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Ultrasound guided Quadratus Lumborum block versus Trasnversus Abdominis Plane Block for perioperative analgesia in patients undergoing total laparoscopic hysterectomy surgery

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Abstract

Background: Effective postoperative analgesia is essential for enhanced recovery after laparoscopic hysterectomy. Ultrasound-guided truncal interfascial plane blocks such as Quadratus Lumborum (QL) block and Transversus Abdominis Plane (TAP) block are increasingly used to reduce opioid consumption and improve perioperative pain control. However, comparative evidence in total laparoscopic hysterectomy remains limited. ***Aim:*** To compare ultrasound-guided Quadratus Lumborum block with Transversus Abdominis Plane block for perioperative analgesia in patients undergoing total laparoscopic hysterectomy. ***Methods:*** This prospective randomized double-blind comparative study included 50 female patients (ASA I-II) undergoing elective total laparoscopic hysterectomy. Participants were randomly allocated into two groups: QL block (Group A) and TAP block (Group B), each receiving bilateral ultrasound-guided block with 0.25% levobupivacaine. The primary outcome was duration of postoperative analgesia. Secondary outcomes included postoperative pain scores (VAS), total opioid consumption over 24 hours, and requirement for rescue analgesia. Continuous variables were analyzed using unpaired t-test, while categorical variables were compared using Chi-square/Fisher's exact test, with $p<0.05$ considered significant. ***Results:*** Baseline demographic and intraoperative characteristics were comparable between groups. The QL block group demonstrated significantly prolonged duration of analgesia compared to the TAP block group ($p<0.001$). Postoperative pain scores were significantly lower in the QL group during the early and intermediate postoperative period. Total opioid consumption and the proportion of patients requiring rescue analgesia were significantly reduced in the QL group. ***Conclusion:*** Ultrasound-guided QL block provides superior and longer-lasting analgesia with reduced opioid requirement compared to TAP block following total laparoscopic hysterectomy. Incorporation of QL block into multimodal analgesia protocols may enhance postoperative recovery and patient comfort.

Keywords: Quadratus lumborum block; Transversus abdominis plane block; Laparoscopic hysterectomy analgesia.

INTRODUCTION

Effective perioperative pain management is a fundamental component of modern surgical care and plays a crucial role in improving patient satisfaction, facilitating early mobilization, reducing hospital stay, and minimizing postoperative complications. With the emergence of Enhanced Recovery After Surgery (ERAS) protocols, multimodal analgesia has gained widespread acceptance as the optimal strategy for postoperative pain control. Multimodal analgesia focuses on combining regional anesthesia techniques with systemic analgesics to reduce opioid consumption and opioid-related adverse effects such as nausea, vomiting, respiratory depression, and delayed recovery. Total laparoscopic hysterectomy (TLH) has increasingly replaced open abdominal hysterectomy due to advantages such as reduced blood loss, smaller incisions, and faster recovery. However, despite being minimally invasive, TLH is associated with significant postoperative pain resulting from trocar insertion, pneumoperitoneum, visceral manipulation, and peritoneal irritation.[1][2]

Regional truncal interfascial plane blocks have emerged as effective adjuncts to general anesthesia for abdominal surgeries. Among these, the Transversus Abdominis Plane (TAP) block and Quadratus Lumborum (QL) block have gained popularity due to their ability to provide somatic analgesia of the anterior abdominal wall. TAP block targets the neurofascial plane between the internal oblique and transversus abdominis muscles, where the thoracolumbar nerves (T6-L1) traverse. This

block has demonstrated efficacy in reducing postoperative pain and opioid consumption following abdominal procedures. However, its analgesic effect is largely limited to somatic pain and may not adequately address visceral components.[3]

Quadratus lumborum (QL) block was described by Blanco in 2007[4] and has subsequently been shown in many randomized controlled studies to provide adequate postoperative analgesia and reduce opioid analgesic use The Quadratus Lumborum block involves deposition of local anesthetic adjacent to the quadratus lumborum muscle within the thoracolumbar fascia. Due to posterior spread toward the paravertebral space, the QL block provides broader dermatomal coverage and has the potential to provide both somatic and visceral analgesia. Several studies have suggested that QL block offers prolonged duration of analgesia, reduced opioid requirement, and improved patient satisfaction compared to TAP block.[5]

AIM

To compare ultrasound-guided Quadratus Lumborum block with Transversus Abdominis Plane block for perioperative analgesia in patients undergoing total laparoscopic hysterectomy.

OBJECTIVES

1. To compare the duration of postoperative analgesia between QL block and TAP block.
2. To compare postoperative pain intensity using Visual Analogue Scale over 24 hours.
3. To compare total postoperative opioid consumption between the two groups.

MATERIALS AND METHODS

Source of Data

The study was conducted after getting approval from institutional ethics committee and was prospectivley registered at Clinical Trials Registry-India with CTRI Reg. No. CTRI/2024/01/061477. Data were collected from female patients undergoing elective total laparoscopic hysterectomy in a tertiary care teaching hospital after obtaining informed consent .

Study Design

The study was conducted as a prospective randomized double-blind interventional comparative study.

Study Location

The study was carried out in the operation theatre complex and postoperative ward of tertiary care teaching hospital, College of medicine and JNMH, Kalyani, Nadia.

Study Duration

The study was conducted over a period of 6 months.

Sample Size ;

Assuming p value <0.05 to be significant and considering effect to be two sided, we get Zα =1.96; assuming power of study to be 90% we get Z1-β = 1.28; considering an effect size (Difference in VAS Score at 12 Hours) of 1 to be statistically significant we got n > 2(Zα + Z1-β)2 x SD2/d2 we get n = 22. VAS Score at 12 Hours Group 1 = 3 and VAS Score at 12 Hours Group 2 = 2. d=Effect Size = (3-2) = 1. SD = Pooled Standard Deviation Assumed to be 1. Taking 10% drop out. Hence minimum 25 patients were taken in each group. Hence Total Sample Size was 50.[6]

Inclusion Criteria

- Female patients aged 35-65 years.
- ASA physical status I and II.
- Patients scheduled for elective total laparoscopic hysterectomy.
- BMI between 18-28 kg/m².
- Patients providing informed written consent.

Exclusion Criteria

- Allergy to study drugs.
- Coagulopathy or infection at injection site.
- Contraindications to regional block.
- Patients with cognitive impairment or inability to use VAS.
- History of drug abuse.

Procedure and Methodology

All patients underwent pre-anaesthetic evaluation including clinical examination and routine investigations. Inform consent was taken and procedures were explained to all the consenting patients. Computerized Random Number table was used to allocate the eligible and consenting patients into two group A (QL group) and group B (TAP group). Sequentially numbered opaque sealed envelops were prepared. The anaesthesiologist who was not the part of this study has done this group allocation. Patient was also unaware of the group allocation. On arrival of the patient in the operating room a intravenous line was secured and infusion of Ringer Lactate was started at the rate of 2-4ml/kg/hr. Standard monitoring was attached.
Preoxygenetion was done with 100% oxygen for 3min. Premedication was done with Inj Glycopyrrolate 0.02mg intravenously (i.v.) , Inj dexamethasone 8mg i.v, inj midazolam 0.01 to 0.02mg/kg b.wt , inj fentanyl 1to 2mcg /kg b.wt intravenously.

Induction was done with Inj propofol 2mg/kg body weight. End point of injection was loss of verbal communication. Adequate ventilation was checked. Inj succinylcholine was given intravenously at a dose of 2mg/kg body weight. Positive pressure ventilation was given for 60 to 90 seconds ,following that larygoscopy and intubation done. Intermittent positive pressure ventilation was initiated. Anaesthesia was maintained with Inj vecuronium, isofluorane (0.6%) inhalation along with oxygen and nitrous oxide (33:66).

Before commencement of surgery, block was performed as per the allocated group. Anaesthetisiologist 1 opened the opaque sealed envelop and decoded the allocated group and also prepared the local anaesthetic solution for block.

Anaesthetist 2 who was experienced enough to give USG guided block, performed the block procedure.

Anaesthetist 3 was not involved in group allocation and intervention, monitored and took the record and maintained the record and involved analysis.

In Group A, QL block was carried out while the patient was positioned laterally. The quadratus lumborum, psoas major, and erector spinae muscles that make up the "shamrock sign" were visible when the ultrasound transducer was positioned transversely on the flank at the horizontal level of L2-3. The needle was inserted in the anterolateral to posteromedial direction. We performed combined type 2 and type 3 QL block bilaterally in Group A. For the type 2 QL block, a local anesthetic was injected between the posterior surface of the QL muscle and thoracolumbar fascia. The point of injection in the type 3 QL block was between theanterior border of the QL muscle and psoas major muscles. A similar process was repeated on the contralateral side.

In Group A, with the patient in supine position, a transversus abdominis plane block was carried out. Between the lower costal border and the iliac crest, an ultrasound probe was positioned in a transverse plane. The 22G needle was inserted in the anterior axillary line after the transversus abdominis muscle was located beneath the external and internal obliques. The needle tip was then advanced until it reached the fascial plane between the internal oblique and transversus abdominis muscles, which was roughly in the midaxillary line, and 20 ml of 0.25% bupivacaine was deposited bilaterally. Real-time visualization of the local anesthetic solution's distribution was performed.

Surgery was commenced. Intra abdominal pressure was maintained at around 12 to 13 mm of Hg. Intraoperative any hypotension (decrease >20% of SBP), bradycardia (HR <50 beats/min) would be managed accordingly and would be noted down.

At the end the of the surgery patient was reversed with Inj Neostigmine (0.05mg/kg b.wt) along with Inj Glycopyrrolate 0.02mg/kg b.wt. and patient was extubated.

POSTOPERATIVE PERIOD:

Patient was shifted to post anaesthesia care unit (PACU) and monitored continuously. After 4 hours patient was shifted to ward. Parameters was recorded in PACU and Ward:

End of surgery was noted as 'Time=0' (T0). Post-operative analgesia was assessed using "Visual Analogue Scale for Pain" [VAS] which was explained to the patient priorly, [0=no pain & 10=worst possible pain].

VAS score was assesed postoperatively at T0 and then at 1hour interval for first 4 hours , then 2 hour interval for next 6hour followed by 4 hourly till 24 hours.

When VAS score >4 time was noted down and rescue analgesia Inj Paracetamol (15mg/kg b.wt) was given intravenously then given thrice daily. If still pain not relived Inj Tramadol 1mg/ kg body weight was given. Total dose of opioid consumption over 24 hour was calculated.

Total duration of peri-operative analgesia was defined as the time interval between the injection of study drug & the time of first rescue analgesia.

Haemodynamic parameters (SBP, DBP,HR,SPO2,RR) was recorded at 1 hour internval upto the VAS score >4. Complications if any in the form of haemodynamic instability, respiratory distress, CNS toxicity etc was noted & monitored and was managed accordingly.

Sample Processing

Pain scores, duration of analgesia, hemodynamic parameters, opioid consumption, and complications were recorded using structured case recording forms by a blinded observer.

Statistical Methods

Categorical variables were expressed as frequency and percentage and analyzed using Chi-square or Fisher's exact test. Continuous variables were expressed as mean ± SD and compared using unpaired t-test or Mann-Whitney U test. A p-value <0.05 was considered statistically significant. Statistical analysis was performed using SPSS software.

Data Collection

Data were collected prospectively using predesigned proforma including demographic details, intraoperative parameters, VAS scores, duration of analgesia, opioid consumption, complications, and patient satisfaction scores.

RESULTS

Table 1: Baseline & perioperative profile of study participants (N=50)

Variable	Group A QL Block (n=25)	Group B TAP Block (n=25)	Test of significance	Effect size (QL-TAP) / OR	95% CI	p-value
Age (years)	47.3 ± 6.8	46.1 ± 7.2	Unpaired t-test	+1.2	-2.68 to +5.08	0.547
BMI (kg/m²)	24.6 ± 2.1	24.2 ± 2.3	Unpaired t-test	+0.4	-0.82 to +1.62	0.524
ASA I	14 (56.0)	13 (52.0)	Fisher's exact	OR 1.17	0.39 to 3.58	1.000
ASA II	11 (44.0)	12 (48.0)				
Hypertension	6 (24.0)	7 (28.0)	Fisher's exact	OR 0.81	0.23 to 2.88	1.000
Diabetes mellitus	4 (16.0)	3 (12.0)	Fisher's exact	OR 1.40	0.28 to 7.00	1.000
Duration of surgery (min)	118.7 ± 22.4	121.3 ± 20.9	Unpaired t-test	-2.6	-14.61 to +9.41	0.673
Intra-op fentanyl total (mcg)	142.6 ± 28.9	148.1 ± 31.2	Unpaired t-test	-5.5	-22.17 to +11.17	0.521
Additional intra-op fentanyl bolus needed	5 (20.0)	8 (32.0)	Fisher's exact	OR 0.53	0.15 to 1.93	0.520

In Table 1, the baseline and perioperative characteristics were comparable between the Quadratus Lumborum (QL) block group and the Transversus Abdominis Plane (TAP) block group. The mean age was similar (47.3 ± 6.8 vs 46.1 ± 7.2 years; mean difference +1.2, 95% CI -2.68 to +5.08; p=0.547) and BMI was also comparable (24.6 ± 2.1 vs 24.2 ± 2.3 kg/m²; mean difference +0.4, 95% CI -0.82 to +1.62; p=0.524). Distribution of ASA physical status showed no significant difference (ASA I: 56% vs 52%; OR 1.17, 95% CI 0.39-3.58; p=1.000). Comorbidities such as hypertension (24% vs 28%; OR 0.81, 95% CI 0.23-2.88; p=1.000) and diabetes mellitus (16% vs 12%; OR 1.40, 95% CI 0.28-7.00; p=1.000) were also comparable. Intraoperatively, duration of surgery (118.7 ± 22.4 vs 121.3 ± 20.9 minutes; mean difference -2.6, 95% CI -14.61 to +9.41; p=0.673) and total fentanyl requirement (142.6 ± 28.9 vs 148.1 ± 31.2 mcg; mean difference -5.5, 95% CI -22.17 to +11.17; p=0.521) did not differ significantly. Although fewer patients in the QL group required additional fentanyl bolus (20% vs 32%), this difference was not statistically significant (OR 0.53, 95% CI 0.15-1.93; p=0.520).

Table 2: Comparison of duration of postoperative analgesia (N=50)

Outcome	GrA QL Block (n=25)	Grp B TAP Block (n=25)	Test of significance	Mean difference (QL-TAP)	95% CI	p-value
Duration of analgesia (minutes)	1034.6 ± 124.8	742.3 ± 118.9	Unpaired t-test (Welch)	+292.3	+224.73 to +359.87	<0.001*

Table 2 demonstrates that the QL block provided significantly prolonged postoperative analgesia compared to the TAP block. The mean duration of analgesia (time to first rescue analgesia) was 1034.6 ± 124.8 minutes in the QL group versus 742.3 ± 118.9 minutes in the TAP group. This corresponds to a clinically meaningful mean difference of +292.3 minutes, with a narrow and strongly positive 95% CI (+224.73 to +359.87), indicating consistent benefit of QL block across participants. The difference was highly statistically significant on Welch's unpaired t-test (p<0.001), confirming superior duration of analgesia with QL block.

Table 3 shows that postoperative pain scores were consistently lower in the QL group compared to the TAP group at most time points, particularly during the early and intermediate postoperative period. Immediately at the end of surgery (T0), VAS scores were similar (0.8 ± 0.6 vs 0.9 ± 0.7; mean difference -0.1, 95% CI -0.46 to +0.26; p=0.590), indicating comparable immediate recovery pain. However, from 2 hours onward, QL block demonstrated significantly better analgesia: at 2 hours (1.6 ± 0.8 vs 2.4 ± 0.9; mean difference -0.8, 95% CI -1.27 to -0.33; p=0.002), 4 hours (2.1 ± 0.9 vs 3.3 ± 1.0; mean difference -1.2, 95% CI -1.73 to -0.67; p<0.001), 8 hours (2.8 ± 1.0 vs 4.1 ± 1.1; mean difference -1.3, 95% CI -1.88 to -0.72; p<0.001), and 12 hours (3.2 ± 1.1 vs 4.2 ± 1.0; mean difference -1.0, 95% CI -1.58 to -0.42; p=0.002). Even at 24 hours, pain remained significantly lower in the QL group (2.4 ± 0.9 vs 3.0 ± 1.0; mean difference -0.6, 95% CI -1.13 to -0.07; p=0.031). Thus, QL block provided superior pain control, especially in the clinically important 2-12 hour postoperative window.

Table 3: Postoperative pain intensity (VAS 0-10) over 24 hours (N=50)

Time point	Grp A QL Block (n=25) Mean ± SD	Grp B TAP Block (n=25) Mean ± SD	Test of significance	Mean difference (QL-TAP)	95% CI	p-value
T0 (end of surgery)	0.8 ± 0.6	0.9 ± 0.7	Unpaired t-test	-0.1	-0.46 to +0.26	0.590
2 hours	1.6 ± 0.8	2.4 ± 0.9	Unpaired t-test	-0.8	-1.27 to -0.33	0.002*
4 hours	2.1 ± 0.9	3.3 ± 1.0	Unpaired t-test	-1.2	-1.73 to -0.67	<0.001*
8 hours	2.8 ± 1.0	4.1 ± 1.1	Unpaired t-test	-1.3	-1.88 to -0.72	<0.001*
12 hours	3.2 ± 1.1	4.2 ± 1.0	Unpaired t-test	-1.0	-1.58 to -0.42	0.002*
24 hours	2.4 ± 0.9	3.0 ± 1.0	Unpaired t-test	-0.6	-1.13 to -0.07	0.031*

Table 4: Total postoperative opioid consumption (24 hours) (N=50)

Outcome	QL Block (n=25)	TAP Block (n=25)	Test of significance	Effect size	95% CI	p-value
Total tramadol consumption (mg/24h)	58.4 ± 28.7	96.2 ± 34.1	Unpaired t-test (Welch)	-37.8 mg	-55.27 to -20.33	<0.001*
Patients requiring tramadol (Yes)	7 (28.0)	17 (68.0)	Fisher's exact	OR 0.18	0.05 to 0.61	0.010*
Patients not requiring tramadol (No)	18 (72.0)	8 (32.0)				

Table 4 indicates that QL block significantly reduced postoperative opioid requirement compared to TAP block. The total tramadol consumption over 24 hours was markedly lower in the QL group (58.4 ± 28.7 mg) than in the TAP group (96.2 ± 34.1 mg), with a mean reduction of 37.8 mg (95% CI -55.27 to -20.33), which was highly significant on Welch's t-test ($p<0.001$). In addition, only 28% of patients in the QL group required tramadol rescue analgesia compared to 68% in the TAP group, reflecting a substantially lower likelihood of opioid requirement with QL block (OR 0.18, 95% CI 0.05-0.61; $p=0.010$). Correspondingly, a higher proportion of patients in the QL group did not require opioids (72% vs 32%).

DISCUSSION

Baseline comparability (Table 1): In the present study, both groups were well matched at baseline. Age, BMI, ASA status, and comorbidities such as hypertension and diabetes showed no statistically significant differences (all $p>0.05$). Intraoperative variables including duration of surgery, total fentanyl consumption, and need for additional fentanyl bolus were also comparable, suggesting that postoperative outcomes were primarily influenced by the block technique rather than confounding baseline or anesthetic factors. Similar baseline equivalence between QL and TAP block groups has been reported in systematic reviews and meta-analyses evaluating hysterectomy patients, thereby supporting the methodological validity of direct analgesic comparisons. Jalilzadeh et al.(2025)[7] and Liu et al.(2020)[8] also demonstrated comparable demographic and perioperative characteristics between groups in their pooled analyses, strengthening the internal validity of comparative regional analgesia studies.

Duration of analgesia (Table 2): A major finding of the present study was the significantly prolonged duration of postoperative analgesia with QL block (1034.6 ± 124.8 min) compared with TAP block (742.3 ± 118.9 min), with a clinically meaningful difference of approximately 292 minutes ($p<0.001$). This observation is consistent with comparative hysterectomy studies showing superior duration of analgesia with QL block due to more extensive spread of local anesthetic along the thoracolumbar fascia. Helali et al.(2024)[9] reported prolonged analgesia with QL block compared with other truncal techniques in hysterectomy patients. Furthermore, Jiang et al.(2023)[10] demonstrated improved analgesic duration and reduced opioid use with transmuscular QL block in laparoscopic hysterectomy, supporting the mechanistic explanation of paravertebral spread. Similar findings were reported by Alaasar et al.(2024)[11], reinforcing that the prolonged analgesic duration observed in the present study is consistent with current literature.

Pain intensity over 24 hours (Table 3): Postoperative pain scores were comparable immediately after surgery but were significantly lower in the QL group during the early and intermediate postoperative period (2-12 hours),

highlighting superior sustained analgesia. This pattern of early equivalence followed by later superiority of QL block has been documented in hysterectomy studies where TAP block primarily provides somatic analgesia while QL block offers additional visceral coverage. Malla et al.(2021)[12] reported similar VAS trends with QL block demonstrating improved analgesia beyond the immediate postoperative period. Abdelaziz et al.(2024)[13] and Khare et al.(2024)[14] further confirmed lower postoperative pain scores with QL block compared with alternative truncal blocks, though variability may occur depending on block approach and local anesthetic technique.

Opioid consumption and opioid-sparing effect (Table 4): The present study demonstrated a significant opioid-sparing benefit with QL block. Total tramadol consumption was markedly lower in the QL group and fewer patients required rescue analgesia. This finding is supported by randomized controlled trials demonstrating reduced opioid requirement with QL block compared with TAP block in abdominal surgeries. Sertcakacilar et al.(2022)[15] reported reduced opioid consumption and improved postoperative comfort with QL block. Additionally, Singh et al.(2021)[16] demonstrated enhanced analgesic efficacy and decreased opioid use with anterior and posterior QL approaches in laparoscopic hysterectomy.

CONCLUSION

The present study demonstrated that ultrasound-guided Quadratus Lumborum (QL) block provides superior perioperative analgesia compared with the Transversus Abdominis Plane (TAP) block in patients undergoing total laparoscopic hysterectomy. Although both techniques were safe and feasible as components of multimodal analgesia, QL block was associated with significantly prolonged duration of postoperative analgesia, lower postoperative pain scores over the first 24 hours, and reduced postoperative opioid consumption. The opioid-sparing effect of QL block also resulted in a smaller proportion of patients requiring rescue analgesia, suggesting improved overall analgesic quality and patient comfort. Baseline demographic and intraoperative variables were comparable between the two groups, strengthening the validity of the observed analgesic differences. The wider dermatomal spread and potential visceral analgesic component of the QL block likely contributed to its superior performance. Therefore, ultrasound-guided QL block may be considered a more effective regional analgesic technique than TAP block for perioperative pain management in total laparoscopic hysterectomy within enhanced recovery protocols.

LIMITATIONS OF THE STUDY

- The relatively small sample size (n=50) may limit generalizability of findings.
- Single-center study design may restrict external validity across diverse surgical settings.
- Only short-term analgesic outcomes (24 hours) were evaluated; long-term recovery and chronic pain outcomes were not assessed.
- Blinding of the block performer was not feasible, which may introduce procedural bias.
- Variability in individual pain perception and subjective VAS scoring could affect outcome precision.
- Different approaches of QL block (lateral/posterior/transmuscular) were not compared.
- Postoperative functional recovery parameters such as ambulation time and length of hospital stay were not formally evaluated.

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