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Comparative Study between Ultrasound Guided Erector Spine Block versus Transversus Abdominis Plane Block for Post-Operative Analgesia in Laparoscopic Cholecystectomy

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ABSTRACT

Cholelithiasis is a common condition, and laparoscopic cholecystectomy (LC) is the preferred minimally invasive procedure for symptomatic gallstones. Postoperative pain management is crucial for enhancing recovery. Ultrasound-guided erector spinae plane block (US-ESP) and transversus abdominis plane block (TAP) are two regional anesthesia techniques used for postoperative analgesia. **Objective:** To compare the mean postoperative numeric rating scale (NRS) scores in patients undergoing LC with US-ESP and TAP blocks. **Methods:** This observational prospective study was approved by the Institutional Review Board (IRB) of RMI, Peshawar. This observational prospective study included 138 patients (69 in each group) who underwent LC at the Department of Anesthesia, RMI, Peshawar, from October 1, 2021, to April 1, 2023. Group A received US-ESP, and Group B received TAP. Postoperative NRS scores were recorded at 12 hours. All patients provided informed consent before participation. The study adhered to ethical guidelines and was approved by the Institutional Review Board (IRB) of Rehman Medical Institute. **Results:** The mean postoperative NRS score was significantly lower in Group A (1.521 ± 0.63) compared to Group B (2.304 ± 0.69) (p=0.000). Both groups had similar demographic and procedural characteristics. **Conclusions:** It was concluded that US-ESP is more effective than TAP in providing postoperative analgesia in LC patients, as evidenced by lower NRS scores.

INTRODUCTION

Cholelithiasis is a common comorbid in patients, but for symptomatic gallstone, the minimally invasive procedure used nowadays is laparoscopic cholecystectomy. During this procedure, 3 ports are inserted into the abdominal cavity. These breach points in the skin are painful post-op; op is responsible for the high intensity of post-operative discomfort. Enhancing recovery after surgery is possible only with good pain control [1]. Postoperative nausea and vomiting (PONV) and respiratory depression are common side effects of the use of opioids for pain relief [2]. Various analgesic strategies have been suggested for the management of postoperative pain. Apart from using opioids, the other options include intraperitoneal instillation with a local anesthetic, port-site infiltration and

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different nerve blocks (transversus abdominis, oblique subcostal transversus abdominis and paravertebral). These operations only address somatic pain, except for the paravertebral block, and in certain cases, they may not provide enough relief [3, 4]. Mounika *et al.*, developed the subcostal technique of TAP block as a postoperative pain management treatment, particularly for upper abdominal procedures [5]. The effectiveness of ultrasound-guided oblique subcostal abdominis plane (US-OSTAP) blocks in reducing postoperative pain and narcotic use during the first 24 hours following laparoscopic surgery (LC) has been shown in several prior studies. The OSTAP block successfully reduces somatic discomfort and parietal pain in the anterior abdomen without affecting visceral nerves [6, 7]. The ventral and dorsal rami of the spinal nerves are targeted by ultrasound-guided erector spine plane block (US-ESP). Once the local anesthetic is injected, it spreads upwards and downwards along the spinal nerves, covering different dermatomes. Past case studies and clinical randomized controlled studies have demonstrated the efficacy of the US-ESP block in providing pain relief after various surgical operations, such as those involving the abdomen, chest, breasts, and spine [8, 9]. A study conducted by Tulgar and colleagues revealed that the average Numeric Rating Scale score after an ultrasound-guided erector spine block was 1.75 ± 0.99. In contrast, the transversus abdominis plane block during laparoscopic cholecystectomy has a score of 2.2 ± 0.89 [10]. An example of peri-paravertebral plane block is erector spinae block. Although the exact mechanism of ultrasound-guided erector spine block is not completely understood, Sensation over a large area is blocked due to the spread of the local anesthetic to the ventral and dorsal rami of the spinal cord. This study was carried out to compare the average postoperative numerical rating scale scores for transversus abdominis plane block with ultrasound-guided erector spinae block in laparoscopic cholecystectomy.

This study aims to validate the impact of receiving an ultrasound-guided erector spine block on the decrease in I/V opioids used postoperatively, as no previous research has been conducted on this topic within our local population.

METHODS

This observational prospective study was conducted at the Department of Anesthesia, RMI, Peshawar, after obtaining permission from the ethical committee. The study duration was from 1st October 2021 to 1st April 2023. The study was approved by the Institutional Review Board (IRB) of RMI, Peshawar, with reference number (RMI/RMI-REC/Article Approval/131). The sample size was 138 (69 in each group). Using power=80% and α=5%, the sample size was determined with a 95% confidence level. After a laparoscopic cholecystectomy, the mean postoperative score on the Numerical Rating Scale was 2.2 ± 0.89, while the mean score with an ultrasound-guided erector spine block was 1.75 ± 0.99. The sampling technique was non-probability consecutive sampling. The sample size was calculated based on a presumed effect size derived from a previous study by Tulgar *et al.*, where the NRS difference between groups was approximately 0.45. Using an effect size of 0.5, a power of 80%, and α of 0.05, the minimum required sample size per group was determined to be 69. The sample size formula used was as follows: n = (Z_alpha/2 + Z_beta) ^2 * (SD1^2 + SD2^2) / (Mean1 - Mean2) ^2 [11]. Where: Z_alpha/2 = 1.96 (for a 95% confidence interval), Z_beta = 0.84 (for 80% power). SD1 and SD2 = Standard deviations from the previous study (0.99 and 0.89, respectively). Mean1 and Mean2 = Mean NRS scores from previous research (1.75 and 2.2, respectively). The calculated sample size per group was 69, making a total of 138 participants. This calculation ensures adequate power to detect a clinically meaningful difference between groups while accounting for potential variability in pain perception and reporting. Inclusion Criteria: Age 18 to 50 years, both genders, undergoing laparoscopic cholecystectomy, ASA grade I and II (Annexure-II). Exclusion Criteria: Patients allergic to local anesthetic, patients with a history of bleeding disorders, patients on anticoagulant therapy, patients with severe liver/kidney diseases and patients with significant previous surgical history. Patients from the Department of Anesthesia, RMI, were included based on the established inclusion criteria. The procedure was explained to all patients, and consent was obtained. Demographic data (age and gender) were collected. Randomization was performed via block randomization, with 69 patients in each group. All patients received uniform induction protocols, and vital signs were monitored throughout the procedure. Patients in Group A were positioned in a left lateral decubitus position, longitudinal parasagittal orientation was chosen for the linear ultrasound probe with the patient's right side elevated, a 21-gauge, 10-centimeter needle was inserted using an approach that was not in line with the plane, precisely 2.5–3 cm to the side of the T9 spinous process, with the erector spinae muscles situated on the surface above the tip of the T9 transverse process. The tip of the needle was placed into the fascial plane on the erector spinae muscle's deep (anterior) side. The evident spread of fluid, which caused the erector spinae muscle to rise off the bone on ultrasonography, confirmed the positioning of the needle point. 10ml of 0.5% Inj Rupivacaine + 4mg Dexamethasone + diluted in 10ml normal saline combination were injected on each side. The identical treatment was given to the other side. Group B employed the in-plane approach with a high-frequency linear transducer to complete blocks while supine. The

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transducer was positioned on the oblique plane below the costal margin. All three layers of abdominal muscles were recognized. A 21-gauge, 10-centimeter needle was placed utilizing a medial-to-lateral technique in-plane. The rectus abdominis muscle was the focus of a 10ml of 0.5% inj Rupivacaine + 4mg Dexamethasone + diluted in 10ml normal saline combination were injected which was injected just above the fascia. On both sides, the same method was used. The duration of the process was recorded for both groups. Postoperative pain assessment was conducted using the Numeric Rating Scale (NRS) at different time intervals: 20 minutes, 40 minutes, 1 hour, 3 hours, 6 hours, 9 hours, and 12 hours. Pain levels were measured both when the patient was at rest and when coughing. The final NRS score was recorded 12 hours after the surgery. The postoperative numeric rating scale score was observed and documented from both groups on a specifically constructed proforma (Annexure-I). Analysis was done with IBM-SPSS version 25.0. Frequencies and percentages were computed for qualitative variables (gender). Mean ± Standard deviation was used for quantitative variables (age, duration of procedure and postoperative numeric rating scale score). Both groups were compared for postoperative numeric rating scale scores. The differences in the mean postoperative numeric rating scale score of the two groups were statistically tested using the independent sample t-test. Postoperative numeric rating scale score was stratified by age, gender and duration of procedure. Post stratification using the independent sample t test for both groups, a statistically significant value of p was less than or equal to 0.05.

RESULTS

Age range: 18 to 50 years with a mean age of 32.811 ± 5.25 years, mean procedure duration 60.231 ± 5.17 minutes, and Group A's mean postoperative NRS score was 1.521 ± 0.63. and mean age of 33.913 ± 6.60 years, mean procedure duration 61.087 ± 5.41 minutes and mean postoperative NRS score was 2.304 ± 0.69 in Group B. For gender, the frequency and percentage in both groups are shown in Table 1.

Table 1: Patients According to Age, Duration of Procedure, Postoperative NRS Score and Gender in Both Groups (n=138)

Demographics	Group A (n=69)	Group B (n=69)
	Mean ± SD	
Age (Years)	32.811 ± 5.25	33.913 ± 6.60
Duration of Procedure (Minutes)	60.231 ± 5.17	61.087 ± 5.41
Postoperative NRS Score	1.521 ± 0.63	2.304 ± 0.69
Gender		
Male	26 (37.7%)	37 (53.6%)
Female	43 (62.3%)	32 (46.4%)
Total	69 (100%)	69 (100%)

Group A's mean postoperative NRS score was 1.521 ± 0.63, as compared to 2.304 ± 0.69 in group B (p=0.000), as shown in Table 2.

Table 2: Comparison of Mean Postoperative NRS Score in Both Groups (n=138)

Variables	Group A (n=69)	Group B (n=69)	t	p-value
Postoperative NRS score	1.521 ± 0.63	2.304 ± 0.69	-6.931	0.001

The p-value for male patients (0.962) suggests no meaningful difference, but the sample size imbalance between groups may have affected the results. Further analysis is needed to confirm the significance of these results when adjusting for potential confounders. Stratification of mean postoperative NRS score in both groups about age, gender and duration of procedure is shown in Table 3.

Table 3: Stratification of Mean Postoperative NRS Score Concerning Age, Gender and Duration of Procedure in Both Groups

Variables	Groups	Mean Postoperative NRS Score (Mean ± SD)	p-value
Age (Years)			
18-35	A (n=48)	1.479 ± 0.61	0.001
	B (n=43)	2.418 ± 0.62	
36-50	A (n=21)	1.619 ± 0.66	0.023
	B (n=26)	2.115 ± 0.76	
Gender			
Male	A (n=26)	1.653 ± 0.62	0.962
	B (n=37)	2.270 ± 0.65	
Female	A (n=43)	1.441 ± 0.62	0.001
	B (n=32)	2.343 ± 0.74	
Duration of Procedure (minutes)			
≤60	A (n=29)	1.344 ± 0.48	0.001
	B (n=25)	2.320 ± 0.69	
>60	A (n=40)	1.650 ± 0.69	0.001
	B (n=44)	2.295 ± 0.70	

DISCUSSION

Two main causes of postoperative pain in LC patients have been established: first is trauma of gallbladder resection causing visceral pain, CO2 exposure to the peritoneum leading to stretching, and the second being the pain due to skin incision [11]. These two causes should be taken into account before starting any analgesic protocol after LC. According to our research, patients who underwent ultrasound-guided bilateral single-shot transversus abdominis plane block and bilateral single-shot erector spinae plane block (ESPB) used fewer analgesics within the first 24 hours and coughed and moved less. The control group's numerical rating scale was greater than the block group's during the first three hours. These were significant reductions of visceral pain caused by Pneumoperitoneum and trauma to the gall bladder. While the difference in NRS scores between groups was statistically significant, both

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groups reported NRS scores under 4, indicating mild pain. This suggests that although ESPB demonstrates better numerical outcomes, the clinical difference may not be significant enough to impact routine postoperative protocols. A randomized controlled trial was done on the effect of ESPB in LC patients. The 9th thoracic vertebral level was chosen and injected with 20 ml of 0.375% concentration of bupivacaine as the local anesthetic agent; the NRS was significantly lowered in the first 3 hours, and less analgesia was used during the first 24 hours. ESPB was also performed postoperatively with a lower amount of local anesthetic, but the outcome was similar to preoperative blocks [12]. The exact amount of local anesthetic to be used in abdominal and thoracic procedures is not yet established [13]. Adequate reported amount in ESPB was 3.6 ml of local anesthetic per vertebral [14]. Local anesthetic distribution in the thoracic and lumbar region may differ, so the volume of local anesthetic should be determined according to the procedure/patient [15-17]. Three to seven vertebral levels in the cephalic as well as caudal region are covered when 20 ml of local anesthetic is applied at the T4 vertebral level [18]. Compared to our research, 10ml of 0.5% Rupivacaine with 4mg Dexamethasone diluted in 10ml normal saline provided better coverage and facial splitting and superior depth of analgesia postoperatively [19]. In a study reporting the distribution of the block and time taken for OSTAP to show its effect, it was reported that blockage of T7–T12 dermatomes blocks the sensory signals for the next 10 hours in the mid-abdomen and the lateral side of the abdomen [20]. Blocking of the anterior abdominal wall was done to provide analgesia for the incisions performed in LC. Like ESPB, which addresses both aspects, OSTAP causes the blockade of both somatic and visceral pain [21]. Results of this study have shown the superiority of ESPB over OSTAP, both have similar results in the long run. Procedure time plays an important role in the severity and time of visceral pain. To decide whether ESPB or OSTAP provide better analgesia will be better assessed through further studies involving longer procedures, such as laparoscopic bariatric procedures. Different studies regarding regional anesthetic procedures either use local anesthetic as it is or with N/Saline. Use of lidocaine in our anesthetic mixture so there's a low onset time at the end of the procedure. It was necessary to ensure that the block was in effect while the patient was being extubated and shifted to the PACU. In other articles regarding local anesthesia morphine is used for comparison, but in current study, we used tramadol instead of morphine as it has the same effect in postoperative LC patients [22].

CONCLUSIONS

It was concluded that ultrasound-guided erector spine block (ESPB) is more effective than transversus abdominis plane (OSTAP) block in reducing postoperative pain. ESPB resulted in lower NRS scores across age groups, procedure durations, and genders. ESPB demonstrated superior analgesic depth and consistent pain relief in the first 12 hours after surgery.

Authors Contribution

Conceptualization: SSA
Methodology: RA, DN, AT
Formal analysis: SK, SSS, AA, HM, MAK
Writing review and editing: SSA, MA, SK, SSS

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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