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Comparative Study Between Ultrasound-Guided Erector Spinae Plane Block Versus Transmuscular Quadratus Lumborum Block for Postoperative Analgesia in Laparoscopic Cholecystectomy

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Abstract

Background: *Somatic and visceral features both contribute to the subsequent pain that ensues after laparoscopic cholecystectomy.*

Aim: *To explore the effectiveness of the Erector Spinae Plane Block (ESPB) and quadratus lumborum block (QLB3) to mitigate postoperative pain and narcotic necessities for subjects scheduled for laparoscopic cholecystectomy.*

Methods: *This study comprised 110 participants who underwent laparoscopic cholecystectomy. The participants were randomly categorized into two equally matched groups (ESPB and QLB3). Each participant received a single injection of 20 mL, 0.25% bupivacaine on both sides. The main outcome was to ascertain the necessity for subsequent narcotic analgesia within the initial 24-hour period.*

Results: *The occurrence of mitigated narcotic consumption after surgery was increasingly prevalent in the ESPB group, as opposed to the QLB3 group (65.45% vs. 61.82%, $P = 0.163$). The median 24-hour morphine consumption was comparable between both groups, with 3 doses per day. The distinction in administration amongst the two groups was not statistically significant ($P < 0.608$). The ESPB group had an extended period to the first request for morphine, as opposed to the QLB3 group (157.21 vs. 122.58 minutes, $P = 0.457$).*

Conclusion: *Ultrasound-guided ESPB and QLB3 exhibited similar effectiveness in pain mitigation and tolerability without triggering substantial hemodynamic alterations. Neither group reported serious consequences. The superiority of one block to another could not be concluded. A non-inferiority research design is preferable in order to accurately determine the degree of similarity observed across the two groups.*

Keywords: Quadratus Lumborum Block; Erector Spinae Plane Block; Pain Management; Laparoscopic Cholecystectomy

1. Introduction

The integration of ultrasonographic advances in the domain of regional anesthesia has not merely simplified the administration of nerve blocks but also facilitated the identification and implementation of numerous innovative interfascial blocks. Indeed, truncal blocks are increasingly frequent.¹

Laparoscopic cholecystectomy (LC) is less intrusive and implies mitigated postoperative pain, as opposed to standard surgery. Nevertheless, pain encountered after LC is comprised of somatic and visceral aspects. Regional anesthetic studies have regularly

explored LC for these particular considerations.²

Fascial plane blocks are advanced approaches employed to reliably alleviate pain. Currently, many varieties of fascial blocks have been documented, and their clinical utilization is steadily expanding.³ Moreover, the fundamental merits provided by these approaches encompass their simplicity of execution, effectiveness of pain alleviation, and minimal likelihood of consequences.⁴

Quadratus lumborum (QL) is a muscle positioned in the posterior portion of the abdomen. QL passes behind the lateral arcuate ligament of the diaphragm, while the psoas major muscle passes behind the medial arcuate ligament. The erector spinal muscle is positioned behind QL.⁵

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The fundamental ESP block approach entails the installation of ultrasound guidance to provide a substantial amount of local anesthetic into the fascial plane located between the ends of the vertebral transverse processes and the erector spinal muscle. The local anesthetic diffuses throughout this potential space, spanning a range of 3-6 vertebral segments in a cranio-caudal trajectory.⁶

This study aims to tackle the implications of ESPB and QLB3 on pain alleviation and the necessity for opioid consumption, subsequent to LC.

2. Patients and methods

This prospective, randomized, controlled study was conducted at Al-Azhar University hospitals between June 2022 and October 2023. Consistent with the Declaration of Helsinki [16], this research followed all relevant regulations. Departmental and institutional ethical committees approved the research methodology. Each participant was individually provided with a comprehensive description of the study aims, process, and associated hazards, and their informed written consent was acquired.

The participants were distributed into two equivalent groups, utilizing random table assignments. The adoption of sealed envelopes guaranteed allocation concealment. Each individual was enrolled after attaining certain eligibility criteria, which encompassed being between the ages of 21 and 60, having an ASA categorization of I-II, and having a BMI between 18 and 35. The standards for exclusion encompassed the following: unwillingness to engage, possessing motor and sensory neurological illnesses, preexisting coagulation conditions, and presence of inflammation at the injection spot.

The principal outcome is to ascertain the necessity for postoperative narcotic analgesia within 24 hours of the surgery. Secondary outcomes encompass static and dynamic pain scoring utilizing the Visual Analogue Scale (VAS), the occurrence of negative consequences corresponding to opioid administration, participant satisfaction, and the occurrence of complications. The frequency of block failure was also revealed and investigated.

Both categories encountered general anesthesia induced by Propofol 2mg/kg, Atracurium 0.5mg/kg, and Fentanyl 2µg/kg. Maintaining anesthesia was ensured by utilizing Isoflurane 1.2 MAC and Atracurium 0.1 mg/kg per 20-30 minutes. The blocks were handled in the operating room, subsequently to the installation of general anesthesia. All participants

received identical local anesthetic mixture with the same constituent and dosage.

ESPB block

After prepping the skin with povidone-iodine, a high-frequency linear probe or a lower-frequency convex probe for obese individuals was positioned 2.5-3 cm to the side of the spinous process of the ninth thoracic vertebra in the parasagittal plane. The skin, subcutaneous tissue, trapezius muscle, erector spinal muscles, and transverse process were observed. A volume of 20 mL of local anesthetic (LA) was administered in the interfascial plane between the erector spinal muscles. The block was conducted on both sides, utilizing the in-plane method.

QLB3

Patients were situated in the lateral decubitus posture. The right block was executed, and subsequently, the patient was relocated to the left block. A convex probe with a low frequency was positioned below the ribs in a horizontal orientation. The lumbar spinal process, vertebral body, psoas muscle, quadratus lumborum muscle, and erector spinal muscles were spotted. A 20 mL of local anesthetic (LA) was administered on each side in the interfascial plane between the anterior border of the quadratus lumborum (QL) muscle and the psoas major muscle.

Intraoperative rescue analgesia

Aggregate fentanyl consumption during the surgical procedure. Opioid rescue was delivered intravenously at a dose of 1 mcg/kg using Fentanyl if there was an enhancement of 20% or more in systolic blood pressure and heart rate as opposed to the baseline readings.

Regimen for pain relief after surgery

Each participant in the trial received an intravenous infusion of paracetamol at a dosage of 15 mg/kg every 8 hours. Patients with a Visual Analog Scale (VAS) score greater than three will encounter titration of 2 mg of intravenous morphine every 10 minutes until their VAS score reaches three or lower, as long as their respiration rate remains above ten breaths per minute. Patients who have a VAS score greater than three after receiving three sequential doses of intravenous morphine at a dosage of 2 mg would be classified as treatment failures.

Statistical analysis

Power analysis was performed utilizing G*Power software (latest ver. 3.1.9.7; Heinrich-Heine-Universität et al.). To detect significant discriminatory power, statistical power was settled at 90%, α error 5%, and 10% dropout. The research ultimately examined 110 patients to validate the hypothesis.

The recorded outcomes were analyzed utilizing SPSS version 23.0, a statistical software designed for social sciences by SPSS Inc. in Chicago, Illinois,

USA. The quantitative data was revealed employing the mean, standard deviation, and ranges for variables that exhibited a parametric (normal) distribution. Variables that deviated from a normal distribution were identified using the median and interquartile range (IQR). Furthermore, qualitative features are expressed quantitatively by numerical values and percentages. The Independent-samples t-test is used to contrast the means of two parametric variables, whereas the Mann-Whitney U test is appropriate for comparing non-parametric variables. The Chi-square test was employed to contrast groups with categorical data. A 95% confidence interval was established with a corresponding margin of error of 5%. P value < 0.05 is deemed significant.

3. Results

This study encountered 110 individuals subjected to LC. Figure 1 depicts the flow diagram, illustrating the sequential steps of the study approach, starting from participant recruitment and concluding with their final enrollment, subsequent follow-up, and data analysis.

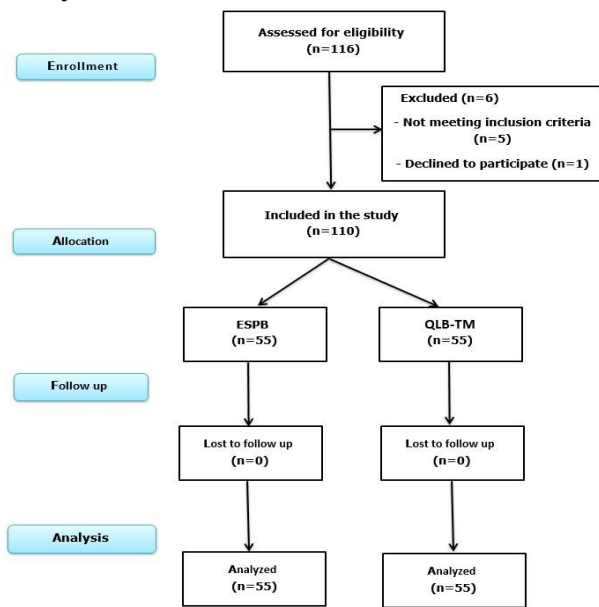


Figure 1. CONSORT flow diagram of the study process.

Table 1. Patient and demographic characteristics in the two study groups.

	ESPB N=55	QLB3 N=55	TEST	P. VALUE
Age (years)	52.5±12.5	53.7±10.5	0.434	0.665
Gende r	male	17 (48.5%)	x ² =0.23	0.631
	female	18 (51.5)		
BMI (kg/m ²)	25.6±2.3	25.5±2.5	0.1742	0.862
ASA	I	16 (45%)	x ² =0.952	0.329
	II	19 (55%)		
Duration of surgery (min)	52.17±7.7	51.5±9.15	T=1.148	0.255
Duration of	7.35±2.47	11.41±3.3	0.662	0.001*

block performance (min) 5

Data presented as mean ± standard deviation, number (%)

x²: Chi- Square test Independent T test

*P-value < 0.05: non-Significant

No significant distinctions were encountered among the groups in terms of age, gender, BMI, ASA, and length of operation.

With respect to hemodynamic measures, there is no significant disparity among the groups concerning the mean arterial blood pressure and heart rate at the various time intervals (p>0.05) (Figures 2 & 3).

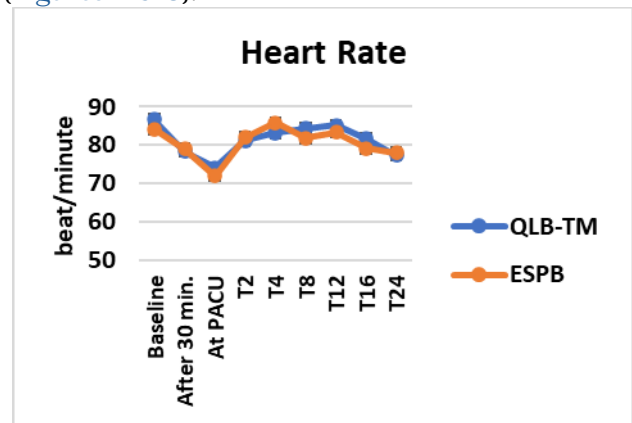


Figure 2. Comparison between the two groups regarding heart rate.

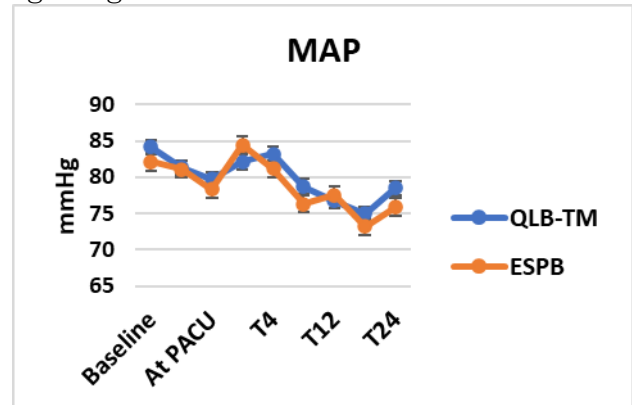


Figure 3. Comparison between the two groups regarding mean blood pressure.

Furthermore, VAS at rest was comparatively lower in ESPB than QLB3 during the initial two hours, but the distinction was not significant. Furthermore, VAS recordings exhibited similar results across both groups at all different time points, as illustrated in Table 2. This study revealed no significant discrepancy in the dynamic VAS score across both study groups, as illustrated in Table 3.

Table 2. Comparison between studied groups according to static VAS score.

TIME POINTS	QLB3 (N=55)	ESPB (N=55)	TEST	P VALUE
T0	3.55±0.81	3.47±0.52	5.421	0.278

T2	2.43±0.76	2.26±0.73	7.326	0.679
T4	3.15±0.84	3.21±0.86	6.821	0.278
T8	3.64±1.34	3.77±1.21	7.433	0.471
T12	3.07±1.08	3.12±1.22	8.105	0.621
T16	2.53±0.99	2.43±0.88	5.379	0.159
T24	2.47±1.08	2.88±0.87	7.824	0.161

Data presented as mean ± standard deviation
*Using: Mann-Whitney U

Table 3. Comparison between studied groups according to dynamic (on cough) VAS score.

TIME POINTS	QLB3 (N=55)	ESPB (N=55)	*TEST VALUE	P VALUE
T0	3.67±1.72	3.59±1.63	6.537	0.386
T2	2.74±1.55	2.63±1.82	7.236	0.496
T4	3.88±1.76	3.51±1.46	6.730	0.328
T8	3.72±1.25	3.82±1.61	7.621	0.562
T12	3.56±1.48	3.14±1.55	7.116	0.631
T16	2.74±1.25	2.61±1.18	6.468	0.417
T24	2.53±0.85	2.71±0.53	5.715	0.502

Data presented as mean ± standard deviation
*Using: Mann-Whitney U

In terms of postoperative opioid intake, the ESPB group exhibited a superior occurrence of postoperative narcotic sparing, as opposed to the QLB3 group (65.45% vs. 61.82%), yet this distinction was not significant (P = 0.163). In addition, the median 24-hour morphine administration shared similarities among QLB3 and ESPB groups (P <0.608) Table 4. Likewise, the consumption of paracetamol corresponded in both groups. In addition, ESPB had an extended period until the first inquiry of morphine, as opposed to the QLB3 group. However, this disparity was not significant (157.21 minutes vs. 122.58 minutes, P= 0.457). Furthermore, no significant disparity was identified among either group in terms of the duration until the initial inquiry for paracetamol.

Table 4. Comparison between studied groups according to the average 24-hour analgesia consumption.

	QLB3 (N=55)	ESPB (N=55)	TEST VALUE	P-VALUE
MORPHINE (DOSE/DAY)	3 (1-4)	3 (2-5)	1.97*	0.608
PARACETAMOL (DOSE/DAY)	2 (1-4)	2 (1-3)	1.45*	0.914

Data presented as median (IQR)
*Mann-Whitney U

Approximately half of the participants in both groups expressed a high level of satisfaction. There was no significant disparity observed among both groups in terms of satisfaction ratings, as demonstrated in Table 5.

Table 5. Comparison between studied groups according to satisfaction score.

SATISFACTION SCORE	QLB3 (N=55)	ESPB (N=55)	P-VALUE
VERY SATISFIED 5	(49.09) 27	(52.73) 29	0.05>
4	(20) 11	(23.64) 13	
3	(23.64) 13	(14.55) 8	
2	(7.27) 4	(9.09) 5	
VERY DISSATISFIED 1	(0) 0	(0) 0	

Data presented as number (%)

Using X2 test

No significant disparities emerged among both groups in terms of consequences, including hypotension, postoperative nausea and vomiting, right shoulder pain, and injection site hemorrhage. Furthermore, there were two instances of block failure recorded in the QLB3 group, in contrast to one instance in the ESPB group, as depicted in Figure 4. No instances of local anesthetic systemic toxicity (LAST), pneumothorax, or visceral damage were observed in any of the cases.

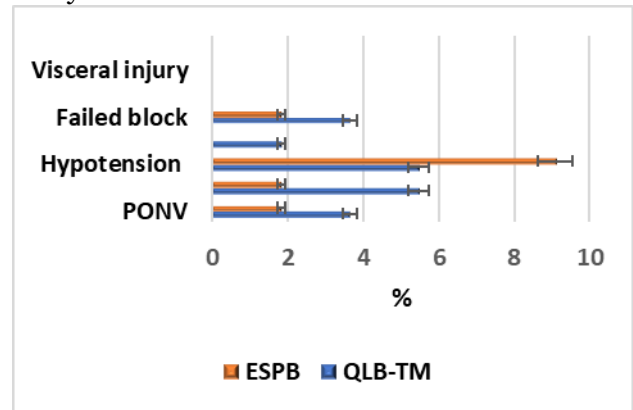


Figure 4. Distribution of complications in the two study groups.

4. Discussion

The paucity of data prevails in exploring the tolerability and effectiveness of QLB3, in contrast to ESPB, among individuals undergoing LC. Three RCTs investigated opioid utilization characteristics of ESPB with other blocks. Two of these trials demonstrated the oblique subcostal transversus abdominis plane block (OSTAP), as detailed by Altıparmak et al.² and Sahu et al.⁷ A study designed by Aygun et al. contrasted the performance of ESPB with QLB-II.¹

Although the transversus abdominis plane block (TAP) has been employed in LC, it is inadequate for offering alleviation from visceral pain. The latest studies have prioritized the investigation of newly recognized regional anesthetic techniques, which offer superior mitigation of visceral pain.⁸

The quadratus lumborum block is a recently established technique that targets the thoracoabdominal nerves, triggering a comprehensive sensory block of both somatic and visceral fibers spanning from Th7-L8 to Th12-L1.⁵ The consequence of QLB in LC was deemed by Ökmen et al.⁹ The study utilized QLB on both a block and sham group. The average 24-hour pain scores were diminished in the block group. The investigators also documented that a significant number of individuals exhibited sensory blocks ranging from the T8-9 to L1 levels.

Baytar et al. carried out a further investigation and established a comparison involving QLB and OSTAP in LC.¹⁰ The study revealed no significant disparity in terms of postoperative analgesia necessity and pain levels.

In addition, ESPB has been demonstrated to boost analgesia in several procedures involving the neck, shoulder, and hip.¹¹ Clinicians need to be more concerning the utilization of ESPB in abdominal and laparoscopic operations are scarce. Tulgar and colleagues conducted the initial randomized controlled research to investigate the usefulness of ESPB and QLB3 in 60 subjects undergoing hip and proximal femur surgery.¹² This study demonstrated no significant distinction in pain scores. They revealed no significant distinction between tramadol use and the proportion of patients seeking rescue analgesics within the initial 24 hours.

The results of our study disclosed that both groups encountered a substantial reduction in pain intensity. No significant discrepancies were observed in the hemodynamic variables among the two groups. Additionally, both groups reported high levels of satisfaction.

In accordance with our research, Aygun et al. revealed that the implications of ultrasound-guided bilateral QLB-II and ESPB on subjects undergoing LC were comparable in terms of postoperative pain alleviation and opiate consumption.¹

Furthermore, a study conducted by Altıparmak et al. in 2019 assessed the utilization of ultrasound-guided ESPB compared to OSTAP block in a group of 64 subjects undergoing LC.² The researchers discovered that ESPB was more efficient than OSTAP block in mitigating postoperative tramadol intake and pain scores.

Unlike our findings, Suri et al., in 2017, explored the impact of ultrasound-guided continuous type I QLB on individuals who endured laparoscopic nephrectomy.¹³ Their report indicated that the QLB approach was not beneficial for postoperative analgesia. The failure was precipitated by disruption to the thoracolumbar fascia (TLF) with dissection, which presumably led to the medication spreading beyond its intended area and ultimately leading to the disintegration of the block.

Indeed, ESPB can be utilized in the lateral, sitting, and prone postures, whereas QLB is often executed in the lateral or prone postures. Consequently, QLB necessitates adjusting the patient's position, whereas ESPB does not. In terms of convenience of application, ESPB is the more straightforward option among the two blocks. After spotting the transverse process, the

needle is directed to approach it, and local anesthetic is injected upon hitting the process.

This study revealed that there was no significant distinction perceived among both groups in terms of hypotension, PONV, and right shoulder pain. Supportingly, a contemporary meta-analysis implemented by Yang et al. revealed that ESPB significantly minimized the occurrence of postoperative nausea (RR 0.47, $p = 0.001$) and vomiting (RR 0.5, $p = 0.02$).¹⁴ They revealed that there was no significant disparity in LC-related shoulder pain among the ESPB and control groups (RR= 0.24).

The scarcity of vasculature diminished anticipates the formation of potentially serious hematomas. Nevertheless, it is prudent to utilize vigilance in individuals with coagulation issues or those undergoing preoperative anticoagulation until further clinical evidence becomes available.¹⁵

Limitations: There are certain constraints in our study. Initially, the dermatomal study was dismissed. Examining the sensory distribution, including various perceptions of the affected nerve branches, will provide greater insight into the block performance. Moreover, a non-inferiority trial could have been an alternative option for the study design. Despite the absence of significant distinction between the two blocks, our study design does not allow for the establishment of equivalence. Furthermore, our ability to further the discussion was hindered due to the paucity of data on this comparison and the relatively recent block approaches.

4. Conclusion

Ultrasound-guided ESPB and QLB3 substantially relieved pain during the perioperative period among individuals undergoing laparoscopic cholecystectomy. The diminished administration of opioids demonstrated this, reduced both static and dynamic VAS scores, and the prolonged period of pain alleviation. Nevertheless, it is not possible to definitively determine if one block is equivalent or preferable to the other. Neither group reported any serious consequences or substantial hemodynamic alterations.

Additional rigorous trials examining the distribution of dermatomes and the extent of local anesthetic diffusion in ESPB and QLB3 are suggested. A non-inferiority research design is preferable to accurately determine the degree of similarity observed across the two groups.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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