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Ultrasound guided quadratus lumborum block reduces opioid requirement in retroperitoneal laproscopic nephrectomy: A prospective study

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Abstract

Background: Retroperitoneal laparoscopic nephrectomy is associated with significant postoperative pain despite its minimally invasive nature. Opioid-based analgesia is effective but frequently associated with adverse effects. Ultrasound-guided quadratus lumborum block (QLB) has emerged as a regional analgesic technique that may reduce perioperative opioid requirement.

Methods: This prospective randomized single-blind study included 60 adult patients with American Society of Anesthesiologists (ASA) physical status I–II undergoing elective retroperitoneal laparoscopic nephrectomy under general anesthesia. Patients were randomly allocated into two groups. Group Q (n = 30) received ultrasound-guided unilateral posterior quadratus lumborum block with 20 mL of 0.25% ropivacaine, whereas Group C (n = 30) received conventional postoperative analgesia. Postoperative pain was assessed using the visual analogue scale (VAS) at 1, 2, 3, 4, 8, 12, and 24 h after surgery. Total tramadol consumption during the first 24 h, time to first rescue analgesia, hemodynamic parameters, and adverse effects were recorded.

Results: The time to first rescue analgesia was significantly longer in Group Q than in Group C (11.43 ±

1.92 h vs. 2.97 ± 1.19 h, P < 0.001). Total tramadol consumption during the first 24 postoperative hours was significantly lower in Group Q compared with Group C (102.5 ± 24.87 mg vs. 205.83 ± 29.13 mg, P < 0.001). VAS scores at rest and during movement were significantly lower in Group Q at most postoperative time points. No major complications, including hematoma, infection, hypotension, or motor blockade, were observed.

Conclusions: Ultrasound-guided quadratus lumborum block provides effective postoperative analgesia and significantly reduces opioid consumption in patients undergoing retroperitoneal laparoscopic nephrectomy.

Keywords: Quadratus Lumborum Block, Laparoscopic Nephrectomy, Postoperative Analgesia, Opioid-Sparing, Ropivacaine

Introduction

Laparoscopic nephrectomy is commonly performed for various renal pathologies, including malignancy, non-functioning kidney and donor nephrectomy. Although postoperative pain is less severe than that associated with open surgery, patients may still experience significant pain due to abdominal wall trauma, peritoneal stretching and carbon dioxide–induced peritoneal irritation.[6,9,26]

Inadequate postoperative analgesia is associated with delayed recovery, prolonged hospital stay and an increased risk of chronic postoperative pain.[5] Opioids, although effective, are associated with adverse effects such as respiratory depression, sedation, nausea, vomiting and opioid-induced hyperalgesia.[21,22] The use of non-steroidal anti-inflammatory drugs is often limited in these patients due to underlying or potential renal dysfunction. Therefore, a multimodal analgesic approach incorporating regional anaesthetic techniques is preferred. Nowadays, ultrasound-guided fascial plane blocks have become an essential part of multimodal analgesia because of the simplicity of operation and fewer complications. Ultrasound-guided fascial plane blocks have gained popularity owing to their simplicity and favourable safety profile. The quadratus lumborum block (QLB), first described by Blanco in 2007, provides both somatic and visceral analgesia by deposition of local anaesthetic within the thoracolumbar fascia, with possible spread to the paravertebral space.[1,3] QLB has been successfully used for postoperative analgesia in abdominal and urological surgeries.[6,9] Most published studies have evaluated the role of QLB in transperitoneal laparoscopic nephrectomy. However, retroperitoneal laparoscopic nephrectomy has been reported to be associated with greater postoperative pain and increased requirement of rescue analgesia.[26] As unilateral QLB is sufficient for the retroperitoneal approach, it avoids the need for bilateral blocks and patient repositioning under anaesthesia. This study was undertaken to evaluate the opioid-sparing effect of ultrasound-guided quadratus lumborum block in patients

undergoing retroperitoneal laparoscopic nephrectomy by assessing postoperative pain scores, opioid consumption and related adverse effects.

Methods

This Prospective randomized, single blind comparative study was conducted from June 2023 to May 2025 after approval from the Institutional Ethics Committee (IEC No. Guts/Ec-06/ A:naes-07).Written informed consent was obtained from all participants prior to enrolment in the study.

We recruited 60 patients from the American Society of Anaesthesiologist (ASA) grade l or 2 undergoing elective retroperitoneal laproscopic nephrectomy under generel anesthesia and were able to understand the study protocol.

The patients having allergy to tramadol, Hypersensitivity to LA, history of bleeding disorder, use of anticoagulants, infection at the site of block, Chronic opioid use, significant cardiorespiratory or neurological disease and patient's refusal were excluded. After dividing all patients into two groups randomly using computer generated random numbers (www.randomizer.org) allotment was done to one of the groups, namely group Q (n=30)in which patients were received QL block with Inj. Ropivacaine 0.25% - 20 mL and group C (n=30) were received conventional postoperative analgesia.

Based on the study done by Ying He (2022) for partial nephrectomy, sample size calculated after pilot study considering 30% reduction in analgesia requirement as significant in QL block group with alpha set at 0.05 and for a power of 90% , they calculated sample size of 27 patients in each group so we decided to take total 60 patients, 30 patients in each group considering the potential dropouts.

P value < 0.05 is considered statistically significant.

Total 60 patients undergoing retroperitoneal laparoscopic nephrectomy were randomly divided into two groups:

QLB GROUP (GROUP Q) and CONTROL GROUP (GROUP C).

All the patients were fasted for 8 hours prior to the surgery. Written and Informed Consent was taken. VAS score was explained to the patients day before surgery. In the operation theatre, baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and oxygen saturation (SpO2) were recorded and monitored throughout the surgery. Peripheral vascular access was established using 18-gauge intravenous cannula and intravenous crystalloids fluid was started. Preoperative baseline vitals were recorded in form of ECG, non-invasive blood pressure and oxygen saturation.

All the patients received standardized general anesthesia with bolus fentanyl 2mcq/kg in premedication and induced with thiopental sodium 7mg/kg, atracurium bolus 0.5 mg/kg.

A sevoflurane + N2O+ O2 was used for maintenance of anesthesia. Anesthetic medication was adjusted according to hemodynamics and BIS (40-60) monitoring. During surgery the blood pressure was maintained within +/- 20% of baseline, the etCO2 was 35- 45 mmhg and all patients in both the groups received inj. paracetamol 1 gm intravenously at the start of skin closure.[26]

In Group Q A unilateral USG guided posterior QL block was given by expert anesthesiologist who did not participate in follow up data collection. Patient were placed in the lateral decubitus position with surgical site upwards. Under all strict asepsis and anti-septic measures a QL block was performed, by using ultrasonography (Vivid iq SGCART, GE, USA) with 3-5 Mhz low frequency curvilinear probe was placed perpendicular to the spine on the L2 vertebral body and then the probe was slowly moved ventrally until the L2 transverse process, the quadratus lumborum muscle, the psoas major muscle and erector spinae were visualized[29]. A 22 gauge stimuplex, 80mm needle was inserted slowly from the dorsal side to ventral side using in-plane technique needle passed through the QL muscle before reaching the fascial interspace of the QL and PM muscle.

Using a hydro dissection technique, isotonic saline 1-2 ml was injected to confirm correct needle position and 20 ml 0.25% ropivacaine was injected after repeated negative aspiration tests for blood. After injection separation of two layers of fascia could be seen and the PM muscle was pressed down, indicating spread of drug in proper fascial plane. After block, the patient’s vital signs were

monitored. All patients were extubated on table and shifted to the post anesthesia care unit (PACU).

At the PACU HR, SBP, DBP, SpO2, VAS score were recorded at 1st, 2nd, 3rd, 4th, 8th, 12th, and 24th postoperative hours. All patients were educated preoperatively about how to use and record the visual analogue scale (VAS). One 10cm scale was provided for reporting pain, zero being no pain and 10 being the worst imaginable pain. Rescue analgesia of 2 mg/kg tramadol in 100 ml normal saline over 20 min was given either on patient's request or if VAS was >3. Inj. Ondensatron 4 mg given 8 hrly. Patients were assessed for and data recorded as time to first rescue analgesia which is described as time interval between the end of block performance and first demand by patient for rescue analgesia. Total amount of rescue analgesia required is described as total dose of tramadol required in 24 hr since the end of block performance.

The primary objective was to compare the total amount of rescue analgesia required in first 24 hrs postoperatively according to VAS scores at rest and on movement. The secondary objectives were to note the time to first rescue analgesia between the two groups and adverse effect [nausea/vomiting, hypotension (< 30% from baseline)] and complications [motor blockade (using modified bromage scale), infection and hematoma] related to block between the two groups.

Statistical analysis

All data were analyzed using Epi Info software (version 7.2, CDC, Atlanta, USA), and Microsoft Office 2021 was used for generating tables and graphs. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as numbers and percentages. Intergroup comparisons were performed using the Student's unpaired t-test for continuous variables and Fisher's exact test for categorical variables, as appropriate. Repeated measures of VAS scores over time were analyzed using repeated measures analysis of variance (ANOVA) for normally distributed variables. A *P* value <0.05 was considered statistically significant.

Results

In this study, 60 patients were recruited and randomized in to two groups for the analysis. None of the patients were excluded from the analysis. Figure 1 shows the CONSORT flow diagram for the study. The demographic were comparable in both groups, and the differences were not statistically significant (*P*>0.05) (Table 1).

The time to first rescue analgesia was significantly longer in the Group Q compared to Group C (11.4333+/- 1.9241 vs 2.9666+/-1.188, *P* <0.05) indicating prolonged duration of postoperative analgesia in Group Q (Table 2). The Total tramadol dose consumption during the first 24hours postoperatively was significantly lower in the Group Q compared to the Group C (102.5+/-24.8703 mg vs 205.8333+/- 29.127 mg, *P* <0.05) (Table 3).

VAS scores at rest and during movement were consistently lower in the Group Q compared to the Group C at most postoperative time intervals. The differences were statistically significant at 1, 2, 3, 4, 8, and 12 hours (*P* <0.05). However, at the 24 th postoperative hour, the difference between the two groups was not statistically significant (*P* > 0.05) (Table 4,5)

Both heart rate (HR) and mean arterial pressure (MAP) remained stable in both groups throughout the observation period. The values were comparable at most time intervals. However, while at the 2nd postoperative hour HR and MAP were significantly higher in the Group C (*P*<0.05), while at the 12th hour, these parameters were significantly higher in the Group Q (*P*< 0.05). These

differences were transient and clinically significant (Table 6,7)

No major complications such as hematoma, infection, hypotension, or motor blockade were observed in either group during the study period.

Figure 1: Consolidation standards of reporting trials (CONSORT) flow diagram

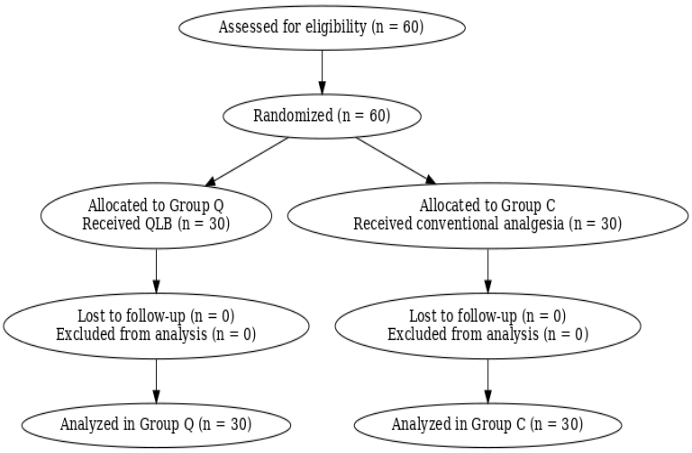

Table 1: Demographic Data

	Group C	Group Q	P-value
Age (year)	46.733+/-8.959	47.633+/-9.474	0.706
Weight (kg)	56.933+/-8.407	55.6+/-8.389	0.5410
Height (cm)	157.833+/-3.384	156.4+/-7.351	0.756
Asa grade	1.466+/-0.507	1.366+/-0.490	0.5092
Duration of surgery (minute)	133.566+/-7.929	134.33+/-7.321	0.6986

P* > 0.05

Table 2: Time for first dose of rescue analgesia

	Group C	Group Q	P-value
Time of first rescue analgesia(hour)		11.4333+/-2.9666+/-1.188	<0.00001 1.9241

P* <0.05

Table 3: Total tramadol consumption in 24 hrs

	Group C	Group Q	P-value
Total Tramadol dose in 24 hr(mg)	205.8333+/-29.127	102.5+/-24.8703	<0.00001

P*<0.05

Table 4: Comparison of vas score at rest

Time	Group C	Group Q	P-value
1 HR	1.733+/-0.449	1.7+/-0.4611	0.027
2 HR	4.2+/-0.8469	4.2+/-0.8469	<0.0001
3 HR	4.066+/-1.2298	1.966+/-0.319	<0.0001
4 HR	3.466+/-2.012	1.833+/-0.5920	0.0015
8 HR	2.466+/-1.3829	3.133+/-1.166	0.01428
12 HR	3.066+/-1.4125	4.4+/-0.855	0.00038
24 HR	2.466+/-0.8603	2.433+/-0.8172	0.7641

Table 5: Comparison of vas score at movement

Time	Group C	Group Q	P-value
1 HR	1.933+/-0.6396	2+/-0.6432	0.0281
2 HR	1.9+/-0.6074	4.566+/-0.7738	<0.00001
3 HR	2.4+/-0.4982	4.633+/-1.0335	<0.00001

4 HR	2.5+/-0.8200	3.766+1.9061	0.0135
8 HR	3.0+/-0.90	3.96+/-1.96	0.41
12 HR	4.8+/-0.8866	3+/-1.1744	<0.00001
24 HR	2.833+/-0.9128	2.766+/-0.9352	0.617

P*<0.05

Table 6: Change in heart rate

Time	Group C	Group Q	P-Value
0 Hr	74.333+/-3.8536	75.166+/-5.2066	0.4838
1 Hr	79.966+/-4.9583	78.3666+/-5.0136	0.2189
2Hr	82.233+/-4.0144	75.633+/-4.7813	<0.0001
3Hr	78.166+/-3.4148	76.133+/-4.7686	0.0625
4 Hr	78.3 +/-3.4854	79+/-5.5832	0.5624
8 Hr	78.2 +/-3.4680	79.466+/-4.2078	0.2083
12 Hr	78.933+/-3.9122	84.2+/-2.5650	<0.00001
24 Hr	76.266+/-3.2263	75 +/-4.0343	0.1844

Table 7: Change in mean blood presuure

Time	Group C	Group Q	P-Value
0 Hr	92.066+/-4.748	94.133+/-5.00	0.1064
1 Hr	93.633+/-4.106	92.366+/-4.671	0.2693
2 Hr	96.7+/-3.435	90.433+/-4.782	<0.00001
3 Hr	93.566+/-4.6255	93.233+/-4.980	0.7896
4 Hr	92.866+/-4.2485	91.833+/-4.457	0.3618
8 Hr	93.166+/-4.379	94.666+/-4.780	0.2101
12 Hr	93.333+/-4.404	97.1+/-3.968	0.0009
24 Hr	92.5+/-4.049	93.766+/-2.500	0.1503

Discussion

Effective postoperative pain control is essential for enhancing recovery and reducing morbidity following laparoscopic nephrectomy. Inadequately managed pain can provoke adverse physiological and psychological responses, delay ambulation, increase opioid consumption, and contribute to the development of chronic postsurgical pain.[5,26] Although laparoscopic surgery reduces surgical trauma, postoperative pain intensity and opioid requirements may still be significant, highlighting the need for effective multimodal analgesic strategies.

Regional anaesthesia techniques form a cornerstone of multimodal analgesia by improving pain control while minimizing opioid-related adverse effects. Among these, ultrasound-guided quadratus lumborum block (QLB) has gained attention for providing prolonged and effective analgesia for abdominal and retroperitoneal surgeries.[3,7,9] In the present study, QLB significantly improved postoperative analgesia, reduced opioid consumption, and delayed the need for rescue analgesia when compared with the control group. The analgesic efficacy of QLB is attributed to the anatomical characteristics of the thoracolumbar fascia, a multilayered connective tissue structure containing a dense network of sympathetic

fibres and nociceptors. Spread of local anaesthetic along the thoracolumbar fascia and into the paravertebral space results in blockade of both somatic and visceral pain pathways.[3,17,25]This mechanism explains the broader dermatomal coverage and longer duration of analgesia observed with QLB compared with other fascial plane blocks such as the transversus abdominis plane block.[1,28,29]

Postoperative pain in the present study was assessed using the visual analogue scale (VAS), a validated and sensitive tool for painmeasurement.[23,24] VAS scores at rest and on movement were significantly lower in the QLB group during the early and intermediate postoperative periods. These findings are consistent with previous randomized controlled trials and systematic reviews evaluating QLB in laparoscopic nephrectomy and other abdominal procedures.[6,12,14] The relatively higher pain scores observed at later postoperative hours in the QLB group likely reflect the gradual waning of the block effect, corresponding to the pharmacokinetic profile of ropivacaine.[13,18,20]

Total opioid consumption during the first 24 postoperative hours was significantly reduced in the QLB group. This opioid-sparing effect is clinically relevant, given the well-documented adverse effects of opioids, including nausea, vomiting, sedation, pruritus and delayed recovery.[5,14] Similar reductions in opioid requirement with QLB have been reported in previous randomized trials and meta-analyses.[7,9,14] In contrast, studies comparing QLB with epidural analgesia or continuous regional techniques have demonstrated comparable analgesic efficacy, which may account for variations in reported outcomes.[11]

The time to first rescue analgesia was significantly prolonged in the QLB group, indicating sustained postoperative analgesia. This observation is in agreement with findings reported by Dam et al. and Brandão et al., who demonstrated prolonged analgesic duration and improved recovery profiles following QLB.[6,30] Variability in analgesic duration across studies may be attributed to differences in block approach, timing, and use of continuous versus single-shot techniques.

Hemodynamic stability observed in the QLB group further supports its favourable safety profile. Minor variations in heart rate and mean arterial pressure corresponded with postoperative pain intensity rather than block-

related complications. No patient experienced block-related adverse effects, motor weakness or hypotension, findings consistent with previously published literature.[9,14]

Overall, the results of this study support the role of ultrasound-guided quadratus lumborum block as an effective and safe component of multimodal analgesia for patients undergoing retroperitoneal laparoscopic nephrectomy.

Limitations

This study was conducted at a single centre, limiting external validity. The block was administered after surgery under general anaesthesia, precluding intraoperative assessment of block efficacy. Long term outcomes such as chronic postsurgical pain and patient satisfaction were not evaluated.

Conclusion

Ultrasound-guided quadratus lumborum block provides effective postoperative analgesia following laproscopic nephrectomy, with significant reduction in pain scores, opioid consumption, and delayed requirement for rescue analgesia. Its favourable safety profile and opioid- sparing

effect make it a valuable adjunct to multimodal analgesia in this surgical population.

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