status I-II undergoing open paraumbilical hernia repair. An informed written consent was obtained from the patient or relatives of the patients. The study was done after approval of our institutional ethics committee. Exclusion criteria were chronic opioid use or analgesic medication, psychiatric disorder, uncooperative patients, coagulopathy, local anesthetic sensitivity, local infections and body mass index (BMI) more than 35 kg/m^2.

The study is randomized double-blinded clinical trial. By using computer-generated random numbers, patients were allocated in 2 groups (37 each). Allocation was done using a sealed opaque envelope by blind chief nurse who did not have further role in the study. The block was performed by the same investigator who had no further role in the study. Intraoperative and postoperative assessments were done by an anesthetist blinded to the group assignment.

Patients were divided into two equal groups: group I (ESPB): patients received bilateral ultrasound-guided ESPB using bupivacaine 0.25% (20 ml) on each side and group II (RSB): patients received bilateral ultrasound-guided RSB using bupivacaine 0.25% (20 ml) on each side. All patients were subjected to history taking, full clinical examination, laboratory investigations (complete blood count, prothrombin time, liver function test, renal function test) ECG.

Intraoperative management

Peripheral intravenous (IV) line, monitoring including pulse oximetry, ECG, and non-invasive arterial pressure, premedication using IV midazolam (0.05 mg/kg), ultrasound guided ESPB or RSB, induction of general anesthesia using IV injection of propofol 2 mg/kg, fentanyl 1 µg/kg and atracurium besylate 0.5 mg/kg then the intubation, anesthesia was maintained with end tidal isoflurane (1-1.2%) in oxygen-air mixture (50-50%), and incremental dose of atracurium besylate (0.1 mg/kg). Skin incision was allowed about 15 minutes after the regional anesthetic technique administration. Inadequate analgesia in form of increase in heart rate or mean arterial blood pressure more than 20% above baseline was managed by IV fentanyl 1 µg/kg. Neostigmine 0.05 µg/kg and atropine 0.15 µg/kg were given then extubation was done.

Postoperative management

Paracetamol 1 gm was given immediately postoperative then every 6 hours. Postoperative pain was evaluated using Visual Analogue Scale (VAS) and IV morphine (0.05 mg/kg) was given when VAS scale was more than or equal to 40mm. Intraoperative fentanyl consumption, the time to the first postoperative rescue analgesia administration, total dose of postoperative rescue analgesia (morphine) consumption, heart rate and mean arterial blood pressure were measured.

Ultrasound-guided erector spinae plane block technique

Ultrasound-guided ESPB was performed in sitting position under strict aseptic precautions. By palpation of spinous process starting from C7 down, T7 spinous process was located, tip of T7 transverse process was identified using an ultrasound probe that is placed in a transverse orientation. By rotation of the probe into a longitudinal orientation process, lower border of rhomboid major muscle situated at T5-T6 vertebral level, and its absence was used to confirm visualization of T7 transverse process. After local anesthetic infiltration, 20-gauge needle was inserted in-plane and directed craniocaudally until it contacted T7 transverse process. Correct location of needle tip in fascial plane deep to the erector spinae muscle was confirmed by injection of 0.5-1 ml saline to visualize lifting erector spinae muscle off the transverse process without distending the muscle and spreading caudally and cranially. After negative pressure aspiration, 20 ml bupivacaine 0.25% was injected on each side below erector spinae muscle at level of T7 [8].

Ultrasound-guided rectus sheath block technique

The ultrasound probe (5-12MHz) was positioned transversely on the rectus abdominis muscle about 1cm above the umbilicus. After local anesthetic infiltration, a 20-gauge needle was inserted in-plane until its tip positioned in the plane between the lateral side of rectus abdominis muscle and the posterior rectus sheath. After negative pressure aspiration, 20 ml bupivacaine 0.25% was injected on each side between rectus abdominis muscle and the posterior rectus sheath [11].
Primary outcome was postoperative pain in first 24 hours. Secondary outcomes were the intraoperative and postoperative opioids consumption.

Sample Size Calculation

The sample size was calculated using Epi-Info software statistical package created by World Health organization and center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. The criteria used for sample size calculation were as follows: 95% confidence limit, 80% power of the study and expected difference in the postoperative pain level between the two groups is about 30%. The sample size based on the previously mentioned criteria was found to be at least 33 patients in each group with 10% drop out of the calculated sample size, so 37 patients were recruited in each group.

Statistical analysis

Statistical analysis was done by SPSS v27 (IBM©, Chicago, IL, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean ± standard deviation (SD) and were analysed by unpaired student t-test. Data do not follow the normal distribution were presented as median and interquartile range (IQR) and were analysed by Mann Whitney-test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or

Fisher's exact test when appropriate. A two tailed P value < 0.05 was considered statistically significant.

(A) (B)

Figure 1: (A) US-guided erector spinae plane block (View of erector spinae plane). (B) US-guided rectus sheath block (Anatomy of rectus sheath block)

Results

In this trial, 82 cases were assessed for eligibility. 74 patients were allocated into two equal groups. All allocated patients were followed up and analyzed statistically.

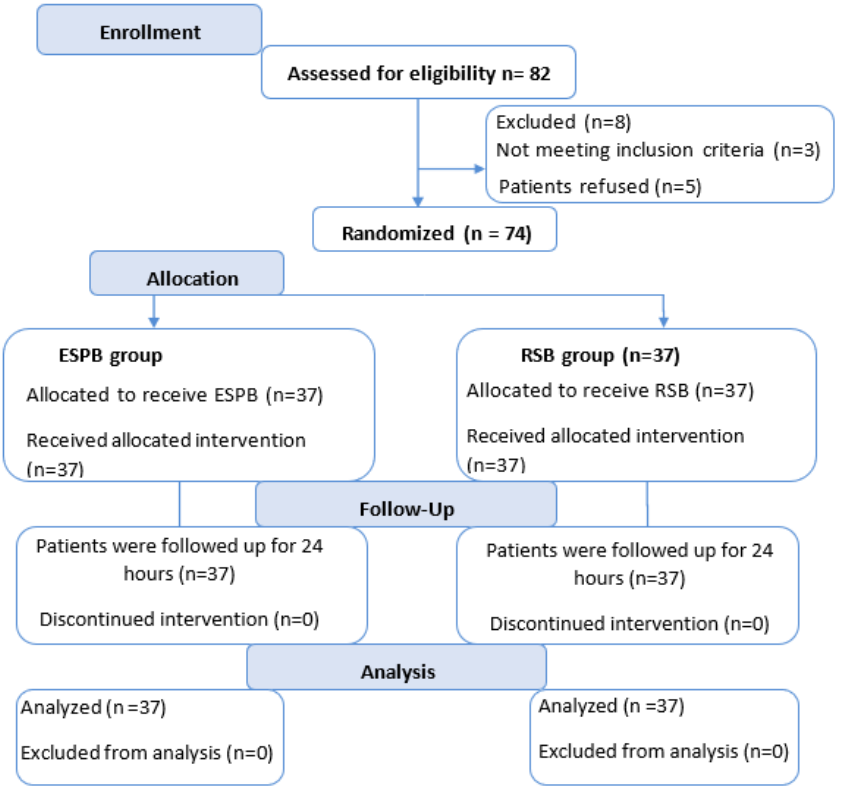


Figure 2: CONSORT flow diagram of the participants through each stage of the randomized trial

Age, gender, BMI, ASA physical status and the operative time were insignificantly different between both groups. Table 1

Table 1: Characteristics of studied groups

		Erector Spinae Plane Block (n=37)	Rectus Sheath Block (n=37)	t/X^2	p
Age (years)		42.11±13.55	45.57±14.07	2.880	0.058
Gender	Males	7 (18.9%)	7 (18.9%)	0.000	>0.999
	Females	30 81.1%)	30 (81.1%)		
Body mass index (kg/m^2)		28.68±3.55	28.26±3.07	0.535	0.594
ASA	1	15 (40.5%)	18 (48.6%)	0.492	0.483
	2	22 (59.5%)	19 (51.4%)		
Operative time (min)		48.24±8.10	48.65±8.30	0.213	0.832

Data are presented as mean ± SD or frequency (%).

The VAS scores were insignificantly different between ESPB and RSB groups at PACU admission, 1, 2, 4, 6, 12, 18 and 24 h postoperative. Figure 3

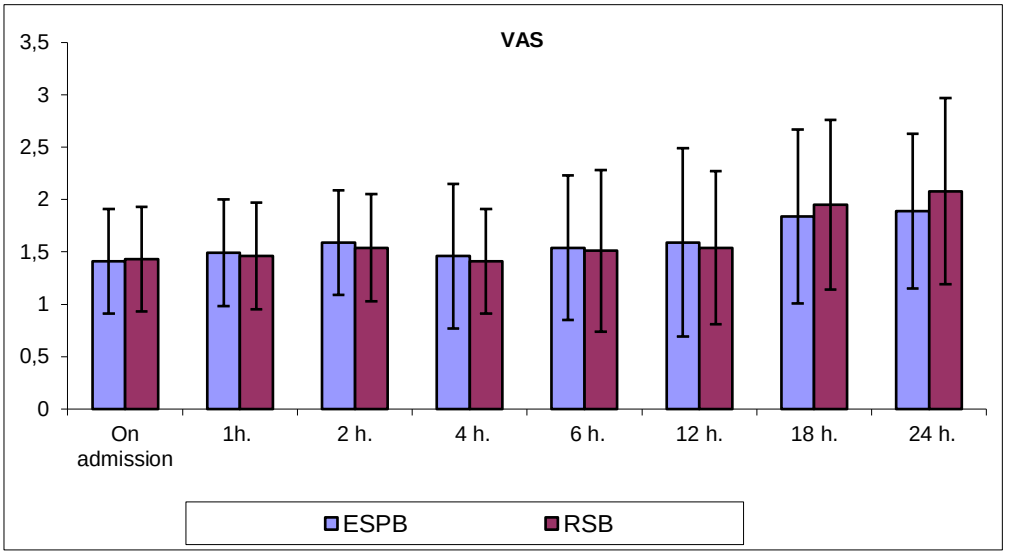


Figure 3: Comparison of postoperative VAS between studied groups at different periods of follow up

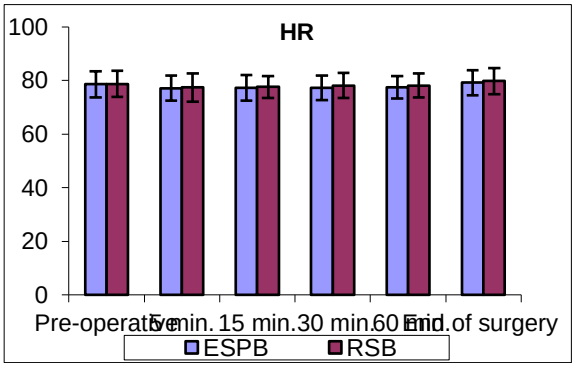
The intraoperative Fentanyl consumption, total amount of Fentanyl, time for the first postoperative rescue analgesia and postoperative morphine consumption were insignificantly different between both groups. Table 1

Table 2: Comparison of intraoperative Fentanyl consumption, total amount of Fentanyl, first rescue analgesia and postoperative morphine consumption between studied groups

	Erector Spinae Plane Block (n=37)	Rectus Sheath Block (n=37)		
Fentanyl consumption	5 (13.5%)	3 (8.1%)		P (Fisher's exact test) 0.711
Total Fentanyl (µg)	0 – 0 (0)	0 – 0 (0)	Z 0.692	p 0.489
Time for first rescue analgesia (min)	563.51±85.80	510.76±95.74	t 1.077	p 0.285
Morphine used (mg)	3.81±1.43	4.11±1.45	t 0.888	p 0.377

Data are presented as mean ± SD or frequency (%).

The heart rate and arterial blood pressure were insignificantly different between ESPB and RSB groups preoperative and at 5, 15, 30, 60 min and at the end of operation. Figure 4



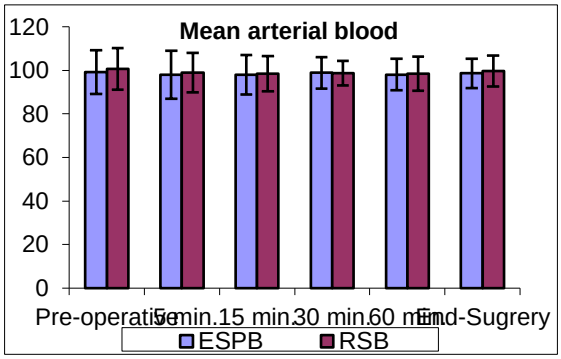


Figure 4: Heart rate and arterial blood pressure between studied groups

The incidence of bradycardia, hypotension, nausea and vomiting was insignificantly different between both groups. Table 3

Table 3: Comparison of complications between studied groups

		Erector Spinae Plane Block (n=37)	Rectus Sheath Block (n=37)	p
Complications	Bradycardia	1 (2.7%)	0 (0%)	0.314
	Hypotension	1 (2.7%)	0 (0%)	0.314
	Nausea	3 (8.1%)	4 (10.8%)	0.691
	Vomiting	2 (5.4%)	3 (8.1%)	0.643

Data are presented as mean ± SD or frequency (%).

Discussion

In our study, postoperative VAS score, intraoperative fentanyl consumption, time for first rescue analgesia and postoperative morphine consumption were insignificantly different between both groups. The analgesic efficacy of ESPB in patients with ventral hernia repair had been studied by Chin et al [8] They performed preoperative bilateral ESPB at the level of the T7 transverse process in four patients undergoing laparoscopic ventral hernia repair. They concluded that ESPB is a promising regional anesthetic technique for laparoscopic ventral hernia repair and other abdominal surgery when performed at the level of the T7 transverse process. Its advantages are the ability to block both supra-umbilical and infra-umbilical dermatomes with a single-level injection and its relative simplicity.

Moreover, Altıparmak et al [12] compared the effects of ESPB and oblique subcostal TAP in 68 patients undergoing laparoscopic cholecystectomy. They concluded that ultrasound guided ESPB reduced postoperative opioid consumption and pain scores more effectively than oblique subcostal TAP block after laparoscopic cholecystectomy surgery. Also Hamed et al [13] evaluated ESPB efficacy in female patients undergoing elective abdominal hysterectomy undergoing general anesthesia. Patients were randomly allocated into two equal groups. ESPB group received ultrasound-guided ESPB at T9 vertebrae level. Control group patients did not receive a block. Total opioid consumption and VAS score pain in the first 24 h

postoperatively were evaluated. They revealed that bilateral ESPB provided effective postoperative analgesia and markedly decreased postoperative opioid consumption in patients undergoing an abdominal hysterectomy.

The mechanism of analgesic effects of ESPB is explained by the spread of an injected local anesthetic below the erector spinae muscle along this fascial plane and with subsequent infiltration of the paravertebral space. This shows local anesthetic from the erector spinae plane through the epidural sinuses to the paravertebral space, leading to both a visceral and a somatic nociceptive blockade. Radiological and anatomical investigations on cadavers have showed that the ESPB takes effect on dorsal and ventral rami of the spinal nerves as these exit the vertebral canal resulting in a block covering both visceral and somatic nociceptive pathways. Local anesthetic diffuses anteriorly to the ventral and dorsal rami, and across intertransverse connective tissue to the paravertebral space. Diffusion may also allow spread into the epidural space. Therefore, the ESPB is an interfascial plane block involving the injection of local anesthetic deep into the erector spinae muscle complex at a site adjacent to the vertebral transverse processes. The analgesic effect correlates to the spread of local anesthetic along the interfascial tissue planes with a median of 3.4 ml injected volume offering analgesic coverage over one dermatome. The proposed spread of local anesthetic anterior to the paravertebral and epidural space provides both visceral and somatic analgesia with distribution between two to five vertebral levels. Consequently, specific vertebral levels can be targeted and the volume of local anesthetic injected can be customized, respectively, according to specific patient or procedure requirements [14].

The analgesic efficacy of RSB in the case of umbilical hernia had been studied by Kartalov et al [15]. They evaluated the analgesic effects of the bilateral ultrasound guided RSB as supplement of general anesthesia on 60 patients undergoing elective umbilical hernia repair. Patients were randomly allocated into two equal groups; The group I (n=30) patents received only general anesthesia. In the group II (n = 30), patents received bilateral ultrasound guided RSB with 40 ml of 0.25% bupivacaine after induction of general anesthesia. Their results showed that the ultrasound guided rectus sheath block used for umbilical hernia repair could reduce postoperative pain scores and the amount of opioid consumption in 24 hours postoperative period.

Also, Gurnaney et al [16] compared the efficacy of ultrasound-guided RSB and local anesthetic infiltration in providing postoperative analgesia for umbilical hernia repair. Their study demonstrated that ultrasound-guided RSB provided superior analgesia in the perioperative period compared with infiltration of the surgical site after umbilical hernia repair.

The RSB provides its analgesic effects through blocking the ventral branches of the seventh to twelfth intercostal nerves which penetrate the posterior wall of the RAM and end in an anterior cutaneous branch supplying the skin of the umbilical area. So it blocks the somatic pain but not the visceral pain [17]. Regarding the measured hemodynamics (heart rate and mean arterial blood pressure) in our study, our results showed that the heart rate and mean arterial blood pressures

were insignificantly different between both blocks in different times during the follow up.

The haemodynamic stability of ESPB had been demonstrated in previous studies [12, 13, 18]. Regarding the complications in our study, 5 patients in ESPB group and 7 patients in RSB group. The safety of ESPB and RSB had been proved by Altıparmak et al [12], Hamed et al [13], Greenbaum et al [19], Flack et al [20], El-Sheikh et al [21], Cho et al [22]. Limitations of our study included sample size was relatively small and may need further studies with increasing sample size, more randomized trials need to be conducted to verify the findings of our study, we did not assess the sensory distribution of the used regional nerve blocks and we did not use catheter to extend the analgesic effect of the blocks.

Conclusions

Ultrasound-guided ESPB is an alternative analgesic technique to RSB in adult patients undergoing open para-umbilical hernia repair. Both blocks were comparable regarding analgesic consumption, haemodynamic stability, and drug related adverse effects.

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Conflict of Interest: Nil

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