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Effects of anterior quadratus lumborum block versus erector spinae plane block on postoperative acute pain in percutaneous nephrolithotomy: a prospective, observational study

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Abstract

Background The study aimed to compare the pain-relieving effectiveness of anterior quadratus lumborum block (QLB3) and erector spinae plane block (ESPB), both of which have been documented to provide relief during abdominal surgery.

Methods This prospective observational study, conducted between February and July 2023, included 96 patients who had undergone percutaneous nephrolithotomy (PCNL). Patients were divided into three groups: QLB3, ESPB, and control (no block) and received the corresponding nerve block in the preanesthetic room for regional block. Cumulative morphine consumption during the initial 24 h after PCNL, numerical rating scale resting/movement scores, intraoperative remifentanil usage, rescue analgesic requirements, time when the first analgesic was requested, and postoperative nausea and vomiting scores were documented and compared between the groups.

Results Total median morphine consumption in the first 24 h postoperatively was similar in the QLB3 and ESPB groups but higher in the control group (QLB3, 7 mg [(Q1-Q3) 7–8.5]; ESPB, 8 mg [6.5–9]; control, 12.5 [10–17]; $P < 0.001$). Similarly, median intraoperative remifentanil consumption did not differ between the block groups but was higher in the control group (QLB3, 1082 µg [IQR 805.5–1292.7]; ESPB, 1278 µg [940.2–1297.5]; control, 1561 µg [1315–2068]; $P < 0.001$). The number of patients receiving rescue analgesic medication was similar in the block groups but higher in the control group (QLB3, $n = 9$ [30%]; ESPB, $n = 14$ [46.7%]; control, $n = 21$ [70%]; $P = 0.008$).

Conclusions QLB3 and ESPB were adequate and comparable in providing postoperative analgesia as part of multimodal analgesia after PCNL.

Trial registration The study was registered on ClinicalTrials.gov (Identifier: NCT05822492).

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Keywords Acute postoperative pain, Erector Spinae plane block, Nerve block, Percutaneous nephrolithotomy, Quadratus lumborum block, Ultrasonography

Introduction

Kidney stones are a prevalent medical issue, and percutaneous nephrolithotomy (PCNL) is the preferred treatment for large (>20 mm) or staghorn kidney stone [1]. Despite its use as a minimally invasive endourological procedure, severe visceral and somatic pain may occur during PCNL, attributable to various factors, including surgical incision, renal parenchymal injury, renal capsule stretch, and nephrostomy tube insertion [2]. While appropriate analgesia management can involve various techniques, such as intercostal block, peritubular local anesthetic infiltration, thoracic paravertebral block, and intravenous (IV) systemic analgesics (particularly opioids) are frequently used [3–5].

The anterior quadratus lumborum block (QLB3) was first described by Børglum et al. in 2013—involves applying local anesthetic (LA) to the interfascial plane between the quadratus lumborum and the psoas major muscles [6, 7]. Following its introduction, QLB3 has attracted increasing attention and has been widely used in various abdominal procedures, with its efficacy being widely acknowledged [8, 9]. Since its introduction in 2016 for treating thoracic neuropathic pain, the erector spinae plane block (ESPB) has gained considerable popularity among anesthesiologists as a relatively new truncal block for postoperative analgesia [10]. In ESPB, a LA is administered into the region bounded by the erector spinae muscle and the transverse vertebral processes. Despite ongoing uncertainty regarding the mechanism of action for QLB3 and ESPB blocks and significant inconsistency in injectate spread in cadaveric/imaging studies, numerous randomized controlled trials (RCTs) and meta-analysis have reported these two blocks as effective and reliable techniques in reducing postoperative pain scores and analgesic consumption in PCNL patients. Although prior RCTs and meta-analysis have demonstrated the effectiveness of both QLB3 and ESPB blocks in managing postoperative pain for PCNL patients, these studies evaluated each block independently. Our current study uniquely contrasts the analgesic effects of QLB3 and ESPB blocks when applied to PCNL surgery, providing a comparative analysis that has not been previously addressed in the literature [11–15].

Consequently, the primary objective of this observational study was to differentiate the analgesic effectiveness of ESPB and QLB3 through comparisons with both control groups and one another. Given the lack of precise elucidation regarding the mechanism of action for both blocks and the potential for significant variations in LA spread, we hypothesized differences in morphine consumption among the blocks. Specifically, we aimed to investigate whether cumulative morphine consumption during the initial postoperative 24 h differs significantly between the control, QLB3, and ESPB groups in patients undergoing PCNL. Thus, the primary endpoint compares the cumulative morphine consumption among the control, QLB3, and ESPB groups. Additionally, we investigate secondary outcomes that include pain scores at rest and during movement, intraoperative remifentanil consumption, the requirement for rescue analgesics, timing to first analgesic request, hemodynamic variables, the incidence of postoperative nausea and vomiting, the need for antiemetic medication, and the rates of complications.

Materials and methods

Study design

This prospective, single-center, observational study was designed and conducted in adherence with the guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (i.e., "STROBE") guidelines [16]. Ethics committee approval was obtained from the local ethics committee (OMU KAEK, reference number 2022/İ.908). Written informed consent was obtained from all participants on the day before surgery. The study was conducted according to the ethical principles of the Declaration of Helsinki [17]. The study was registered on ClinicalTrials.gov (Identifier: NCT05822492). Physicians not involved in this study performed data collection, anesthesia management, and blocks. Thus, the investigators and outcome assessors were able to remain blinded.

Participants

The present study included patients 18–65 years of age with the American Society of Anesthesiologists (ASA) Physical Status of I-III who underwent unilateral PCNL surgery. However, patients with allergies to the drugs used in the study, individuals for whom regional anesthesia was contraindicated due to conditions such as coagulopathy, those for whom a numerical rating scale (NRS) score could not be assessed, those with cognitive dysfunction, and those with a body mass index>35 kg/m^2 were excluded. Furthermore, patients with neuropsychiatric disorders, musculoskeletal abnormalities, or alcohol or drug addiction(s) were also excluded.

In this prospective observational study, we meticulously monitored the post-treatment progression of ninety-six patients undergoing PCNL to assess natural clinical outcomes. Patients meeting the inclusion criteria were consecutively enrolled until the target sample size was achieved. Allocation to one of three groups—QLB3,

ESPB, or a control group—was determined by the clinical discretion of the anesthesiologist overseeing the anesthesia management for the procedure. To preserve the integrity of the study's results, the group assignments were kept confidential from the research team. Prior to participation, patients were comprehensively informed about the nature of the study and the specifics of this allocation approach, ensuring that they provided informed consent with full understanding of the methodology.

Block procedures

Before surgery, in the regional anesthesia room, patients undergoing QLB3 or ESPB were monitored with electrocardiography, non-invasive arterial pressure monitoring, and peripheral oxygen saturation monitoring. Additionally, nasal oxygen was administered at a flow rate of 3 L/min, and intravenous midazolam was given at a dose of 0.02 mg/kg to get the patient's Ramsey Sedation Score to reach 2 (alert, calm, observing surroundings).

Ultrasound-guided QLB3

Patients were placed in the lateral decubitus position with the surgical side facing upward and the hip flexed. Following aseptic measures, a curvilinear ultrasound (US) probe operating at 3–5 MHz (LOGIQ V1 Ultrasound System, GE) was positioned between the iliac crest and the subcostal margin. Sonographic imaging of the abdominal muscles, latissimus dorsi, erector spinae, psoas, transverse process of the fourth lumbar vertebra, and the vertebral body was performed. On identifying the "shamrock" sign formed by the erector spinae, quadratus lumborum, and psoas major muscles, the block needle (100 mm long, 21-gauge short bevel; Stimuplex Ultra 360, B. Braun) was advanced inplane between the quadratus lumborum and psoas muscles [7]. Following hydro dissection, a mixture of 30 ml containing 0.25% bupivacaine (Marcaine™, AstraZeneca) and 1:400,000 adrenaline was injected, while negative aspiration was performed every 5 ml. Concurrent observation of local anesthetic diffusion between the quadratus lumborum and the psoas major muscles was performed (Fig. 1A). A pinprick test (blunt-tipped, 27-gauge hypodermic needle)

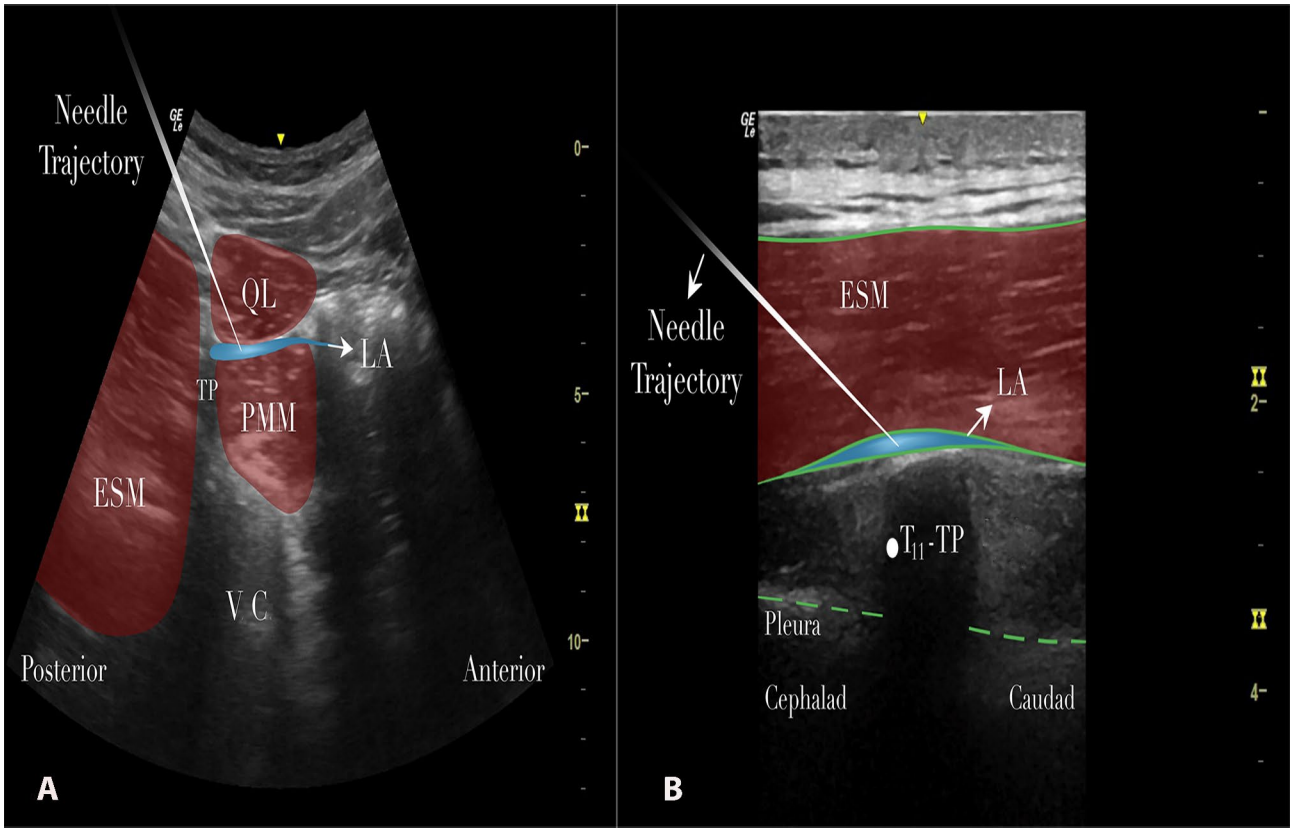

Fig. 1 **A**-**B**. The sonoanatomy for the QLB3 and ESPB. (**A**) US-guided QLB3. The relevant technique is depicted in an ultrasound image. The white line indicates needle trajectory, and the blue highlighted area is the desired spread of local anesthetic. (**B**) US-guided ESPB. The relevant technique is depicted in an ultrasound image. The white line indicates needle trajectory, the blue highlighted area is the desired spread of local anesthetic, and the dashed line denotes the pleura. QLB3, anterior quadratus lumborum block; QL, quadratus lumborum muscle; PMM, psoas major muscle; VC, vertebral corpus. ESPB, erector spinae plane block; ESM, erector spinae muscles; TP, transverse process; LA, local anesthetic

was used to assess post-procedure sensory block between the T9–L2 dermatomes every 5 min (0, no sensory block; 1, touch sensation, no pain; 2, no touch sensation, no pain) [18]. Patients with a sensory block score ≥ 1 were deemed to have a successful QLB3, with the remaining excluded from the study.

US-guided ESPB

Patients were initially positioned sitting, aseptic precautions were taken, and a linear or curvilinear US probe (3–5 MHz or 8–13 mHz, LOGIQ V1 Ultrasound System, GE) was placed at the T10 level. The correct level was determined by counting the upward movement from the 12th rib to T10. The trapezius muscle, erector spinae muscle group, and transverse process of the T10 vertebra were visualized. The plane between the transverse process and the erector spinae muscles was reached in-plane with the block needle (100 mm long, 21-gauge short bevel; Stimuplex Ultra 360, B. Braun). Following hydro dissection with 1–2 ml of normal saline, 30 ml 0.25% bupivacaine (Marcaine™, AstraZeneca), and 1:400,000 adrenaline was injected, with negative aspiration controlled at every 5 ml. Simultaneously, the craniocaudal spread of the local anesthetic mixture was visualized (Fig. 1B). After performing the ESPB , the patient's posture was changed to a supine position. A pinprick test (27-gauge hypodermic needle) was used to intermittently assess sensory block in the T10–L2 dermatomes for 30 min following the procedure (0, no sensory block; 1, touch sensation, no pain; 2, no touch sensation, no pain). Patients with a sensory block score ≥ 1 were deemed to have a successful ESPB, with the remaining excluded from the study.

Anesthesia management

Following standard ASA monitoring in the operating room, anesthesia induction and intubation were performed after administration of propofol 1.5–2 mg/kg IV, rocuronium 0.6 mg/kg IV, and remifentanil infusion (0.1–0.25 mcg/kg/min). Anesthesia was achieved using O_2/Air (fraction of inspired oxygen, 0.40), sevoflurane, and remifentanil infusion. Remifentanil infusion was adjusted according to intraoperative mean arterial pressure (MAP) and heart rate (within 20% of preoperative levels). At the conclusion of procedures, patients were extubated following neuromuscular reversal with 0.04 mg/kg neostigmine IV and 0.02 mg/kg atropine IV.

To prevent postoperative nausea and vomiting (PONV), patients were routinely administered dexamethasone 8 mg IV before induction and ondansetron 0.15 mg/kg IV 20 min before the conclusion of the procedure. In patients who scored ≥ 3 on a 5-point PONV verbal descriptive scale (0, no nausea; 1, mild nausea; 2, moderate nausea; 3, 1 vomiting episode; and 4, vomiting > 1), 4 mg ondansetron IV was administered. The number of patients requiring antiemetics and postoperative post-anesthesia care unit (PACU), 3 h, 6 h, 12 h, 18 h, and 24 h PONV scores were recorded. The assessments were conducted by an independent physician, specifically an anesthesia resident.

Analgesia management

Patients were provided with information regarding patient-controlled analgesia (PCA) and NRS scores during the preoperative visit. Patients were informed that the NRS would consist of a 10 cm chart featuring the words "no pain" at one end and "the most severe pain imaginable" at the other. They were further instructed to assess their pain intensity based on the information presented in the chart.

Patients received 20 mg of tenoxicam intraoperatively following induction, 1 g paracetamol IV before the conclusion of surgery, and 1 g paracetamol IV every 8 h during the postoperative period. The PCA device (BodyGuard 575 Pain Manager, BD) was set to deliver 20 μg/kg morphine with a lockout time of 10 min and a 4 h limit of 80% of the total calculated dose without baseline infusion.

All patients were given access to a PCA device in the recovery unit. When rescue analgesia was required (NRS score ≥ 4 despite the use of PCA device), a 30-minute infusion of 100 mg tramadol IV (maximum 300 mg/day) was administered. Postoperative PACU, 3 h, 6 h, 12 h, 18 h, and 24 h NRS scores at rest and during movement (coughing or deep inspiration) were noted. Additionally, the number of patients requiring rescue analgesia and the time from awakening to the first requirement for analgesia from the PCA were pointed out in the PACU.

Surgical procedure

During the procedure, after the stone was located using retrograde pyelography in the lithotomy position, the patients were positioned prone, and the stone was accessed using a nephroscope through a small incision (approximately 2 cm). Once the stone was extracted, a nephrostomy catheter was inserted, and the procedure was concluded.

Outcomes

The primary outcome of the study was cumulative morphine consumption within the first 24 h postoperatively. Secondary outcomes were postoperative pain at rest/movement, intraoperative remifentanil consumption, number of patients requiring rescue analgesics, time of first analgesic requirement, hemodynamic data, nausea-vomiting scores, number of patients requiring antiemetics, and complications (local anesthetic systemic toxicity, vascular puncture, pneumothorax, kidney

damage, retroperitoneal hematoma, or lower extremity weakness).

Sample size calculation and statistical analysis

Sample size calculation was performed using Minitab version 16.0 (Minitab LLC). The following parameters were set: a type I error rate of 5% and a power of 80%. The study involved three groups; a pilot study was conducted with 13 patients in each group. Based on the pilot study, the mean ± standard deviation (SD) for each group were as follows: Group QLB3: 9.15 ± 2.09, Group Control: 12.53 ± 5.71, and Group ESPB: 10.03 ± 3.48. The calculated effect size was 0.359. Using the above parameters and effect size, the total sample size required for the main study was determined using an ANOVA (F-test) for comparing means. The total sample size required was 78 patients. Considering potential data losses estimated at approximately 20%, the total sample size was adjusted to 96 patients (Table 1). A post hoc power analysis confirmed that these parameters robustly powered our study to detect significant intergroup differences.

Statistical analysis was performed using SPSS version 28.0 (IBM Corporation). The Kolmogorov–Smirnov test was used to assess the conformity of the variables to a normal distribution. Continuous variables are expressed as mean ± standard deviation (95% confidence interval [CI]), mean difference, and median (interquartile range [IQR, i.e., Q1–Q3]), while categorical variables are expressed as frequency (n) and percentage (%). When applicable, categorical variables were compared using the chi-squared test or Fisher's exact test. Data with a normal distribution were compared using one-way analysis of variance (ANOVA), and where variables deviated from the normal distribution, the Kruskal-Wallis ANOVA was used for post hoc comparisons; the Mann–Whitney U test with Bonferroni correction was used when required. The threshold for statistical significance was set at $p<0.05$. In the Mann–Whitney U test, a statistical significance value of $P<0.017$ was accepted, with the Bonferroni correction applied.

Table 1 Parameters of the power analysis

Power analysis	
We performed the POWER analysis:	a priori
on the primary outcome:	Morphine consumption within the first 24 h postoperative
based on the two-tailed statistical test:	F tests- ANOVA
and accepting the cutoff for significance (α):	0.05, two tailed
and a power (1-β) of:	0.80
The variability of the primary outcome was:	Group QLB3: 9.15 ± 2.09, Group Control: 12.53 ± 5.71, and Group ESPB: 10.03 ± 3.48.
based on data taken from:	Preliminary pilot study
We considered as clinically relevant a difference:	20%
Consequently, the effect size was:	0.359

Results

Eligibility was assessed for a total of 103 patients in this study, 7 of whom were excluded due to morbid obesity ($n=4$), history of local anesthetic allergy ($n=1$), and refusing inclusion ($n=2$). Additionally, two patients from each group were excluded due to a modification in the surgical plan that occurred during the procedure, and the remaining 90 patients' data were analyzed (Fig. 2). No block failure was observed in any patient. The groups were comparable in demographic, clinical, and surgical characteristics (Table 2).

In the first 24 postoperative hours, median morphine consumption was notably higher in the control group compared to the block groups (control, 12.5 mg [Q1-Q3, 10–17]; QLB3, 7 mg [Q1-Q3, 7–8.5]; ESPB, 8 mg [6.5–9]; $P<0.001$, effect size = 0.513), addressing our primary outcome measure. Secondary outcomes revealed that the median intraoperative remifentanil consumption did not differ significantly between the block groups but was greater in the control group (QLB3, 1082 µg [IQR 805.5 − 1292.7]; ESPB, 1278 µg [940.2–1297.5]; control, 1561 µg [1315–2068.2]; $P<0.001$, effect size = 0.316). The time to the first opioid request from the PCA device was comparable among all groups ($P=0.258$, effect size = 0.008). However, the control group required more rescue analgesia ($n=21$ [70%]) compared to the QLB3 ($n=9$ [30%]) and ESPB groups ($n=14$ [46.7%]; $P=0.008$, effect size = 0.329) (Table 3). The NRS scores for postoperative rest were lower in the QLB3 group for up to 18 h and in the ESPB group for the first 12 h post-surgery, compared to the control group ($P<0.001$). Similarly, during the initial 12 h, activity NRS scores were lower in both block groups than in the control group ($P<0.001$). Consistent across all time points measured, rest and movement NRS scores within the block groups remained similar (Fig. 3).

Furthermore, the pairwise mean difference in total morphine consumption over the first 24 h was 6.93 mg less in the QLB3 group and 6.06 mg less in the ESPB group compared to the control group ($P<0.001$), with no significant difference between the block groups. Intraoperatively, the QLB3 and ESPB groups consumed less remifentanil by a mean of 697.26 µg and 615.16 µg, respectively, compared to control ($P<0.00.1$), while again, the difference between the block groups was not significant. The time to first opioid request showed no meaningful variation among the groups (Supplement 1).

Regarding hemodynamic data, heart rate was similar across the three groups. However, mean arterial pressure was lower in the QLB3 group at 30, 45, and 60 min

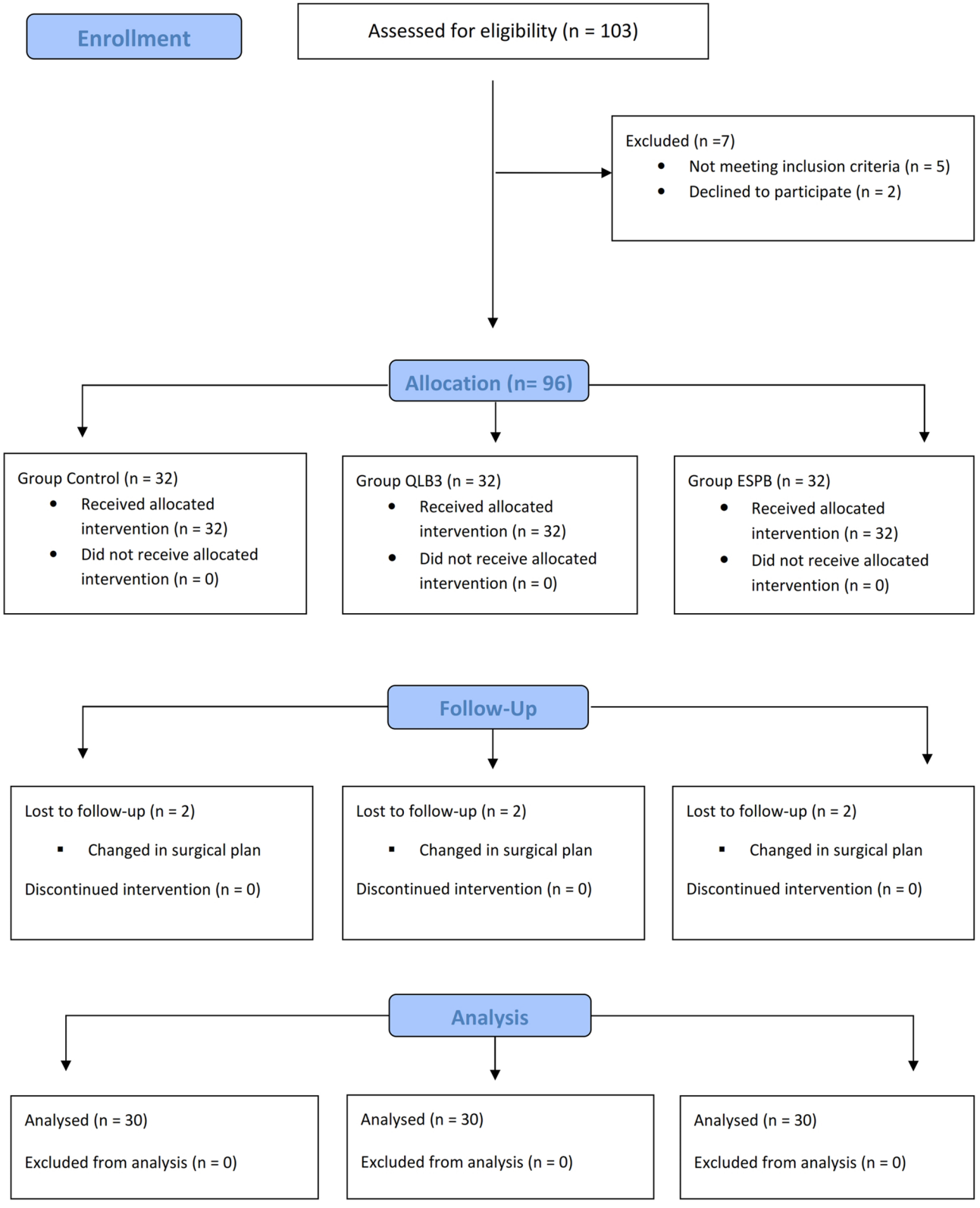

Fig. 2 Consort flow diagram of the study. QLB3, anterior quadratus lumborum block; ESPB, erector spinae plane block

Table 2 Patient demographic and surgical characteristics and clinical outcomes

	Group Control (*n* = 30)	**Group QLB3 (*n* = 30)**	**Group ESPB (*n* = 30)**	***p***
	Mean ± SD (95% CI)/ Median [Q1-Q3]	**Mean ± SD (95% CI)/ Median [Q1-Q3]**	**Mean ± SD (95% CI) / Median [Q1-Q3]**	
Age (years)	56.0 (37.5–63.0)	55.0 (44.2–59.0)	47.0 (36.0–63.0)	0.728
BMI (kg/m2)	27.6 ± 4.8 (25.7–29.3)	26.6 ± 3.4 (25.3–27.9)	27.7 ± 4.4 (25.3–28.6)	0.709
Duration of anesthesia (min)	114.9 ± 32.5 (102.8-127.1)	116.1 ± 28.8 (105.4–126.0)	117.6 ± 30.8 (106.1-129.1)	0.945
Duration of surgery (min)	94.4 ± 32.1 (82.5-106.4)	91.7 ± 25.9 (82.0-101.3)	95.6 ± 27.7 (85.2-105.9)	0.862
Preoperative hemoglobin (g/dL)	12.7 ± 1.9 (12.0-13.4)	12.5 ± 2.1 (11.7–13.2)	13.2 ± 1.9(12.4–13.8)	0.424
Preoperative creatinine (mg/dL)	1.0 (1.0-1.2)	1.0 (0.9–1.1)	1.1 (1.0-1.3)	0.383
GFR (mL/dk)	77.9 ± 21.1(69.9–85.8)	81.0 ± 24.2 (71.9–90.0)	76.8 ± 37.1 (62.9–90.6)	0.834
Size of stones (mm)	22.0 (18.0-28.5)	22.0 (17.0-24.7)	25.0 (21.5–35.0)	0.075
Sex, female/male, n (%)	12 (40) / 16 (60)	13 (43.3) / 17 (56.7)	12 (40) / 16 (60)	0.955
ASA, n (%)				
I	9 (30)	9 (30)	6 (20)	0.098
II	16 (53.3)	19 (63.3)	24 (80)	
III	5 (16.7)	2 (6.7)	0 (0)	
Nephrostomy, n (%)				
(-) / (+)	13 (43.3) / 17 (56.7)	7 (19.2) / 23 (80.8)	10 (33.3) / 20 (66.7)	0.157
Side of surgery, n (%)				
Right/Left	21 (70) / 9 (30)	15 (50) / 15 (50)	14 (46.7) / 16 (53.3)	0.144

NOTE. Continuous variables are presented as median [Q1-Q3] or mean ± standard deviation (95% CI), and categorical variables are presented as counts (%)

Abbreviations: QLB3, anterior quadratus lumborum block; ESPB, erector spinae plane block; BMI, body mass index; GFR, glomerular filtration rate; ASA, American Society of Anesthesiologists

Table 3 Comparison of intraoperative and postoperative opioid consumption by study groups

	Group Control (*n* = 30) Median [Q1-Q3]	**Group QLB3 (*n* = 30) Median [Q1-Q3]**	**Group ESPB (*n* = 30) Median [Q1-Q3]**	***p***	**Effect size**
Cumulative morphine consumption in first 24 h (mg)	12.5 (10.0–17.0)	7.0 (7.0-8.5)	8.0 (6.5-9.0)	< 0.001a	0.513c
Time to first opioid request (min)	45.0 (28.7–86.2)	53.5 (37.7–78.5)	55.0 (39.7–90.0)	0.258a	0.008c
Intraoperative remifentanil consumption (µg)	1561 (1315.0-2068.2)	1082 (805.5-1292.7)	1278 (940.2-1297.5)	< 0.001a	0.316c
Patients given rescue analgesic in first 24 h, n (%)	21 (70.0)	9 (30.0)	14 (46.7)	0.008b	0.329d

NOTE. Continuous variables are presented as median [Q1-Q3], and categorical variables are presented as counts (percentages) (%)

aKruskal Wallis test, bChi-Square test, cEta squared (η2) effect size, dEffect size w,

The results were statistically significant for the Kruskal-Wallis test ($p < 0.05$) and the Bonferroni-adjusted Mann-Whitney U Test ($p < 0.017$)

Abbreviations: QLB3: anterior quadratus lumborum block; ESPB: erector spinae plane block

compared to the control and ESPB groups ($p < 0.05$) (Supplement 2). Respective PONV scores and the percentage of patients requiring antiemetics at all measurement time points of the groups (control, 9 [30%]; ESPB, 7 [23%], QLB3, 3 [10%]; $P = 0.344$] were similar (Supplement 3). Furthermore, no block-, drug- or surgery-related complications were observed.

Discussion

Patients undergoing PCNL, who underwent QLB3 and ESPB as part of a multimodal analgesic protocol, exhibited a reduction in intraoperative and postoperative opioid use, as well as a decrease in pain scores when compared with the control group; however, block efficacy was similar.

Considering the anatomical innervation of the kidneys (T10-L1) and ureters (T10-L2), along with the incisions and access points (mostly T10-11), T10-L2 spinal nerve blockade is necessary for the management of somatic and visceral pain in PCNL surgery [2]. Recent meta-analysis have provided evidence that ESPB, which is among the fascial plane blocks applicable in this context, improves the postoperative pain response during PCNL surgeries, diminishes the need for analgesics, extends the duration to the initial analgesic requirement, and does not give rise to significant postoperative complications [11, 12]. Our results are comparable to those of meta-analysis in this regard. Additionally, numerous fascial plane blocks have been proposed as potential substitutes for neuraxial blocks in abdominal interventions, among which

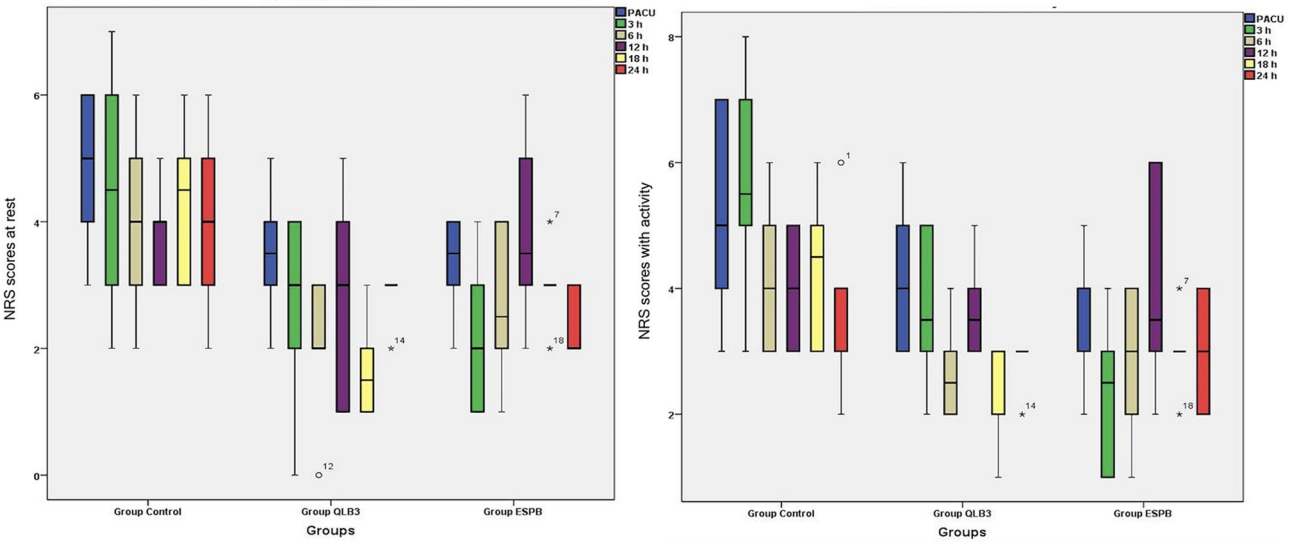

Fig. 3 Postoperative NRS pain scores at rest and activity in the groups at different time points. Data are presented as median (Q1-Q3). QLB3, anterior quadratus lumborum block; ESPB, erector spinae plane block; PACU, post-anesthesia care unit; NRS, numerical rating scale

QLB3 is believed to offer analgesic effects through blockage of T7-L1 segmental innervation [8]. In cadaveric investigations with a more restricted spread, even segmental involvement (T9-L2) appears to offer sufficient analgesia for PCNL procedures [19, 20]. Research has demonstrated that QLB3 blockade decreases the need for analgesics during and after surgery while extending the period until the first analgesic is required [21, 22]. Consistent with previous research, QLB3 demonstrated superior analgesic efficacy and safety when compared with the control group in our study. Despite the lack of evidence linking QLB3 to opioid-related adverse effects, Chen et al. reported paralysis in the lower extremities [23]. No patients experienced difficulties with ambulation during our study. This could be attributed to the relatively smaller volume/concentration of local anesthetic administered in our study compared to previous research, preventing the involvement of the lumbar plexus.

In the context of postoperative analgesia in abdominal surgeries (laparotomy [C/S and nephrectomy] and laparoscopic [cholecystectomy and hysterectomy]), recent studies have compared QLB3 and ESPB [24–27]. However, to the best of our knowledge, no previous research has investigated the postoperative analgesic efficacy of QLB3 and ESPB in PCNL. Examining the literature, it is notable that, despite the use of different types/doses of local anesthetics (0.25% bupivacaine or 0.375% ropivacaine) and volumes (20–30 ml) for these two blocks in abdominal surgeries and despite the differences in ESPB application (such as being performed at different levels [T7-T10], different patient positions [lateral decubitus or prone], and different ultrasound probe orientations [parasagittal or transverse]), they could similarly reduce analgesic consumption and pain scores. In contrast, the efficacy of these two blocks may vary in abdominal surgeries where significant visceral analgesia is required. For instance, a study focusing on colorectal surgeries found that ESPB provided more effective postoperative analgesia than QLB3 [28]. Further examination of the study revealed that patients reported more colic pain (visceral component) than incisional pain (somatic component). This difference could be attributed to the need for a broader blockade involving thoracolumbar (TL; T10–L2) and lumbosacral (LS; L5–S1) dorsal root ganglia in procedures involving extensive organ manipulation, such as colorectal surgery [29]. Achieving the desirable level of visceral analgesia, on the other hand, is possible during open major abdominal surgeries when a dermatomal blockade level of T4-L1 can be maintained with continuous QLB3 block [30]. For abdominal surgeries, selecting the appropriate QLB3 technique (continuous vs. single injection) may enhance the likelihood of successful visceral analgesia. Based on the results observed in our study, a single injection was sufficient to provide adequate visceral analgesia during PCNL.

Another noteworthy finding of our study was that patients who underwent ESPB experienced a marginally shortened duration of analgesia (12 h) compared to the QLB3 group (18 h). Although the clinical significance of this difference remains uncertain, one plausible explanation for this phenomenon is the utilization of ESPB before PCNL surgery. ESPB has been demonstrated to produce a more prolonged analgesic effect (24 h) when administered postoperatively as opposed to preoperatively [12]. Similarly, the duration of analgesia for patients undergoing laparoscopic cholecystectomy was observed to be longer in ESPB patients when administered during the postoperative period, compared to the QLB3 group

(16 h vs. 12 h) [26]. Additionally, Ma et al. demonstrated in their meta-analysis that the timing of ESPB administration impacts the duration of analgesia. Accordingly, they found that prolonged analgesia was observed only when the block was administered in the postoperative period instead of the preoperative period [12]. Therefore, ESPB should be planned during the postoperative phase to prolong its efficacy. Moreover, prone positioning during PCLN surgery may facilitate ESPB during the postoperative phase.

Our findings, which demonstrated comparable efficacy between the two blocks, suggest a preference for a block technique that affords ease of application and safety. Its more superficial nature, unique sonoanatomical landmark for the block needle, and use of a bone structure as the reference for the injection endpoint make ESPB a simpler and safer block to use [31]. In contrast, QLB3 is relatively difficult to perform and more time-consuming due to its deeper nature, difficulty in completely visualizing the needle with the convex probe, and the need for more experience to avoid complications (such as kidney damage, retroperitoneal hematoma, or weakness in the lower extremity due to lumbar plexus involvement) [8, 32, 33]. In patients undergoing PCNL, all of these factors may contribute to the preference for ESPB, a more straightforward technique compared with QLB3.

However, the current study had several limitations, the first of which was its single-center, observational design. Implementing an RCT could mitigate potential biases and provide a more reliable elucidation of the cause-effect relationship. Second, the sample size needed to be increased to identify subtle variations in complications and secondary outcomes between the two groups. Third, another concern is the potential for selection bias due to the subjective nature of patient allocation by the anesthesiologist, which could impact the generalizability of the findings. To mitigate this, the research team was blinded to the group assignments of patients, aiming to reduce the influence of subjective biases. Fourth, the lack of knowledge regarding the ideal concentration and volume of bupivacaine for the ESPB and QLB3 prevented us from concluding the adequacy or minimal effectiveness of the dose or volume used in our study. Fifth, although the extent of systemic absorption of LA used in these two fascial plane blocks contributes to the overall analgesic efficacy is unknown, it cannot be ruled out. Therefore, studies comparing the efficacy of these blocks with that of lidocaine infusion would be useful. Sixth, an assessment of lower extremity muscle strength could have been conducted in our study to investigate the potential involvement of the lumbar plexus in QLB3. Seventh, extending the follow-up period to >24 h may have been useful. Lastly, the duration of the block application was not monitored, and future studies could address this to correlate with clinical outcomes.

Conclusion

In summary, our observational study demonstrated that both QLB3 and ESPB are effective components of a multimodal analgesia approach, providing significant postoperative pain relief for patients undergoing PCNL. With similar efficacy observed, selecting between these blocks may be guided by technical ease and safety profile considerations.

Abbreviations

QLB3	anterior quadratus lumborum block
ESPB	erector spinae plane block
PCNL	percutaneous nephrolithotomy
LA	local anesthetic
RCT	randomized controlled trials
NRS	numerical rating scale
US	ultrasound
ASA	American Society of Anesthesiologists
PONV	postoperative nausea and vomiting
PCA	intravenous patient-controlled analgesia
NRS	numeric rating scale
PACU	post-anesthesia care unit

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions

CK and HT: Conceptualization, Methodology, Investigation, Software, Writing-Original draft preparation, Funding acquisition; ET: Methodology, Validation, Software, Reviewing and Editing; BD and YBU: Visualization, Investigation, Reviewing and Editing. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study available from thr corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ondokuz Mayis University Clinical Research Ethics Committee (approval no: 2022/l.908). The study was conducted in accordance with the Declaration of Helsinki. The trial was registered prior to patient enrollment in the clinical trial database using the ClinicalTrials.gov (Identifier: NCT05822492, date of registration: 10/04/2023). Written informed consent was obtained from all participants and/or their legal guardians on the day before surgery. The study was performed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (i.e., "STROBE") guidelines.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Conflict of interest
None.

Congresses
Preliminary data for this study were submitted as an oral presentation at the Turkish Society of Anesthesiology and Reanimation Congress, 2–5 November 2023, Antalya, Turkey.

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