



Comparative Evaluation of Posterior and Lateral Quadratus Lumborum Block for Postoperative Analgesia in Percutaneous Nephrolithotomy

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Abstract

Background: Percutaneous nephrolithotomy (PCNL) is commonly associated with significant postoperative pain despite its minimally invasive nature. Ultrasound-guided quadratus lumborum block (QLB) has emerged as an effective regional analgesic technique for urological procedures. However, evidence comparing different QLB approaches in PCNL remains limited.

Aim: To compare the analgesic efficacy of ultrasound-guided posterior and lateral quadratus lumborum block in patients undergoing PCNL.

Methods: This prospective, single-blind, randomized clinical study included 60 adult patients (ASA I–III) scheduled for elective PCNL under general anaesthesia. Patients were randomly allocated into two groups: Posterior QLB (Group P, n=30) and Lateral QLB (Group L, n=30). At the completion of surgery, patients received either posterior or lateral QLB using 30 mL of 0.125% levobupivacaine with dexmedetomidine (1 µg/kg). Postoperative pain was assessed using the Visual Analogue Scale (VAS) at rest and during movement at 30 minutes, 2, 6, 12, and 24 hours. Rescue analgesic requirement, total rescue analgesic consumption, and time to first rescue analgesia were also recorded.

Results: Baseline demographic and perioperative characteristics were comparable between the groups. VAS scores at rest were significantly lower in the posterior QLB group at 2 hours (2.81 ± 0.94 vs. 3.44 ± 1.17 ; $p=0.024$), 6 hours (2.11 ± 0.78 vs. 2.96 ± 0.90 ; $p<0.001$), and 12 hours (1.95 ± 1.03 vs. 2.59 ± 1.05 ; $p=0.021$). During movement, significantly lower pain scores were observed in the posterior QLB group at 6 hours (4.12 ± 0.97 vs. 4.66 ± 0.98 ; $p=0.036$). Total rescue analgesic consumption was significantly lower in Group P (21.67 ± 32.07 mg) compared to Group L (42.83 ± 42.57 mg; $p=0.034$), while the time to first rescue analgesia was significantly longer (8.09 ± 3.77 vs. 5.33 ± 2.86 hours; $p=0.044$). Although fewer patients in the posterior QLB group required rescue analgesia, the difference was not statistically significant (33.3% vs. 53.3%; $p=0.12$).

Conclusion: Posterior quadratus lumborum block provides superior postoperative analgesia compared with lateral quadratus lumborum block following PCNL. It is associated with lower pain

scores, reduced rescue analgesic consumption, and prolonged analgesic duration. Posterior QLB may therefore be preferred as part of a multimodal analgesic strategy for patients undergoing PCNL.

Keywords: Percutaneous nephrolithotomy, Quadratus lumborum block, Posterior QLB, Lateral QLB, Postoperative analgesia, regional anaesthesia, Pain management.

Introduction

Percutaneous nephrolithotomy (PCNL) is widely used for the management of large and complex renal calculi and is considered a standard minimally invasive alternative to open stone surgery. Despite being less invasive than open procedures, PCNL is frequently associated with moderate to severe postoperative pain due to nephrostomy tract dilatation, parenchymal injury, and trauma to the flank musculature¹. Inadequate postoperative analgesia may delay mobilization, impair respiratory function, prolong hospitalization, and increase the need for systemic opioids. Standard urology and anaesthesia textbooks similarly emphasize that effective pain control after PCNL is crucial for enhanced recovery and prevention of pulmonary and thromboembolic complications².

Postoperative analgesia for PCNL typically relies on a multimodal regimen combining non-opioid analgesics with systemic opioids, and in some centres neuraxial or paravertebral techniques are also employed³. Although these strategies can provide satisfactory pain relief, opioid-based analgesia is associated with adverse effects such as nausea, vomiting, pruritus, sedation, and respiratory depression, which may be particularly undesirable in patients with impaired renal function⁴. Neuraxial blocks and thoracic paravertebral blocks offer effective analgesia but require technical expertise and carry the risk of hypotension, urinary retention, and rare yet serious complications including epidural haematoma and neurological injury. These limitations have prompted interest in alternative regional techniques that can provide reliable analgesia with a more favourable safety profile⁵.

Ultrasound-guided quadratus lumborum block (QLB) has emerged as a truncal fascial plane block capable of providing both somatic and visceral analgesia for abdominal and urologic procedures. By depositing local anaesthetic adjacent to the quadratus lumborum muscle, QLB can result in spread toward the thoracolumbar fascia and thoracic paravertebral space, potentially covering dermatomes relevant to the nephrostomy tract and flank incision in PCNL⁶. Randomized controlled trials in patients undergoing PCNL have demonstrated that QLB, including anterior and transmuscular variants, can reduce postoperative pain scores and opioid consumption compared with conventional systemic analgesia or placebo. A randomized controlled study specifically evaluating posterior QLB for PCNL has further supported its efficacy for postoperative analgesia in this setting. In addition, QLB has shown beneficial analgesic effects in patients undergoing nephrectomy and other renal surgeries, as summarized in a narrative review and a recent systematic review and meta-analysis, reinforcing its role as part of multimodal analgesia for urologic procedures⁷.

Several approaches to QLB have been described, including lateral, posterior, anterior, and transmuscular techniques, which differ in needle trajectory, target fascial plane, and pattern of local anaesthetic spread. These anatomical and technical differences may translate into variations in dermatomal coverage, duration of analgesia, and ease of performance in the perioperative setting⁸. Existing literature in PCNL has predominantly compared one QLB approach (e.g. anterior or transmuscular) with conventional systemic analgesia, peritubal infiltration, or paravertebral block. Direct head-to-head comparisons of different QLB approaches remain limited, although studies in other abdominal procedures comparing lateral and posterior QLB suggest that the clinical effects of these approaches may not be equivalent. Thus, anaesthesiologists still lack clear evidence on whether posterior or lateral QLB provides superior postoperative analgesia in patients undergoing PCNL⁹.

In this context, clarifying the relative efficacy of posterior versus lateral QLB in PCNL is of practical importance for optimising perioperative pain management. The present single-blind randomized controlled study was designed to compare the efficacy of ultrasound-guided posterior and lateral quadratus lumborum block on postoperative pain following percutaneous

nephrolithotomy. The primary objective was to compare postoperative pain scores between the two groups, as measured by visual analogue scale (VAS) at rest and during movement at 30 minutes, 2, 6, 12 and 24 hours after surgery. Secondary objectives were to compare the requirement for additional postoperative rescue analgesia between the groups and to document any block-related adverse events.

Materials And Methods

Study design and setting

This was a prospective, single-blind, randomized clinical study conducted in the Department of Anaesthesiology, after approval from the Institutional Ethics Committee (IEC/NMC/10th July 2025/06). Written informed consent was obtained from all participants prior to enrolment, and the study was conducted in accordance with the Declaration of Helsinki.

Participants

Sixty adult patients of either sex, aged 20–60 years, with American Society of Anesthesiologists (ASA) physical status I–III, scheduled for elective percutaneous nephrolithotomy under general anaesthesia were included in the study. Patients were eligible if they provided written informed consent for participation and for administration of quadratus lumborum block. Exclusion criteria were patient refusal, coagulopathy, known allergy to local anaesthetics or study drugs, local infection at the proposed injection site, and pre-existing neurological or psychiatric disorders that could interfere with pain assessment.

Randomization, blinding, and groups

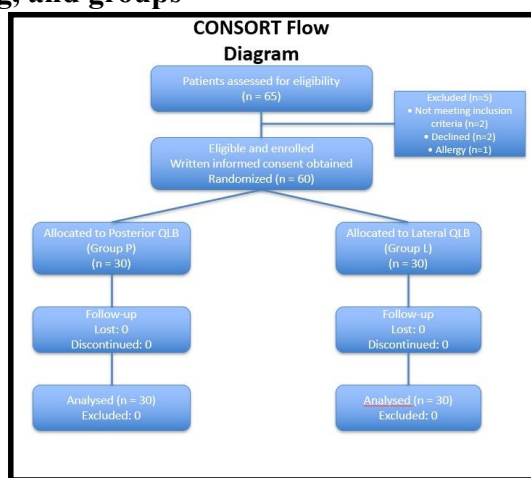


Figure 1: CONSORT FLOW DIAGRAM

This Patients were randomly allocated in a 1:1 ratio to one of two groups (n = 30 each):

Group P: posterior quadratus lumborum block (QLB)

Group L: lateral quadratus lumborum block (QLB)

Randomization was performed using a computer-generated random sequence with allocation concealment achieved by sealed, opaque, sequentially numbered envelopes opened only after induction of anaesthesia. The anaesthesiologist performing the block was aware of group allocation, whereas the patients and the investigator recording postoperative outcomes were blinded to group assignment (single-blind design).

Anaesthetic technique

All patients fasted as per standard guidelines and received routine premedication according to institutional protocol. Standard monitoring (electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography) was instituted in the operating room. General anaesthesia was induced with propofol, muscle relaxation achieved with cisatracurium, and the trachea intubated.

Anaesthesia was maintained with inhalational agent, sevoflurane along with air- oxygen mixture and intermittent doses of muscle relaxant as required. Intraoperative analgesia was standardised in both groups. At the end of surgery, after completion of skin closure and before extubation, the assigned QLB was performed under ultrasound guidance.

Quadratus lumborum block techniques

With the patient in the lateral position, a low-frequency (2–5 MHz) curvilinear ultrasound probe covered with a sterile sheath was placed in the flank region. After skin asepsis and local infiltration with lignocaine, an echogenic needle was advanced in-plane under ultrasound guidance.

Group P (posterior QLB): The needle was directed toward the fascial plane posterior to the quadratus lumborum muscle at the junction of the thoracolumbar fascia and the lateral border of the erector spinae muscle. After negative aspiration, 30 mL of 0.125% levobupivacaine and 1 microgram/kg Dexmedetomidine was injected incrementally, observing appropriate spread in the posterior plane.

Group L (lateral QLB): The probe was moved more laterally to identify the transversus abdominis, internal oblique, and quadratus lumborum muscles. The needle was advanced to the fascial plane at the lateral border of the quadratus lumborum muscle, and after negative aspiration, the same volume and concentration of local anaesthetic as in Group P was injected incrementally, confirming spread between the quadratus lumborum and transversus abdominis aponeurosis.

Total dose of local anaesthetic was kept within recommended safety limits based on patient weight. Haemodynamic parameters and any signs of local anaesthetic systemic toxicity were monitored for at least 30 minutes after block performance in both groups.

Postoperative analgesia and outcome assessment

All patients received a standard postoperative analgesic regimen, which was administered as rescue analgesic, when the visual analogue scale (VAS, 0–10 cm) score was ≥ 4 at rest or on patient request. Pain intensity was assessed using a 10-cm VAS (0 = no pain, 10 = worst imaginable pain) at rest and during movement (e.g. deep breathing or turning in bed) at 30 minutes, 2, 6, 12 and 24 hours after surgery by a blinded observer. The primary outcome measure was VAS score at rest and on movement at the specified time points. Secondary outcome measures included total additional rescue analgesic requirement in the first 24 hours and the number of patients requiring rescue analgesia. Any block-related complications (e.g. vascular puncture, local anaesthetic toxicity, haematoma, infection) and other adverse events were recorded.



FIGURE 2: LATERAL QL BLOCK



FIGURE 3: POSTERIOR QL BLOCK

Statistical analysis

Data were analysed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median (interquartile range) as appropriate and compared between groups using the independent samples t-test or Mann–Whitney U test. Categorical variables were presented as frequencies and percentages and analysed using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS:

Table 1. Baseline characteristics

Variable	Posterior QLB (n=30)	Lateral QLB (n=30)	T Test	p value
Age (years)	43.57 $\pm$ 7.17	44.07 $\pm$ 7.51	−0.26	0.79
BMI (kg/m ²)	23.91 $\pm$ 3.31	24.43 $\pm$ 2.76	−0.66	0.51
Duration of surgery (min)	78.67 $\pm$ 14.94	82.33 $\pm$ 18.66	−0.84	0.40

The two groups were comparable with respect to demographic and perioperative variables. Mean age was 43.57 $\pm$ 7.17 years in the posterior QLB group and 44.07 $\pm$ 7.51 years in the lateral QLB group, with no significant difference between them ($t = -0.26$, $p = 0.79$). Similarly, mean BMI did not differ significantly (23.91 $\pm$ 3.31 vs 24.43 $\pm$ 2.76 kg/m²; $t = -0.66$, $p = 0.51$), and non-parametric tests for age and BMI also showed no group differences. The duration of surgery was comparable (78.67 $\pm$ 14.94 vs 82.33 $\pm$ 18.66 min; $t = -0.84$, $p = 0.40$).

Variable	Posterior QLB (n=30)	Lateral QLB (n=30)	χ^2	p value
male (n (%))	23 (76.7)	17 (56.7)	2.70	0.10
Female (n (%))	7 (23.3)	13 (43.3)		
ASA	I	5	1.83	0.40
	II	15		
	III	10		
Surgery site	right	15 (50.0)	0.61	0.44
	left	15 (50.0)		

The two groups were comparable with respect to baseline demographic and clinical characteristics. There were no statistically significant differences in sex distribution between the Posterior QLB and Lateral QLB groups (male: 76.7% vs. 56.7%; $\chi^2 = 2.70$, $p = 0.10$). Similarly, ASA physical status classification was comparable between groups ($\chi^2 = 1.83$, $p = 0.40$). The distribution of the surgical site was similar between the groups, with right-sided surgeries accounting for 50.0% and 40.0%, and left-sided surgeries accounting for 50.0% and 60.0% in the Posterior QLB and Lateral QLB groups, respectively ($\chi^2 = 0.61$, $p = 0.44$). These findings indicate that the study groups were well matched at baseline.

Table 2. VAS at rest (0–10)

Time point	Posterior QLB	Lateral QLB	t statistic	p value
30 min (0.5 h)	3.22 ± 1.02	3.62 ± 1.22	t = -1.38	0.17
2 h	2.81 ± 0.94	3.44 ± 1.17	t = -2.31	0.024
6 h	2.11 ± 0.78	2.96 ± 0.90	t = -3.92	<0.001
12 h	1.95 ± 1.03	2.59 ± 1.05	t = -2.38	0.021
24 h	1.42 ± 1.09	1.70 ± 0.96	t = -1.06	0.30

Postoperative pain scores at rest were generally lower in the posterior QLB group, particularly in the early and intermediate postoperative period. At 30 minutes, mean VAS at rest was 3.22 ± 1.02 in the posterior group and 3.62 ± 1.22 in the lateral group; this difference was not statistically significant ($p = 0.17$). At 2 hours, VAS at rest was significantly lower with posterior QLB (2.81 ± 0.94 vs 3.44 ± 1.17), with a mean difference of -0.63 and $p = 0.024$. The difference widened at 6 hours, where scores were 2.11 ± 0.78 versus 2.96 ± 0.90 (mean difference -0.85 ; $p < 0.001$), and remained significant at 12 hours (1.95 ± 1.03 vs 2.59 ± 1.05 ; mean difference -0.64 ; $p = 0.021$). By 24 hours, VAS at rest had decreased in both groups and the difference was no longer significant (1.42 ± 1.09 vs 1.70 ± 0.96 ; $p = 0.30$). These findings suggest that posterior QLB provides superior analgesia at rest from 2 to 12 hours postoperatively, with the effect attenuating by 24 hours.

Table 3. VAS on movement (0–10)

Time point	Posterior QLB	Lateral QLB	t statistic	p value
30 min (0.5 h)	4.68 ± 0.98	4.98 ± 0.88	t = -1.24	0.22
2 h	4.62 ± 1.14	5.01 ± 0.72	t = -1.60	0.11
6 h	4.12 ± 0.97	4.66 ± 0.98	t = -2.15	0.036
12 h	4.01 ± 0.92	4.09 ± 0.84	t = -0.32	0.75
24 h	2.95 ± 1.04	3.34 ± 1.00	t = -1.48	0.14

On movement, pain scores also tended to favour posterior QLB, with a significant difference at 6 hours. At 30 minutes, mean VAS on movement was 4.68 ± 0.98 in the posterior group and 4.98 ± 0.88 in the lateral group ($p = 0.22$). At 2 hours, scores were 4.62 ± 1.14 versus 5.01 ± 0.72 , indicating a non-significant trend toward lower movement pain in the posterior group ($p = 0.11$). At 6 hours, posterior QLB was associated with significantly lower VAS on movement (4.12 ± 0.97 vs 4.66 ± 0.98 ; mean difference -0.54 ; $p = 0.036$). No significant differences were observed at 12 hours (4.01 ± 0.92 vs 4.09 ± 0.84 ; $p = 0.75$) or 24 hours (2.95 ± 1.04 vs 3.34 ± 1.00 ; $p = 0.14$). Overall, posterior QLB reduces dynamic pain significantly at 6 hours, with only trends at other time points.

Table 4. Additional analgesia

Outcome	Posterior QLB (n=30)	Lateral QLB (n=30)	Test	p value
Rescue analgesia yes, n (%)	10 (33.3)	16 (53.3)	$\chi^2 = 2.44$	0.12
Total rescue dose (mg)	21.67 ± 32.07	42.83 ± 42.57	t = -2.18	0.034
Time to first rescue (h)*	8.09 ± 3.77	5.33 ± 2.86	t = 2.12	0.044

Although a higher proportion of patients in the lateral group required additional analgesia compared with the posterior group (53.3% vs 33.3%), this difference did not reach statistical significance ($\chi^2(1) = 2.44$, $p = 0.12$). However, both the total dose and timing of additional analgesia favoured posterior QLB. The mean total additional dose was significantly lower in the posterior group (21.67 ± 32.07 mg) than in the lateral group (42.83 ± 42.57 mg), with a mean difference of -21.2 mg ($p = 0.034$ by t test; $p = 0.033$ by Mann–Whitney test). Among the subset of patients who required rescue

analgesia, the time to first rescue was significantly longer with posterior QLB (8.09 ± 3.77 h vs 5.33 ± 2.86 h; $p = 0.044$), suggesting a more prolonged analgesic effect.

Discussion:

In this single-blind randomized study, posterior quadratus lumborum block provided better postoperative analgesia than lateral quadratus lumborum block after percutaneous nephrolithotomy, as reflected by significantly lower VAS scores at rest from 2 to 12 hours, lower movement pain at 6 hours, reduced rescue analgesic dose, and a longer time to first rescue analgesia, with comparable baseline characteristics between groups. These findings suggest that the posterior approach offers more effective coverage of nociceptive pathways from the nephrostomy tract and flank musculature than the lateral approach.

Our results are in agreement with previous PCNL trials demonstrating that QLB improves postoperative analgesia compared with standard care or placebo. Kılıç and Bulut (2018) 2 reported that QLB type III significantly reduced pain scores and opioid consumption and facilitated early mobilization after PCNL. Raman and Prabha (2021) 3 showed that posterior QLB produced lower pain scores and prolonged analgesia relative to saline control in PCNL patients. Ökmen and Ökmen (2020) 9 demonstrated that anterior QLB also reduced pain and opioid use after PCNL. Combined with these data, the present comparison between two active QLB techniques indicates that the way the block is performed—posterior versus lateral—has a relevant impact on clinical efficacy.

The superiority of posterior over lateral QLB in our cohort is consistent with anatomical and clinical observations from other abdominal procedures. In a randomized trial of laparoscopic cholecystectomy, Ökmen et al. (2019) 9 found that posterior QLB yielded lower pain scores and less rescue analgesia than lateral QLB, supporting the concept that more posterior injections provide broader dermatomal coverage. Akerman et al. (2018) 10 reviewed QLB evolution within the broader family of truncal blocks and highlighted that injectate spread to the thoracolumbar fascia and paravertebral space is more likely with posterior and transmuscular approaches than with more superficial lateral techniques. Rytel et al. (2025) 6 similarly emphasized that QLB-2 (posterior) and QLB-3 provide the widest sensory coverage and longer analgesia, and may offer advantages over TAP and even epidural blocks in some abdominal surgeries. These mechanistic and clinical data are in keeping with our finding that posterior QLB achieved lower pain scores and reduced rescue requirements compared with lateral QLB.

The present results also sit within a wider QLB literature across abdominal and pelvic surgery. In a systematic review and meta-analysis of 42 randomized trials, Uppal et al. (2020) 11 concluded that QLB confers clear analgesic benefits compared with placebo in abdominal wall and hip surgeries, primarily through reduced opioid consumption, while offering only modest advantages over other regional techniques in many settings. Liu et al. (2020) 12 pooled eight randomized trials and found that QLB provided significantly lower pain scores at multiple time points, reduced 24-hour morphine consumption, and prolonged duration of analgesia compared with TAP block after abdominal surgery, without an increase in postoperative nausea and vomiting. Rytel et al. (2025) 6 further summarized that QLB has been successfully integrated into enhanced recovery protocols for diverse abdominal procedures, with meta-analyses repeatedly showing decreased opioid use, lower pain scores, and in some studies shorter hospital stays. Our data extend these observations to PCNL by suggesting that within QLB itself, posterior placement may be preferable to lateral placement for this specific urologic surgery.

From a PCNL-specific perspective, the present findings add to an evolving body of work on postoperative pain strategies. Paneque et al. (2023) 13 reviewed current pain regimens for PCNL and underscored that multimodal analgesia—including regional techniques, tubeless PCNL, and reduced nephrostomy size—is central to reducing morbidity and promoting recovery, but no single regimen has emerged as standard. Suvina et al. (2024) 5 showed that QLB was more effective than peritubal infiltration for PCNL analgesia, while Devaram et al. (2023) 15 found that a single-level thoracic paravertebral block provided superior analgesia and longer time to first rescue analgesic than transmuscular QLB. Little and Rahman (2021) 7 and Wang et al. (2023) 8 both concluded, in a

nephrectomy narrative review and meta-analysis respectively, that QLB reduces early postoperative pain and opioid use, but that effect sizes depend on the specific QLB approach and comparator technique. In this context, our trial helps refine the role of QLB in PCNL by supporting posterior QLB as the more effective option when a QLB-based strategy is chosen.

Not all evidence has shown large incremental benefits of QLB in every clinical scenario. Uppal et al. (2020)¹¹ noted that while QLB clearly outperforms no block or placebo, its advantage over other regional techniques is often modest. Case data from Graça et al. (2018)¹⁴ suggest that continuous QLB type II can provide excellent analgesia and minimal opioid requirements after partial nephrectomy, but these observations are limited to small series. The heterogeneity in effect across surgeries and approaches, highlighted in both meta-analyses and narrative reviews, indicates that the value of QLB is context-dependent and heavily influenced by technique. Our finding of a clear difference between posterior and lateral QLB under an identical multimodal regimen reinforces the importance of optimising the approach rather than treating all QLB variants as equivalent.

This study has limitations. It was conducted at a single centre with a relatively small sample size, which may restrict generalisability and the ability to detect rare complications. Only single-shot blocks were studied with follow-up limited to 24 hours; continuous catheter techniques, such as the continuous QLB type II described by Graça et al. (2018)¹⁴, may further prolong analgesia and merit evaluation in PCNL. We did not perform detailed sensory mapping or imaging of injectate spread, so mechanistic inferences remain indirect. Future multicentre randomized trials comparing posterior, lateral, and transmuscular QLB—with and without continuous catheters—and incorporating functional outcomes such as time to ambulation, hospital discharge, and patient-reported recovery are needed to more fully define the optimal regional strategy for PCNL within enhanced recovery pathways.

Clinically, our results suggest that when quadratus lumborum block is selected as part of multimodal analgesia for percutaneous nephrolithotomy, the posterior approach should be preferred over the lateral approach to achieve superior early postoperative analgesia, lower rescue analgesic consumption, and a longer duration of pain relief.

Conclusion

The present study demonstrated that ultrasound-guided posterior quadratus lumborum block provides more effective postoperative analgesia than the lateral quadratus lumborum block in patients undergoing percutaneous nephrolithotomy. Patients receiving posterior QLB experienced significantly lower pain scores at rest during the early postoperative period, reduced dynamic pain at 6 hours, decreased rescue analgesic consumption, and a longer duration before requiring additional analgesia. Although the proportion of patients requiring rescue analgesia did not differ significantly between groups, the overall analgesic profile consistently favoured the posterior approach.

These findings suggest that the anatomical spread of local anaesthetic achieved with posterior QLB may result in superior blockade of the somatic and visceral pain pathways involved in PCNL. By providing enhanced pain relief while reducing analgesic requirements, posterior QLB has the potential to improve patient comfort and facilitate postoperative recovery as part of a multimodal analgesic strategy.

In conclusion, posterior quadratus lumborum block is a safe, effective, and clinically superior regional analgesic technique compared with lateral quadratus lumborum block for postoperative pain management following PCNL. Its incorporation into routine perioperative analgesic protocols may contribute to improved postoperative outcomes and patient satisfaction. Further large-scale multicentre studies are recommended to confirm these findings and establish the optimal role of different QLB approaches in enhanced recovery pathways for urological surgery.

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