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ORIGINAL PAPER

Is quadratus lumborum block combined with low dose-spinal anesthesia an effective alternative to general anesthesia in patients undergoing percutaneous nephrolithotomy?

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Summary ***Background: General anesthesia in high-risk patients has many complications and needs long preoperative preparations and postoperative intensive care unit (ICU). Therefore the present study aimed to evaluate the efficacy of combined low-dose spinal anesthesia with quadratus lumborum block (QLB) as an alternative to general anesthesia for patients undergoing percutaneous nephrolithotomy.***

Patients and methods: A prospective study was conducted at the urology department of Al-Azhar University Hospitals in Cairo, Egypt, from January 2021 to January 2022. The study included 60 patients of ASA ll-lll scheduled for percutaneous nephrolithotomy. All patients received low-dose spinal anesthesia (5 mg bupivacaine) and QLB (QL1-QL2-QL3) approaches. The primary observation parameter was the efficacy of this technique as an alternative to general anesthesia. The secondary parameters measured were evaluation of need for intraoperative narcotics, postoperative pain score (VAS), and patients satisfaction as assessed using a 5-point Likert Scale.

Results: None of the patients was given general anesthesia, and intraoperative sedation was given to nineteen patients (32.2%). No hemodynamic changes were observed in all patients. There was a significant correlation between the use of intraoperative sedation and stone site, intraoperative blood loss, and hospital stay. Pain intensity on VAS at rest and movement was low until the 24th postoperative hour. Patient satisfaction score was 3, 4, and 5 in 1 (1.7%), 4 (6.7%), and 55 (91.6%) patients, respectively.

Conclusions: Combined low-dose spinal anesthesia with quadratus lumborum block is an effective alternative to general anesthesia in patients undergoing PCNL procedures with good postoperative analgesia. Patients with lower calyceal punctures have a lower incidence of intraoperative sedation requirements.

KEY WORDS: Quadratus lumborum block; Low dose spinal anesthesia; Percutaneous nephrolithotomy.

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is considered the standard method for managing large or complex renal calculi (1). Although opioids are effective in controlling intra and postoperative pain, they are associated with significant side effects (2). Recently, a new regional analgesic technique, known as *Quadratus Lumborum Block* (QLB), has been introduced for pain relief following abdominal surgery. This technique has been used successfully to provide postoperative analgesia for patients undergoing various types of abdominal surgeries, including renal surgeries (3-7). The QLB technique functions by blocking somatic nerve fibers that supply the abdominal wall, and it may potentially block the sympathetic nerve supply of the abdomen, inhibiting visceral pain (8). Several modifications to the technique have been introduced, including injection into the posterior segment of the *quadratus lumborum muscle* (QLM) (QLB2), injection into QLM and the fascia of the psoas muscle using the trans-muscular approach (QLB3), and injection into the QLM itself (QLB4). It is apparent that this block is highly effective in providing analgesia from T7 to L1 dermatomes, and it affords analgesia to the anterior abdominal wall while reducing visceral pain (9). The current study presents a novel technique for providing anesthesia by fascial peripheral block with low-dose spinal anesthesia. The fascial block serves as the primary element of anesthesia for PCNL, and we are optimistic that it can be used as a standalone anesthesia. We utilized low-dose spinal anesthesia for cystoscopy, ureteric catheter insertion, and the long-term onset of QLB. This technique will serve as the foundation for further research aimed at reducing the requirement for general anesthesia, with its attendant complications, among high-risk patients. The present study aimed to evaluate the efficacy of combined low dose spinal anesthesia with quadratus lumborum block as an alternative to general anesthesia for patients undergoing PCNL.

PATIENTS AND METHODS

A prospective study was conducted at the urology department of *Al-Azhar University Hospitals in Cairo, Egypt*, from January 2021 to January 2022.

The study included 60 patients who were deemed suitable

candidates for PCNL. The local ethics committee approved the research (*registration number of: ClinicalTrial.gov ID NCT04852874.*), and all patients provided informed written consent to participate. The study adhered to ethical guidelines and regulations, ensuring the safety and confidentiality of all participants.

We excluded patients with coagulopathy, mental retardation, airway problem, sleep apnea syndrome, pregnancy, and ASA (IV). Upon induction of anesthesia, an intravenous line was established for all patients and oxygen was administered at a rate of 3 liters per minute through a nasal cannula while vital signs were continuously monitored. Spinal anesthesia was then administered using a 25-gauge (BD Quincke spinal needle), which was inserted and directed towards the midline in order to access the intrathecal space between the L3 and L4 intervertebral space following successful dural puncture. A combination of 5 milligrams of bupivacaine (1 milliliter) and 25 micrograms of fentanyl (0.5 milliliters) were then administered via the intrathecal space. Low-frequency ultrasound with a curved probe (6:15 MHs) (*Sonosite M Turbo, Fujifilm, Bothel Washington USA*) was utilized in all patients, and a 22-gauge spinal needle (BD Quink spinal needle) was used to administer the local anesthetic injection. The injection was performed with the patient in the lateral position. The needle tip was carefully positioned at the anterolateral border of the *quadratus lumborum muscle* (QLM) at its junction with the transversalis fascia (QL1). Subsequently, the needle was placed between QLM and the erector spinae muscle (QL2) and between QLM and the psoas muscle (QL3). After ensuring the correct position of the needle, an injection of 0.25 ml/kg of 0.25% bupivacaine, along with 1.5 mg dexamethasone and 100 mg magnesium sulfate, was administered at each site of the quadratus lumborum muscle under ultrasound guidance. After performing the block, each patient was evaluated for effectiveness of the technique (accomplishing of the procedure with no need to general anesthesia with surgeon and patient satisfaction). Intraoperative hemodynamics (BP, Pulse, SPO2) were measured at beginning then every 10 /min. Intraoperative pain was assessed utilizing a 10 cm *visual analog scale* (VAS), in case of VAS > 4, narcotic was given in the form of 50 mcg fentanyl. The evaluation of postoperative analgesia was conducted at the conclusion of surgery, followed by assessments at 1, 2, 4, 8, 12, 16, 20, and 24 hours, utilizing the *Visual Analogue Scale* (VAS) both at rest and during movement. In cases where patients reported pain intensity exceeding a VAS score of 4, intravenous infusion of paracetamol at a dose of 15 mg per kg was administered, limited to a maximum of 1000 mg per dose for analgesia purposes, with a maximum cumulative dose of 4000 mg over 24 hours. Nonsteroidal medication was prescribed as a secondary option if the pain remained unresolved following the administration of paracetamol. Adverse effects were monitored and documented, including but not limited to direct needle trauma to abdominal viscera, bleeding, prolonged muscle weakness, and hemodynamic instability. On the second postoperative day, perioperative patient satisfaction was assessed using a 5-point Likert Scale ranging from very dissatisfied (1) to completely satisfied (5).

Table 1.
General descriptive data.

		Min-max	Mean ± SD or F (%)
Age		34-65	50.5 ± 8.4
Sex	Female		19 (31.7%)
	Male		41 (68.3%)
Site of stones	Lower calyx		6 (10%)
	Pelvis		11 (18.3%)
	Pelvis, Lower calix		28 (46.7%)
	Pelvis, Upper calyx		15 (25%)
Size of stones/cm		2-4	3.0 ± 0.5
HFU of stones		650-1500	1010.2 ± 162.0
Urine analysis	Pus negative		53 (88.3%)
	Pus positive		7 (11.7%)
Hb Pre		12-16	13.4 ± 0.8
Creatinine		0.7-1.5	1.1 ± 0.2
Previous surgery	NO		44 (73.3%)
	YES		16 (26.7%)
Morbidity	ASA2		39 (65%)
	ASA3		21 (35%)
Operative time/min		50-150	80.5 ± 16.7
Blood loss/ml		80-700	248.0 ± 112.1
Hospital stay/days		1-3	2.7 ± 0.5
Ambulation	After 2 hrs		40 (66.7%)
	After 3 hrs		20 (33.3%)
MAP base		64-95	77.6 ± 6.4
MAP 10 m		62-91	76.8 ± 6.2
MAP 20 m		60-90	75.1 ± 6.9
MAP 30 m		66-95	79.6 ± 6.3
MAP 1 hour		68-95	80.9 ± 6.5
MAP 2 h		68-91	79.3 ± 5.4
MAP 4 h		68-91	81.4 ± 5.4
Pulse base		66-785	92.4 ± 9.1
Pulse 10 m		64-90	76.6 ± 6.0
Pulse 20 m		75-99	84.2 ± 5.9
Pulse 30 m		74-99	84.7 ± 5.9
Pulse 1 h		75-96	84.2 ± 5.3
Pulse 2 h		72-95	81.5 ± 4.7
Pulse 4 h		73-93	83.2 ± 5.0
VAS 10		2-4	2.9 ± 0.8
VAS 30		2-5	3.0 ± 0.8
VAS 1 h		2-5	3.2 ± 1.0
VAS 2 h		2-5	2.9 ± 1.0
VAS 2 h		2-5	3.2 ± 0.9
VAS 4 h		2-5	3.2 ± 0.9
VAS 8 h		2-5	2.8 ± 0.7
VAS 16 h		2-5	3.1 ± 0.9
VAS 24 h		2-5	3.2 ± 1.0
Hb post		10.5-13	11.5 ± 0.6
Blood transfusion	No		60 (100%)
	Yes		0 (0%)
KUB	Free		57 (95%)
	Positive		3 (5%)
US	Free		60 (100%)
	Positive		0 (0%)
Success rate	No		0 (0%)
	Yes		60 (100%)
Intraoperative narcotics	No		41 (67.8%)
	Yes		19 (32.2%)

Age, Size of stones, HFU of stones, HB pre and post, Creatinine, Operation time, Blood loss, Hosp. stay, Pulse and VAS parameters were represented as Min- Max and Mean ± SD, while Sex, Site of stones, Urine analysis, Previous surgery, Morbidity, Blood transfusion, KUB, US, Success rate and Intraoperative narcotics were represented as frequency and percent F (%).

Statistical analysis

The *Statistical Package for Social Science* (SPSS) software, version 29 (*SPSS Inc., Chicago, IL, USA*), was utilized for data analysis. Categorical variables were presented as frequency and percentage, while numeric variables were presented as a mean and standard deviation. The paired-sample t-test was employed to determine the significance level between different data within the same group.

A P value less than 0.05 was considered statistically significant.

Results

Sixty patients were included in the study. Table 1 illustrates the patients' demographics, renal stone criteria, operative time, blood loss, and hospital stay. None of the patients was given general anesthesia, and intraoperative sedation was given to nineteen patients (32.2%).

Univariate analysis revealed a significant correlation between the use of intraoperative sedation and stone site, intraoperative blood loss, and hospital stay. Specifically, patients with lower calyceal and combined pelvic and lower calyceal stones exhibited a statistically significant infrequent utilization of intraoperative sedation, 100% of patients with lower calyceal stones had no intraoperative sedation, while 71.4% of patients with combined pelvic and lower calyceal stones had no sedation (p = 0.02) (Table 2).

The mean intraoperative blood loss was significantly higher in patients requiring intraoperative sedation; it was 260.5 ml compared to 242.2 ml in patients who did not require intraoperative sedation (p = 0.03). Similarly, the mean hospital stay was longer in patients receiveing intraoperative sedation (p = 0.05) (Table 2). Regarding patients who required narcotics, there were no significant differences in mean arterial pressure (MAP) or pulse rate at any point in time when compared to patients who did not require them (P-value > 0.05). Similarly, there were no statistically significant differences in the stone-free rate between patients who required narcotics (94.7%) and those who did not (95.1%) (p-value > 0.05) (Table 2). Pain intensity on VAS at rest and on the movement was low till the 24th postoperative hour (Table 1). Patient satisfaction score was 3, 4, and 5 in 1 (1.7%), 4 (6.7%), and 55 (91.6%) patients, respectively.

Discussion

The QLB, originally described by *Blanco et al.*, is a variant of the *transversus abdominis*

Table 2.

The associations of studied in relation of use of intraoperative narcotics.

		Intraoperative narcotics			Risk assessment	
		No n = 41	Yes n = 19	P-value	OR (95% C.I)	P-value
Age		50.6 ± 8.4	50.2 ± 8.5	0.9	1.0 (0.9- 1.1)	0.8
Sex	Female	13 (31.7%)	6 (31.6%)	0.9	1.0 (0.3- 3.2)	0.9
	Male	28 (68.3%)	13 (68.4%)			
Site of stones	Lower calyx	6 (14.6%)	0 (0.0%)	0.02 *	-	-
	Pelvis	5 (12.2%)	6 (31.6%)	0.7	1.2 (0.4- 3.9)	0.8
	Pelvis, Lower calix	20 (48.8%)	8 (42.1%)	0.02 *	0.4 (0.2- 0.9)	0.03 *
	Pelvis, Upper calyx	10 (24.4%)	5 (26.3%)	0.1	0.5 (0.2- 1.5)	0.2
Size of stones/cm		3.0 ± 0.5	3.0 ± 0.5	0.7	1.1 (0.3- 3.5)	0.9
HFU of stones			1024.2 ± 157.9	0.9	1.0 (1.0- 1.0)	0.6
Urine analysis	Pus negative	38 (92.7%)	15 (78.9%)	0.1	3.4 (0.7-16.9)	0.2
	Pus positive	3 (7.3%)	4 (21.1%)			
HB pre	13.5 ± 0.8	13.0 ± 0.8	0.8	0.4 (0.2- 1.0)	0.8	
Creatinine	1.1 ± 0.2	1.1 ± 0.2	0.7	1.0 (0.1- 2.6)	0.9	
Previous surgery	NO	28 (68.3%)	16 (84.2%)	0.2	0.4 (0.1- 1.6)	0.3
	YES	13 (31.7%)	3 (15.8%)			
Morbidity	ASA2	25 (61.0%)	14 (73.7%)	0.3	0.6 (0.2- 1.9)	0.4
	ASA3	16 (39.0%)	5 (26.3%)			
Op.time/min	80.6 ± 12.8	80.3 ± 23.4	0.08	1.0 (1.0 - 1.0)	0.9	
Blood loss/ml	242.2 ± 88.1	260. 5 ± 154.0	0.02 *	1.0 (1.0- 1.0)	0.6	
Hosp. st./days	2.7 ± 0.5	2.8 ± 0.4	0.05 *	1.8 (0.5- 6.1)	0.3	
Ambulation	After 2 hrs	28 (68.3%)	12 (63.2%)	0.7	1.3 (0.4- 3.9)	0.8
	After 3 hrs	13 (31.7%)	7 (36.8%)			
MAP base	77.7 ± 6.8	77.3 ± 5.5	0.4	1.02 (0.4- 1.34)	0.3	
MAP 10 m	76.6 ± 6.1	77.3 ± 6.7	0.6	1.0 (0.9- 1.2)	0.6	
MAP 20 m	75.0 ± 6.9	75.2 ± 7.0	0.9	1.0 (0.9- 1.1)	0.9	
MAP 30 m	79.5 ± 6.4	79.8 ± 6.4	0.8	1.0 (0.9- 1.2)	0.8	
MAP 1 hour	80.8 ± 6.6	80.9 ± 6.7	0.7	1.0 (0.9- 1.1)	0.8	
MAP 2 h	78.9 ± 5.4	80.1 ± 5.4	0.8	1.1 (0.9- 1.2)	0.4	
MAP 4 h	81.1 ± 5.5	81.8 ± 5.2	0.96	1.0 (0.9- 1.2)	0.5	
Pulse base	98.6 ± 110.1	79.1 ± 4.7	0.2	1.1 (0.7- 1.21)	0.3	
Pulse 10 m	76.8 ± 6.1	76.3 ± 6.0	0.8	1.0 (0.9- 1.1)	1.0	
Pulse 20 m	84.0 ± 6.1	84.6 ± 5.6	0.9	1.1 (1.0- 1.3)	0.2	
Pulse 30 m	85.2 ± 6.2	83.5 ± 4.9	0.4	0.9 (0.8- 1.1)	0.4	
Pulse 1 h	84.0 ± 5.4	84.5 ± 5.2	0.6	1.0 (0.8- 1.2)	0.9	
Pulse 2 h	81.5 ± 4.8	81.5 ± 4.6	0.7	1.0 (0.9- 1.1)	0.7	
Pulse 4 h	83.9 ± 4.8	81.9 ± 5.2	0.4	0.9 (0.8- 1.0)	0.1	
VAS 10	3.0 ± 0.8	2.6 ± 0.7	0.7	1.15 (0.8- 1.31)	0.3	
VAS 30	2.9 ± 0.9	3.1 ± 0.8	0.7	1.0 (0.4- 1.1)	0.3	
VAS 1 h	3.2 ± 0.9	3.2 ± 1.1	0.1	1.3 (0.6- 3.0)	0.5	
VAS 2 h	3.0 ± 1.0	2.6 ± 0.9	0.8	0.9 (0.5- 1.8)	0.8	
VAS 2 h	3.3 ± 0.9	2.8 ± 0.8	0.3	0.7 (0.3- 1.4)	0.3	
VAS4 h	3.2 ± 1.0	3.1 ± 0.8	0.09	0.5 (0.2- 1.1)	0.07	
VAS 8 h	2.7 ± 0.7	2.8 ± 0.8	0.3	1.2 (0.5- 2.5)	0.7	
VAS 16 h	3.1 ± 0.9	3.0 ± 0.9	0.4	1.1 (0.4- 2.7)	0.9	
VAS 24 h	3.2 ± 0.9	3.2 ± 1.1	0.4	0.6 (0.3- 1.5)	0.3	
Hb Post	11.4 ± 0.6	11.6 ± 0.6	0.6	0.9 (0.5- 1.7)	0.7	
Blood transfusion	No	41 (100.0%)	19 (100.0%)	N.A	-	-
	Yes	0 (0.0%)	0 (0.0%)			
KUB	Free	39 (95.1%)	18 (94.7%)	0.9	1.1 (0.1- 12.7)	0.9
	Positive	2 (4.9%)	1 (5.3%)			
US	Free	41 (100.0%)	19 (100.0%)	N.A	-	-
	Positive	0 (0.0%)	0 (0.0%)			
Success rate	No	0 (0.0%)	0 (0.0%)	N.A	-	-
	Yes	41 (100.0%)	19 (100.0%)			

Age, Age, Size of stones, HFU of stones, HB pre and post, Creatinine, Operation time, Blood loss, Hosp. stay, Pulse and VAS parameters were represented as Min- Max and Mean ± SD, the data were analyzed by t test. While Sex, Site of stones, Urine analysis, Previous surgery, Morbidity, Blood transfusion, KUB, US, Success rate and Intraoperative narcotics were represented as frequency and percent F(%); the data were analyzed by X2 test.

OR: Odd Ratio; C.I: Confidence Interval; p value calculated depend on log linear regression analysis.

** p value < 0.05 is significant, ** p value < 0.01 is highly significant.*

plane (TAP) block that has four subtypes named on the location of the local anesthetic delivery in relation to the quadratus lumborum muscle.

These subtypes include the lateral QLB, posterior QLB, anterior QLB, and intramuscular QLB. Lateral QLB, also known as QLB Type 1, was initially proposed. The posterior QLB is administered by depositing the local anesthetic between the posterior surface of the quadratus lumborum muscle and the medial *lamina of the thoracolumbar fascia* (TLF). Like other interfascial blocks, the posterior QLB has a variable spread of the drug solution. However, it consistently spreads to the TAP, around the quadratus lumborum muscle, and along the middle lamina of the TLF. The TLF contains a dense network of sympathetic nerve fibers of the abdomen. Blocking these nerve fibers provides relief from sympathetic-mediated pain.

Furthermore, the injected drug may spread cranially to the lumbar paravertebral space along the TLF and endothoracic fascia, which may be responsible for the additional visceral and somatic block with wider width of analgesia (T7 to L4 dermatome) observed in posterior QLB compared to the more traditional TAP block (10-11). In this trial, we studied the efficacy of combined low dose spinal anesthesia with quadratus lumborum block as an alternative to general anesthesia for patients undergoing PCNL. We observed that this anesthesia technique is safe and feasible specifically in high-risk patient for general anesthesia.

The results of previous studies are consistent with our own findings, which indicate that QLB provides effective postoperative analgesia with low VAS scores and minimal need for additional analgesia. *Chen et al.* observed that QLB reduced intraoperative sufentanil consumption and provided effective postoperative pain relief within 24 hours for patients undergoing PCNL procedures (12). *Kılıç and Bulut* reported that QLB effectively managed pain levels and reduced morphine consumption for up to 48 hours post-surgery in PCNL patients (13). In a randomized, double-blind, controlled, prospective study, Raman and Prabha found that QLB provided significantly longer analgesia duration compared to placebo in patients undergoing PCNL. They concluded that QLB is a viable option for prolonged postoperative pain control (11). Similarly, *Peksoz et al.* reported that QLB significantly reduced postoperative opioid consumption and VAS scores compared to a control group for PCNL patients. Opioid consumption was significantly lower in the QLB group compared to the control group at all times (14). In the current study, there was a significant correlation between the use of intraoperative sedation and stone site, intraoperative blood loss, and hospital stay. The mean intraoperative blood loss was significantly higher in patients requiring intraoperative sedation; similarly, the mean hospital stay was longer in patients receiving intraoperative sedation.

Interestingly, patients with lower calyceal stones, and patients with combined pelvic and lower calyceal stones had a statistically significant lower intraoperative sedation utilization; this can be explained with lower calyceal puncture in such patients accompanied with lower pain compared to middle and upper calyceal punctures.

Limitations of the study

Although our study was conducted prospectively focusing on a single anesthesia technique used to manage patients undergoing PCNL, it is not a comparative or randomized trial. Additionally, we did not record the dermatomal distribution of analgesia in our patients. It is highly recommended that a prospective randomized study be conducted to evaluate the effectiveness of this technique. This approach will provide a more comprehensive understanding of the technique's potential benefits and limitations.

Conclusions

Combined low-dose spinal anesthesia with quadratus lumborum block is effective for patients undergoing PCNL procedures with good postoperative analgesia. Patients with lower calyceal punctures have a lower incidence of intraoperative sedation requirements.

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