Original Article

The efficacy and safety of continuous transmuscular quadratus lumborum block for postoperative analgesia after laparoscopic nephrectomy: A prospective randomized clinical trial

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Abstract

Background and Aims: Analgesic efficacy and safety of continuous catheter technique in transmuscular quadratus lumborum block (QLB3) for laparoscopic nephrectomy has not been studied. This study was planned to evaluate the efficacy and safety of ultrasound (US)-guided continuous QLB3 for postoperative analgesia after laparoscopic nephrectomy.

Material and Methods: In this randomized, open-label, single-centered trial, 64 patients belonging to the American Society of Anesthesiologists, physical status grade I and II, 18–65 years of age, scheduled for laparoscopic nephrectomy were included. Patients were randomized into the QLB group and the control group. After surgery, the QLB group received transmuscular QLB with a 0.4 mL/kg bolus of 0.25% ropivacaine and catheter insertion for continuous infusion of 0.25% ropivacaine at 0.1 mL/kg/h. Patients in both groups received fentanyl (0.5 μg/kg) as rescue analgesia by IV PCA pump.

Results: The data of 30 patients in each group were analyzed. Total fentanyl consumption during the first 48 h postoperatively was significantly lower in the QLB group compared to the control group (mean ± SD; QLB group = 74.33 ± 32.75 μg; control group = 209.10 ± 52.04 μg) ($P < 0.001$). Postoperative NRS pain scores at rest and on movement were significantly lower in the QLB group compared to the control group at various time intervals up to 48 h postoperative ($P < 0.05$). No severe complications were seen in any of the patients.

Conclusions: US-guided continuous catheter transmuscular QLB reduced postoperative opioid consumption by 64.45% and decreased NRS pain scores after laparoscopic nephrectomy without complications.

Keywords: Analgesia, nephrectomy, nerve block, postoperative pain

Introduction

Laparoscopic nephrectomy can cause significant postoperative pain due to the collective effects of the incision given to retrieve the specimen, port site pain, nociceptive pain caused by pelvic organs, colonic dissection, and neuropathic pain caused by trocars.[1,2] Inadequate pain control results in increased cardiopulmonary complications, delayed postoperative ambulation, and hospital discharge and may result in chronic postoperative pain.[3] Among the various analgesic methods for postoperative pain control, epidural, NSAIDS, intravenous local anesthetics (LAs), and opioids are commonly used. All these methods are associated with systemic side effects

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and wide fluctuations in clinical outcomes.[4] As a part of the multimodal analgesia regimen, ultrasound (US)-guided truncal blocks provide better postoperative pain control, are devoid of systemic and neuraxial side effects, and reduce postoperative opioid use, thus enhancing the quality of recovery.[5] Quadratus lumborum block (QLB) is a truncal interfascial plane block that has already been established to provide postoperative analgesia in thoracic and abdominal surgeries.[6] In transmuscular QLB (or QLB3), the needle is advanced through the QL muscle, and LA is deposited between the QL muscle and the psoas major (PM) muscle [Figure 2a and b]. We used the QLB3 approach as LA deposited in this facial plane spreads to the thoracic sympathetic trunk and thoracic paravertebral space, blocking more dermatomes (T7-L1) and providing better analgesia.[7,8] Moreover, QLB3 is associated with fewer complications as the needle passes through the muscle, and the endpoint is away from major blood vessels or visceral organs.[9]

The literature revealed only a few studies on the single-shot technique of QLB3 in laparoscopic nephrectomy, providing postoperative analgesia for 16–24 h and further pain control by opioid analgesics.[10,11] The efficacy and duration of analgesia of QLB3 block can be extended by continuous catheter infusion of LAs.[12,13] We hypothesized that US-guided continuous QLB3 block would provide satisfactory postoperative analgesia and reduce opioid consumption in the postoperative period.

Material and Methods

This single-center, prospective, open-labeled, randomized clinical trial was carried out after approval from the institutional ethical committee (AIIMS/IEC/2019-20/1023) and CTRI registration (REF/2020/01/031016). Written informed consent was taken from all 64 patients included in the study. American Society of Anesthesiologists (ASA) physical status grade I and II, 18–65 years of age, scheduled for laparoscopic nephrectomy, were included in the study. Patients with block site infection, coagulation disorders, morbid obesity (BMI >40 kg/m^2), allergy to the LA agent, major cardiac or respiratory disorders, severe renal or hepatic dysfunction, and preexisting neurological deficits or psychiatric illness were excluded from the study. All eligible patients were randomly allocated into the QLB and control groups by using a computer-generated randomized list, and allocation concealment was done using sealed opaque envelopes. A single anesthesiologist performed patient enrolment and allocation. During the preoperative visit a day before surgery, all eligible patients were familiarized with the patient-controlled analgesia (PCA) pump and Numerical Rating Score (NRS) with scores ranging from 0 to 10.

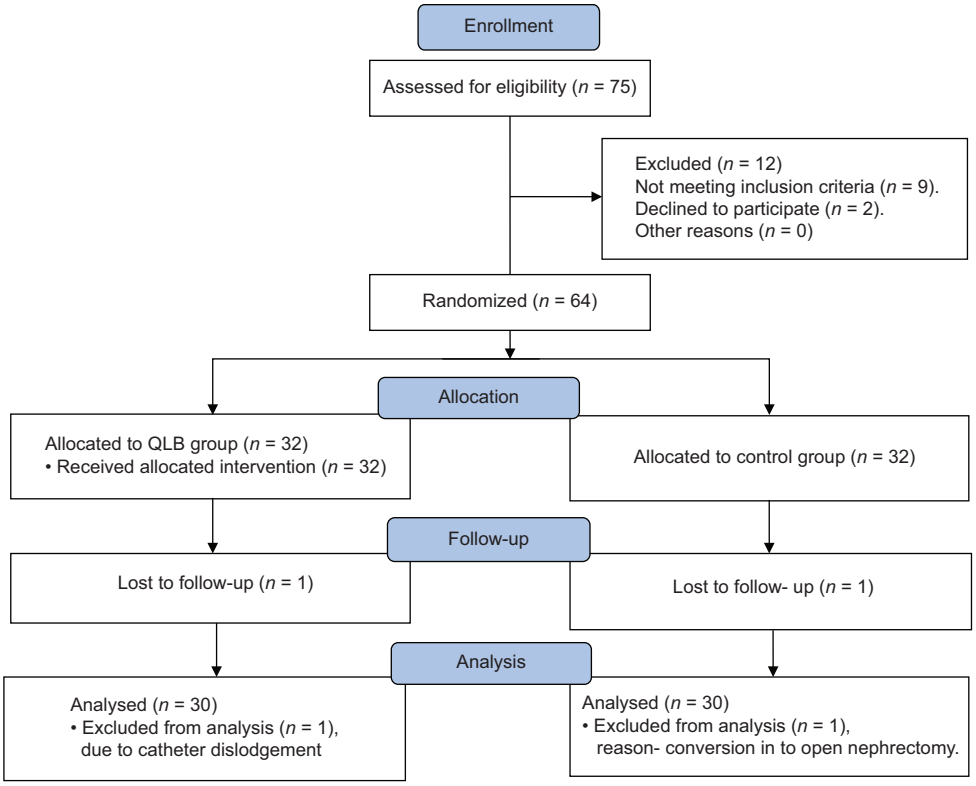

Figure 1: The CONSORT flow chart. QLB, Quadratus lumborum block

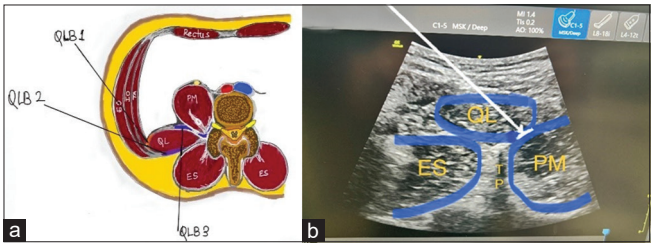

Figure 2: (a and b) Digital illustration for the anatomy of QL muscle and sites of injection of LA for QLB1, QLB2, and QLB3. Ultrasonographic image showing anatomy and site of injection for QL-transmuscular approach. The structures labeled in the figure include QL, quadratus; PM, psoas major; EO, external oblique; IO, internal oblique; TA, transverse abdominus; ES, erector spinae

The primary outcome of this study was to compare total fentanyl consumption (as a rescue analgesic) during the first 48 h postoperatively. The secondary outcomes were to compare NRS pain score; duration of analgesia (time for request of first rescue analgesia after surgery); patient satisfaction score; and any adverse effects and complications related to the block, catheter, or drugs used (nausea, vomiting, catheter dislodgement, lower limb paraesthesia, LA toxicity) in both groups.

Routine perioperative management was followed for all the patients. This included standard ASA monitoring, premedication with intravenous midazolam 0.04–0.06 mg/kg and fentanyl 2 μg/kg, anesthesia induction propofol 2 mg/kg and rocuronium 0.9 mg/kg, and intubation and maintenance of anesthesia with isoflurane in oxygen and air mixture (MAC 0.8–1.0). The patients were placed in the lateral position for the surgery. Fentanyl at the dose of 1 μg/kg was repeated every hour. At the end of the surgery, both groups received an injection ondansetron 0.1 mg/kg and an injection paracetamol 15 mg/kg approximately 15 min before extubation.

In the QLB group, after the surgery, the patient was kept in the same lateral decubitus position as for surgery, for the block. Following all aseptic precautions, a curvilinear low-frequency US probe (LOGIQe, GE Healthcare, China) was positioned in transverse orientation 4 cm from the midline at the L2-L4 level. Transverse process, erector spinae (ES), QL, and PM muscle were identified. An 11-cm 18-G needle (15° bevel, Contiplex^{R} D BBraun) was inserted until the needle tip reached between the QL and PM muscle, and the location was confirmed with hydro-dissection with 1 mL of 0.9% normal saline in the interfacial plane [Figure 1]. Next, 0.4 mL/kg of 0.25% ropivacaine was injected, followed by 20-G catheter insertion (1000 mm, Contiplex^{R} D BBraun) 3 cm distal to the needle tip. The catheter was tunneled through the skin and was secured with a transparent dressing. An infusion of 0.25% ropivacaine at 0.1 mL/kg/h was commenced after extubation and continued for 48 h in the postoperative ward. The QLB was performed by anesthesiologists skilled in regional anesthesia.

After the block, patients were placed in a supine position, extubated after adequate reversal of muscle relaxant, and shifted to the post-anesthesia care unit (PACU); from there, the patients were shifted to the ward after half an hour. Patients in both groups received fentanyl as rescue analgesia by IV-PCA pump. PCA pump (CADD Legacy PCA pump, Smiths Medical MD, Inc., St. Paul, MN) was prepared with 300 μg fentanyl in 30 mL of saline and a bolus dose of 0.5 μg/kg, and a lockout interval of 20 min was set, with no background infusion. An independent observer assessed postoperative pain intensity using an NRS (1–10) at rest and on movement at 1, 2, 4, 8, 12, 24, 36, and 48 h. Patient satisfaction was assessed using the Likert scale: 1- very bad, 2- bad, 3- good, 4- very good, and 5- perfect.

The sample size was derived based on a study by Zhu *et al.*,[14] where opioid consumption [Mean(SD)] in the QLB group was [34.1 (9.9)] μg and in the control group was [42.1 (11.6)] μg. Assuming a standard deviation of 9.9 in the study group and 11.6 in the control group, with an effect size of 0.74 and a clinically meaningful mean difference of 8 in the consumption of drug for analgesia in two treatment groups, with 80% power and alpha error of 5%, the sample size was estimated to be 29 per treatment group. As it was a follow-up study considering the dropout rates of 10%, we recruited 32 patients per treatment group. P values < 0.05 were considered to be statistically significant.

Results

Out of 75 patients assessed for eligibility, nine did not meet the inclusion criteria and two were unwilling to participate. After informed written consent, we enrolled 64 patients and randomized them into both groups. Thirty patients in each group completed the study, and their results were analyzed. The Consolidated Standards of Reporting Trials (CONSORT) diagram is shown in Figure 1. The two groups did not differ in demographic and operative characteristics (operative side and duration of surgery) [Table 1]. The indication for nephrectomy was renal stone disease in 70% of patients, whereas in the rest of the 30%, pelvi-ureteric junction obstruction, pyelonephritis, and dysplastic/hypoplastic kidney were the indications.

Total mean fentanyl consumption (as rescue analgesic) during the first 48 h after surgery was lower in the QLB group when compared to the control group (mean ± SD; QLB group $=74.33 \pm 32.75$ μg; control group $=209.10 \pm 52.04$ μg)

($P < 0.001$). In the QLB group, the total number of fentanyl boluses required was significantly lower ($P < 0.001$) (median [1Q, 3Q]; QLB group =2 [2, 3]; control group =6 [6, 7]). The median time to first rescue analgesia demand was significantly longer in the QLB group as compared to the control group (median [1Q, 3Q]; QLB group =180 min [120, 240]; control group =60 min [60, 90]) ($P < 0.001$) [Table 2]. NRS at rest and on movement showed that the QLB group had significantly less pain than the control group at almost all time points up to the first 48 h [$P = 0.018$, Figure 3a and b], as shown by the analysis of variance using repeated measures ANOVA. QLB group patients had higher satisfaction than the control group ($P = 0.018$) [Table 2].

Table 1: Baseline general characteristics

Variables	QLB Group	Control Group	P
Age (years)	40.77±12.73	41.93±12.49	0.721
Female	18 (60%)	16 (53.3%)	0.794
Weight (kg)	65.33±10.18	64.97±9.56	0.886
ASA- I/II	63.3%/36.6%	76.7%/23.3%	0.385
Operative side (left/right)	46.7%/53.3%	60%/40%	0.438
Surgical duration (min)	170.67±40.59	158.67±42.97	0.271

Data are mean±SD or n and percentage. ASA, American Society of Anesthesiologists; QLB group, Quadratus lumborum block group

Table 2: Rescue Analgesia characteristics, patient satisfaction

Variables	QLB Group (n=30)	Control Group (n=30)	P
Total dose of fentanyl (μg)	74.33±32.75	209.10±52.04	<0.001
Time to rescue analgesia (min)	180 (120–240)	60 (60–90)	<0.001
Total no. of bolus given	2 (2–3)	6 (6–7)	<0.001
Patient Satisfaction			
2	0 (0%)	5 (16.7%)	0.018
3	14 (46.7%)	19 (63.3%)	
4	15 (50%)	6 (20%)	
5	1 (3.3%)	0 (0%)	

Data are mean±SD, median (1 quartile, 3 quartile), n, and percentage. Patient satisfaction, 1- very bad, 2- bad, 3- good, 4- very good, 5- perfect. QLB, Quadratus lumborum block

In the QLB group, seven patients (23.3%) developed nausea and three patients (10%) had vomiting, whereas in the control group, 13 (43.3%) patients had nausea and seven (23.3%) had vomiting. One of the patients in the QLB group had catheter dislodgement in the postoperative period, which was excluded from the final analysis. None of the severe complications were noted, including LA toxicity, visceral organ injury, bleeding, infection, and lower limb paraesthesia.

Discussion

The present study demonstrated that US-guided continuous catheter quadratus lumborum block (QLB3) reduced postoperative fentanyl consumption by 64.45% and decreased pain intensity (NRS pain scores) after laparoscopic nephrectomy without complications. Thus, continuous transmuscular QLB is an effective and reliable method for managing postoperative pain in patients undergoing laparoscopic nephrectomy.

Small incisions with less pain and rapid recovery are the advantages of laparoscopic nephrectomy. However, many patients suffer from significant early postoperative pain, requiring parenteral opioids.[1,2] The adverse effects associated with the use of opioids, such as sedation, nausea, vomiting, and paralytic ileus, delay recovery and prolong the hospital stay.[4] As a component of the multimodal analgesia technique, the truncal nerve blocks effectively reduce postoperative pain and opioid consumption and their adverse effects. Although there is variation in the number of dermatomes covered in QLB, T7-L1 dermatomes are covered in most cases.[15] Compared to central neuraxial blocks, truncal nerve blocks

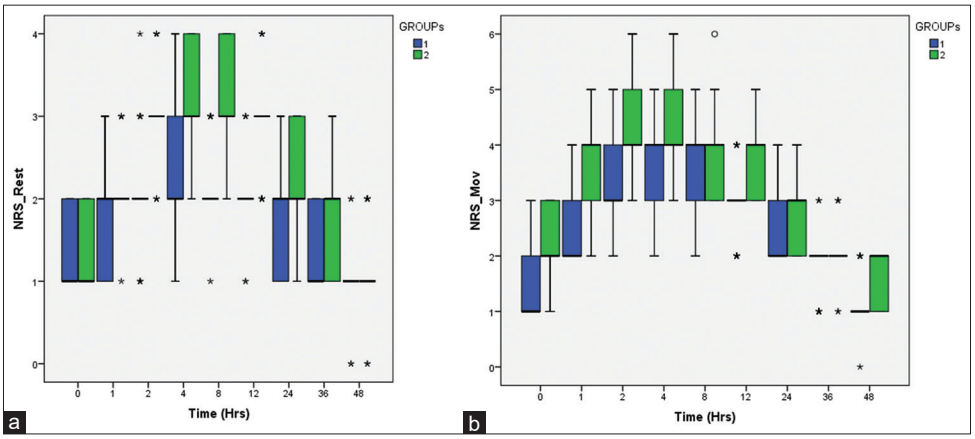

Figure 3: (a and b) Shows the median NRS at rest in the QLB and control groups at various intervals. Shows the median NRS on movement in the QLB and control groups at various intervals

are easy to perform and have a low risk of complications such as hypotension, which is common with epidurals.[5]

In the present study, the postoperative requirement of rescue analgesia during the first 48 h, measured as total fentanyl consumption, was significantly lower in the study group than in the control group. Our results agreed with the study inference by Blanco *et al.*[16] They were the first to describe the QLB and found that it significantly lowers postoperative morphine consumption in patients undergoing cesarean section. Venkatraman R *et al.*[17] studied QLB for postoperative analgesia in unilateral laparoscopic renal surgeries; they reported that QLB provides adequate postoperative analgesia with significantly reduced rescue analgesic requirement. Our results were similar to a recent study by Karadeniz *et al.*,[18] where the analgesic efficacy of QLB was studied in laparoscopic donor nephrectomy patients via a continuous catheter placed by the surgeon under laparoscopic vision. More than 70% opioid (morphine) sparing effect was seen during the first 24 h in the postoperative period. Our results were similar to a few recent studies on using single-shot transmuscular QLB for laparoscopic nephrectomy. In their study, Zhu *et al.*[14] showed that consumption of opioids (sufentanil) and the number of patients requiring rescue analgesics in the first 24 h after surgery were significantly lower in the transmuscular QLB group compared to the control group in the patients undergoing laparoscopic nephrectomy. Preoperative bilateral transmuscular QLB was studied in patients undergoing laparoscopic nephrectomy by Dam M *et al.*[11] They reported a 43% reduced opioid consumption in the postoperative period and a significantly prolonged time to first opioid consumption. However, in their study, the opioid-sparing effect of the transmuscular QLB was limited to the first 12 h. In our study, using continuous catheter infusion of LAs, analgesia- and opioid-sparing effects were seen up to 48 h postoperatively. Postoperative opioid consumption was significantly reduced by 64.45% by continuous catheter QLB. Our study showed that continuous catheter infusion of LAs could extend the efficacy and duration of analgesia of transmuscular QLB block.

In our study, the time to first rescue analgesia (fentanyl) demand was significantly prolonged in the QLB group compared to the control group (median [Q1, Q3]; QLB group =180 min [120, 240]; control group =60 min [60, 90]). Our results were similar to the study by Dam M *et al.*,[11] where the median time to first rescue opioid demand was significantly higher in the study group compared with the control group (median [Q1, Q3]; study group =4.4 h [2.8, 17.6]; control group =0.3 h [0.1, 1.0]).

In the present study, postoperative pain at rest and on movement, assessed using NRS pain scores, were significantly lower in the transmuscular QLB group than in the control group at almost all time intervals up to the 48th h postoperatively. Our results are similar to the study by Li *et al.*,[19] where lateral and posterior QLB given preoperatively effectively reduced pain scores at rest and on coughing for up to 24 h in patients undergoing laparoscopic renal surgery. However, in the study by Dam M *et al.*,[11] no statistical intergroup differences were observed for pain (neither at rest nor during activity) in the QLB and control group in patients undergoing laparoscopic nephrectomy. In the literature, a few studies have highlighted the effect of the single-shot technique of QLB3 in laparoscopic nephrectomy, providing postoperative analgesia for 16–24 h and further pain control by opioid analgesics.[10,11] However, in our study pain scores were significantly lower up to 48 h with no or minimal use of opioids due to the use of continuous catheter infusion of LAs. This has highlighted the added advantage of continuous catheter transmuscular QLB compared to a single-shot transmuscular QLB.

In our study, the incidence of nausea and vomiting was lower in the QLB group (23.3% and 10%, respectively). This is not statistically significant compared to the control group (43.3% and 23.3%, respectively). Our results were similar to the study by Zhu *et al.*[14] The lower incidence of nausea and vomiting can be explained by less consumption of opioids in the postoperative period in patients of the QLB group. In our study, no other significant adverse effects related to QLB block or catheter, such as LA toxicity, allergy, visceral organ injury, or postoperative infection, were seen in any of the patients. Sá M *et al.*[20] reported hypotension with QLB, possibly due to the paravertebral spread of LA.

In limitations, our study did not check the dermatomal coverage of the sensory block after LA injection. In addition, the quality of postoperative recovery and length of hospital stay was not assessed in our patients. Although no significant complications were seen in our study, the safety of this block cannot be extrapolated due to a small sample size. More randomized controlled studies are required to assess the safety of continuous transmuscular QLB and compare the efficacy and safety of single-shot versus continuous transmuscular QLB.

Conclusion

US-guided continuous catheter transmuscular QLB is an effective method for reducing postoperative opioid consumption and decreasing postoperative pain up to 48 h without complications in patients undergoing laparoscopic nephrectomy.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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