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Research Article

COMPARISON OF ULTRASOUND-GUIDED LUMBAR ERECTOR SPINAE PLANE BLOCK AND TRANSMUSCULAR QUADRATUS LUMBORUM BLOCK FOR POST-OPERATIVE ANALGESIA IN TOTAL HIP REPLACEMENT SURGERIES: A PROSPECTIVE RANDOMIZED STUDY

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ABSTRACT

Objectives: The objective of the study is to compare the efficacy of ultrasound-guided lumbar erector spinae plane block (ESPB) and transmuscular quadratus lumborum block (QLB) in providing post-operative analgesia for patients undergoing total hip replacement (THR) surgeries.

Methods: This prospective, randomized, double-blind study compared the efficacy of ultrasound-guided lumbar ESPB and transmuscular QLB (QLB-t) for post-operative analgesia in THR surgeries. Ninety patients were randomized into three groups: ESPB, QLB, and a control group. Primary outcomes included the duration of analgesia, measured by numeric rating scale scores, and secondary outcomes assessed total analgesic consumption and the incidence of post-operative nausea and vomiting (PONV) within 24 h. For statistical purposes, $p<0.05$ was taken as statistically significant.

Results: This study compared lumbar ESPB and QLB for post-operative analgesia in THR surgeries. At the 1st h, pain scores were significantly lower in the ESPB (1.30) and QLB (1.05) groups compared to the control group (2.15) ($p<0.001$). Tramadol consumption in the first 12 h was significantly lower in the ESPB (52.3 mg) and QLB (50.1 mg) groups compared to the control group (135.20 mg) ($p<0.001$). PONV was absent in 60% of ESPB and 63% of QLB patients, compared to only 33% in the control group ($p=0.038$).

Conclusion: Lumbar-ESPB and QLB-t blocks effectively reduce post-operative pain and analgesic requirements in THR surgeries, showing comparable benefits. Both techniques also lower the incidence of PONV.

Keywords: Multimodal analgesia, Total hip replacement, Erector spinae plane block, Quadratus lumborum block.

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INTRODUCTION

Multimodal analgesia has become an important part of perioperative pain management, particularly in orthopedic surgeries where significant post-operative pain is a common occurrence. By combining various analgesic modalities that act on different actions on pain pathways, multimodal analgesia aims to provide superior pain relief, reduce opioid consumption, and minimize opioid-related adverse effects [1]. This approach is particularly beneficial in the context of aging populations undergoing surgeries like total hip replacement (THR) where comorbidities such as cardiovascular and respiratory diseases require optimal use of opioid-sparing techniques. The addition of regional anesthesia techniques to the multimodal analgesic regimen is important not only to enhance analgesia but also to promote early mobilization and functional recovery. Non-opioid analgesia strategies such as regional blocks are important in minimizing opioid-related complications [2].

THR surgery is one of the most commonly performed procedures worldwide, and its incidence has been on the rise. Several factors have contributed to this increase, including the global aging population, the higher prevalence of degenerative joint diseases, and increasing incidence of avascular necrosis of the femur. THR is a major orthopedic procedure associated with significant post-operative pain, which can impair rehabilitation efforts if not managed effectively. As such, optimizing post-operative analgesia is a key concern in THR patients to enhance recovery, improve patient satisfaction, and reduce complications such as chronic pain [3].

The choice of anesthesia and post-operative analgesia in THR is important for achieving optimal outcomes. While general anesthesia remains a common choice, regional anesthesia techniques, such as spinal anesthesia, combined with peripheral nerve blocks, have gained popularity due to their ability to provide targeted pain relief and minimize systemic opioid use. Effective post-operative analgesia is crucial in the early post-operative period since poorly controlled pain can limit rehabilitation efforts and prolong hospital stay. Among the various regional anesthesia techniques, ultrasound-guided lumbar erector spinae plane block (ESPB) and transmuscular quadratus lumborum block (QLB) have emerged as promising modalities for managing post-operative pain in THR. These blocks are increasingly being used into multimodal analgesia protocols for THR due to their ability to provide prolonged analgesia with minimal opioid requirements [4].

The ultrasound-guided lumbar ESPB was first described by Forero *et al.* in 2016 for managing thoracic neuropathic pain. Since then,
ESPB has been used for various types of acute and post-operative pain, including in hip surgeries. When performed at the lumbar level, ESPB has been shown to provide effective post-operative analgesia in patients undergoing hip and proximal femoral surgeries [5]. Although initially described for thoracic procedures, lumbar ESPB has gained traction in hip surgeries due to its simplicity, low complication rates, and ability to provide extensive sensory blockade. On the other hand, transmuscular QLB (QLB-t) is another ultrasound-guided regional anesthesia technique that has been employed for post-operative analgesia in various abdominal and lower limb surgeries. QLB targets the thoracolumbar fascia and provides analgesia by spreading the local anesthetic to the paravertebral and thoracic sympathetic chains [6].

Both lumbar ESPB and QLB-t offer the advantage of reducing opioid requirements in the perioperative period. Opioid-sparing strategies

are particularly important in the elderly population, who are more susceptible to opioid-related side effects such as respiratory depression, nausea, vomiting, and constipation [7]. By providing effective analgesia through regional blocks, these techniques can decrease the need for high-dose opioids and improve patient outcomes. Studies have shown that both ESPB and QLB can significantly lower opioid consumption in the first 24–48 h contributing to faster recovery, shorter hospital stays, and better overall patient satisfaction [8].

Although both lumbar ESPB and QLB have been shown to be effective for post-operative analgesia in THR, few studies have directly compared the two techniques. Each block has its own anatomical targets and mechanisms of action leading to differences in the extent and duration of analgesia [9]. We undertook this study to compare the efficacy of ultrasound-guided lumbar ESPB and QLB-t in providing post-operative analgesia for patients undergoing THR surgeries.

METHODS

This was a prospective, randomized, double-blind study that aimed to compare the efficacy of ultrasound-guided lumbar ESPB and QLB-t for post-operative analgesia in patients undergoing THR surgeries. The study was conducted following approval from the Institutional Ethical Review Board, and written informed consent was obtained from all participants. The sample size calculation was based on an effect size of 0.5, a power of 0.80, and a significance level of 0.05, which indicated that 14 patients per group were necessary. To account for potential dropouts, 30 patients were included in each group. Hence, a total of 90 patients were enrolled and randomized into three groups: Group A (ESPB group), Group B (QLB group), and the Group C control group. Each group consisted of 30 patients. Group assignments were determined using simple randomization through the sealed envelope technique. Patients were assigned random identification numbers before surgery and all data were collected using these identification numbers. The data collection and analysis were performed by personnel blinded to group allocation. The blocks were administered by an anesthesiologist who was not involved in the data collection or outcome assessments.

Patients in the control group received a standardized post-operative analgesia protocol, including intravenous paracetamol every 8 h and tramadol. If the numeric rating scale (NRS) score [10] was ≥4/10 during the first 60 min postoperatively, 50 μg fentanyl was administered with the dose repeated every 30 min if the NRS score remained ≥4. Paracetamol (1 g every 8 h) was continued during ward follow-up, and diclofenac sodium (75 mg intramuscularly) was provided as rescue analgesia during the first 24 h if NRS remained ≥4.

All blocks were performed postoperatively in the lateral position under sterile conditions, using ultrasonographic guidance with a convex transducer. For the lumbar ESPB, the 4th lumbar vertebral level was identified using the conventional method, with an imaginary line drawn between the iliac crests. The transducer was placed 3.5–4 cm lateral to the midline, allowing visualization of the erector spinae muscle and the transverse process. The needle was advanced out-of-plane until it contacted the transverse process, and after confirming with hydrodissection, 40 mL of levobupivacaine 0.25% was administered between the transverse process and the erector spinae muscle. For the transmuscular QLB, the transducer was placed in the transverse plane cranial to the iliac crest. The transverse process, erector spinae muscle, psoas muscle, and quadratus lumborum muscle were identified, and the needle was advanced to deliver 40 mL of levobupivacaine 0.25% into the fascial plane between the quadratus lumborum and psoas muscles.

The primary outcome was the duration of post-operative analgesia, measured by NRS scores at rest at multiple time points: 30 min, 1, 3, 6, 12, 15, 18, 21, and 24 h. The secondary outcomes included the total analgesic consumption, including tramadol and rescue analgesic requirements within the first 24 h, as well as the incidence and severity of post-operative nausea and vomiting (PONV). Nausea and sedation were assessed using a four-point scale (none, mild, moderate, and severe).

Statistical analysis was performed using the Statistical Packages for the Social Sciences 16.0. Descriptive statistics were reported as mean±standard deviation. Continuous variables were analyzed using the independent t-test or the Mann–Whitney U test for non-normally distributed data, while categorical variables were compared using the Chi-square or Fisher's exact test. One-way analysis of variance was used to compare mean NRS scores and tramadol consumption between groups, with Bonferroni correction applied to NRS score comparisons across 10 time points ($p<0.005$ was considered significant). NRS scores were also analyzed using repeated measures analysis. A $p<0.05$ was considered statistically significant for all other analyses.

Inclusion criteria

1. Patients undergoing THR surgeries
2. Age between 18 and 65 years
3. Those who were ready to give informed and written consent to be part of study
4. Patients having American Society of Anesthesiology (ASA) physical status classification score of I-III.

Exclusion criteria

1. Age <18 years or above 65 years
2. Those who refused consent to be part of study
3. Patients known to be allergic to any of the local anesthetic drugs
4. Presence of contraindications to lumbar ESPB or QLB-t
5. Significant psychiatric illness or cognitive dysfunction
6. Thrombocytopenia, hepatic or renal failure.

RESULTS

The analysis of the gender distribution of the studied cases showed that in Group A (ESPB group), 53.33% of the participants were male (16 cases), while 46.67% were female (14 cases). In Group B (QLB group), 60.00% were male (18 cases) and 40.00% were female (12 cases). Group C (Control group) had 56.67% males (17 cases) and 43.33% females (13 cases). The gender distribution was comparable with no significant difference ($p=0.873$) (Table 1).

The mean age of patients in Group A (66.75 years), Group B (65.90 years), and Group C (67.30 years) was comparable in all the 3 groups with no significant difference ($p>0.05$). The ASA grade distribution showed most cases belonged to ASA II across all 3 groups and in terms of ASA grades, the groups were comparable with no significant difference. The mean height and weight were also comparable among the groups with no significant differences. However, body mass index (BMI) showed a statistically significant difference between the groups, with Group A having a BMI of 31.25, Group B at 30.10, and Group C at 29.85 ($p<0.05$). The mean duration of surgery was similar across groups, with no significant differences ($p>0.05$) (Table 2).

The analysis of pain scores at different time points across the three groups showed significant differences in the early hours. At the 1st h, the pain scores were significantly lower in the lumbar-ESPB (L-ESPB) group (1.30) and QLB-t group (1.05) compared to the control group (2.15), with a $p<0.001$. This trend continued at the 2nd and 3rd h, where the L-ESPB and QLB-t groups maintained significantly lower pain scores than the control group ($p<0.001$ for both time points). At the 6th h, pain scores in the L-ESPB (1.60) and QLB-t (1.35) groups were still significantly lower than in the control group (2.40), with a $p=0.002$. However, from the 9th h onward, there were no significant differences between the groups ($p>0.05$) (Table 3).

The analysis of analgesic requirements across the three groups showed that the number of patients requiring fentanyl in the recovery room (RR) was slightly higher in the control group (5 patients) compared to the L-ESPB group (4 patients) and QLB-t group (3 patients), though this difference was not statistically significant ($p=0.144$). Tramadol

Table 1: Gender distribution of the studied groups

Parameters	Group A (ESPB group)		Group B (QLB group)		Group C (Control group)		p-value (Significance)
	Number of cases	Percentage	Number of cases	Percentage	Number of cases	Percentage	
Male (n)	16	53.33	18	60.00	17	56.67	0.873 (Not significant)
Female (n)	14	46.67	12	40.00	13	43.33	
Total (n)	30	100.00	30	100.00	30	100.00	

ESPB: Erector spinae plane block, QLB: Quadratus lumborum block

Table 2: Demographic details, ASA grades, height, weight, BMI, and mean duration of surgeries in studied cases

Parameters		Group A (ESPB group)	Group B (QLB group)	Group C (Control group)	p-value (Significance)
Mean age		66.75±2.80	65.90±3.10	67.30±2.50	p>0.05
ASA grades	ASA I	4	6	5	p>0.05
	ASA II	18	20	21	
	ASA III	8	4	4	
Mean height (cms)		162.40±5.90	163.10±4.30	161.50±3.95	p>0.05
Mean weight (kgs)		79.8±7.10	78.6±6.80	77.3±5.20	p>0.05
BMI (kg/m^2)		31.25±3.90	30.10±3.20	29.85±3.00	p<0.05*
Mean duration of surgery (min)		120.5±15.2	118.7±16.0	121.3±14.8	p>0.05

ASA: American Society of Anesthesiology, BMI: Body mass index, ESPB: Erector spinae plane block, QLB: quadratus lumborum block. *Significant

Table 3: Severity of pain as assessed by NRS in studied groups

Time point	Group A (ESPB group)	Group B (QLB group)	Control	p-value (significance)
1st h	1.30±0.70	1.05±0.72	2.15±0.67	<0.001*
2nd h	1.35±0.60	1.10±0.58	2.05±0.55	<0.001*
3rd h	1.50±0.55	1.05±0.60	2.00±0.50	<0.001*
6th h	1.60±0.52	1.35±0.60	2.40±1.20	0.002*
9th h	2.50±1.05	2.45±1.20	2.40±0.95	p>0.05
12th h	2.85±0.60	2.40±1.00	2.20±0.62	p>0.05
15th h	2.90±0.85	2.40±0.62	2.35±0.75	p>0.05
18th h	2.05±0.60	2.00±0.70	1.90±0.80	p>0.05
21st h	2.20±0.95	2.05±0.93	2.05±0.50	p>0.05
24th h	2.20±0.40	2.15±0.48	2.00±0.40	p>0.05

ESPB: Erector spinae plane block, QLB: Quadratus lumborum block. *Significant

Table 4: Requirement of rescue analgesic doses in studied cases

Parameters	Control	Group A (ESPB group)	Group B (QLB group)	p-value (significance)
Patients requiring fentanyl in RR (n)	5	4	3	0.144
Tramadol consumption (mg)				
Up to 12 h	135.20±28.50	52.3±32.50	50.1±34.10	<0.001
12–24 h	90.50±22.60	82.2±31.25	87.4±24.15	0.321
Mean of total tramadol required	225.70±34.80	132±51.20	138±36.90	<0.001
Rescue analgesia doses required in patients (numbers)	11	4	5	<0.05

ESPB: Erector spinae plane block, QLB: quadratus lumborum block, RR: recovery room

consumption in the first 12 h was significantly lower in both the L-ESPB group (52.3 mg) and QLB-t group (50.1 mg) compared to the Control group (135.20 mg), with a p<0.001. However, from 12 to 24 h, the tramadol consumption was comparable across all groups, with no significant difference (p=0.321). The total mean tramadol required over 24 h was significantly lower in the L-ESPB group (132 mg) and QLB-t group (138 mg) compared to the control group (225.70 mg), with a p<0.001. The number of rescue analgesia doses required was also higher in the control group (11 doses) compared to the L-ESPB group (4 doses) and QLB-t group (5 doses) (Table 4).

The analysis of PONV across the three groups showed a statistically significant difference (p=0.038). In Group A (ESPB), 18 patients experienced no PONV, while Group B (QLB) had 19 patients with no PONV, and Group C (control) had only 10 patients in this category. Mild PONV was reported in 8 patients in Group A, 7 in Group B, and 9 in Group C. Moderate PONV occurred in 3 patients each in Groups A and B, but 6 patients in Group C. Severe PONV was most frequent in the control group, with 5 cases, compared to only 1 case each in Groups A and B (Fig. 1).

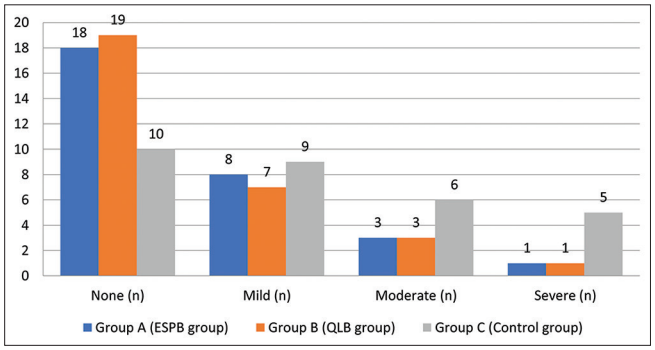

Fig. 1: Incidence of post-operative nausea and vomiting in studied cases

DISCUSSION

Regional anesthesia techniques such as the L-ESPB and transmuscular quadratus lumborum (TQL) block are being increasingly used for pain management in various surgical settings [11]. These blocks which are usually performed under ultrasound guidance provide targeted analgesia by blocking sensory input from the surgical site while sparing motor function. This minimizes opioid use and its side effects such as nausea, constipation, and respiratory depression. The use of these techniques is particularly advantageous in high-risk patients, where minimizing systemic drug exposure is crucial for safer post-operative outcomes [12]. In orthopedic procedures, like THR, effective post-operative pain control is vital for improving recovery. THR is a major surgery associated with significant post-operative pain, and inadequate pain management can delay rehabilitation and prolong hospital stays. In these patients using regional anesthesia techniques such as the lumbar ESP block and TQL block, superior pain control can be achieved. Optimal pain management facilitates early mobilization, improves patient satisfaction, and enhances recovery process [13].

In this study both the L-ESPB and QLB-t groups experienced significantly lower pain scores compared to the control group during the early post-operative hours, particularly at the 1st, 2nd, and 3rd h ($p<0.001$). This effect persisted at the 6th h ($p=0.002$), but from the 9th h onward, no significant differences in pain scores were observed between the groups ($p>0.05$). Tulgar *et al*. conducted a prospective randomized study to compare the effectiveness of L-ESPB and QLB-t for post-operative analgesia in hip and proximal femur surgery [14]. For this purpose, the authors undertook a study comprising 60 patients, randomized into three equal groups: Control, L-ESPB, and QLB-T. The study found that both block groups had significantly lower pain scores, tramadol consumption, and rescue analgesic needs compared to the control group. Similar superior analgesic effects of spinae plane block (L-ESPB) and QLB-t in orthopedic and abdominal surgeries were also reported by the authors such as Schnabel *et al*. [15] and Jadon *et al*. [16].

The analysis of rescue analgesic requirement in all the 3 groups in post-operative period showed that fentanyl requirements in the RR were slightly higher in the control group compared to the L-ESPB and QLB-t groups, though not statistically significant. Tramadol consumption in the first 12 h was significantly lower in the L-ESPB and QLB-t groups compared to the control group. Over 24 h, total tramadol use and the need for rescue analgesia were also significantly lower in the L-ESPB and QLB-t groups. Kavishwar *et al*. conducted a prospective, randomized, double-blinded study to compare the effectiveness of ultrasound-guided ESPB and anterior QLB (AQLB) for post-operative pain management in THR surgery [17]. The study found that there was no significant difference in NRS pain scores between the ESPB and AQLB groups at 6, 12, and 24 h postoperatively ($p>0.05$). The first request for rescue analgesia occurred at 17.5±6.6 h in the ESPB group and 18.5±6.1 h in the AQLB group ($p=0.537$). Neither block caused hemodynamic instability or resulted in a prolonged hospital stay. On the basis of these findings, the authors concluded that both ESPB and AQLB were effective for pain relief after THR, reducing the need for additional analgesia without motor weakness or delayed ambulation. Similar analgesic efficacy of ESPB and AQLB in various orthopedic surgeries were also reported by Zhu *et al*. [18] and Asar *et al*. [19].

The analysis of PONV across the three groups revealed a statistically significant difference ($p=0.038$). In Group A (ESPB), 12 patients experienced PONV with 8 reporting mild PONV, 3 having moderate PONV, and 1 experiencing severe PONV. Group B (QLB) had 11 patients with PONV including 7 with mild, 3 with moderate, and 1 with severe PONV. In contrast, Group C (control) had a higher incidence with 20 patients affected by PONV with 9 reporting mild, 6 moderate, and 5 having severe PONV. In a similar study, Huda and Ghafoor also reported that the incidence of PONV was lower in the ESPB group compared to the control group [20].

CONCLUSION

Both L-ESPB and QLB-t blocks are effective in reducing post-operative analgesia requirements and improving pain management compared to the control group. There was significant reduction in pain scores and analgesic consumption in the early post-operative period with a comparable effect between the two block techniques. In addition, both blocks contributed to a lower incidence of PONV. These findings suggest that L-ESPB and QLB-t blocks are valuable components of a multimodal analgesia strategy. Further research with standardized protocols and evaluations of optimal anesthetic volumes and concentrations would help refine their clinical utility.

CONFLICT OF INTEREST

None.

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