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ORIGINAL ARTICLE

Postoperative Narcotic Sparing Effect of Ultrasound-guided Quadratus Lumborum Block in Patients Undergoing Percutaneous Nephrolithotomy

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Abstract

Background: **Quadratus lumborum block (QLB) technique is strongly recommended as an appropriate adjunctive to systemic intravenous analgesia for pain control. Some modifications of this technique were subsequently introduced.**

Aim of the work: **The purpose of this study is to assess the effectiveness of quadrates lumborum plane block as a postoperative analgesic with Percutaneous Nephrolithotomy.**

Patients and methods: **A prospective randomized controlled single-blinded clinical research study on 98 patients was conducted at Al-Azhar University hospitals in Cairo. After receiving institutional ethics committee approval, patients were scheduled for Percutaneous Nephrolithotomy. 98 patients were randomly divided into two equal groups: 49 patients were given GA (General Anesthesia) and postoperative analgesia in the form of paracetamol 1 g/8 h and Morphine as required, 49 patients, in addition to GA, the patient received preoperative ultrasound-guided quadratus lumborum block.**

Results: **The results of this study showed that QLB showed a significant difference than the control group in hemodynamics. In terms of duration of analgesia and total analgesic consumption, QLB is better than the control group with $P < 0.001$, $P < 0.001$, respectively.**

Conclusion: **US-guided QLB provided satisfactory analgesia in patients undergoing PCNL. It lengthened the analgesia's duration and reduced opioid consumption and postoperative pain scores. Patients in the QLB group significantly showed more hemodynamic stability and less variations from baseline. No serious complications were reported related to the technique. Accordingly, US-guided QLB is strongly recommended for postoperative pain management in patients undergoing PCNL.**

Keywords: Percutaneous nephrolithotomy, Quadratus lumborum, Ultrasound-guided

1. Introduction

Quadratus lumborum is a muscle of the posterior abdominal wall. Moreover, it originates starting from posteromedial iliac crest and inserts to reach the 12th rib from the medial border and the transverse processes regarding the 1st until 4th lumbar vertebrae. Patients with multiple or complex kidney or upper urinary tract stones should consider percutaneous nephrolithotomy (PCNL), which requires careful multi-modal analgesia due to mild to moderate pain caused by renal capsule dilation or nephrostomy tube-related stress in the first 24 h following surgery.[1]

The quadratus lumborum block (QLB) approach is a suitable augmentation of systemic intravenous analgesia for the management of pain. The Shamrock sign was used to designate transmuscular quadratus lumborum block (QLB-TM) in 2015.[2]

The interfascial plane between the quadratus lumborum (QL) muscle's anterior border and the psoas major muscle is where the injectate trajectory

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is aiming. Compared to Blanco's 2007 introduction of the lateral QLB technique (QLB-L), which is currently only used in a small number of clinical settings.[3]

Because of its potent narcotic sparing effect, the transmuscular technique has been more widely accepted in a range of abdominal surgeries, including cesarean sections, renal, hernioplasty, and laparoscopic procedures.[4] QLB-effectiveness in controlling postoperative pain following PCNL was questioned due to its inability to provide a suitable analgesic plane from T9-12.[5]

As part of the TQL (transmuscular quadratus lumborum) block procedure, local anaesthetic (LA) is injected into the fascial area between the quadratus lumborum (QL) and the psoas major (PM) muscles. The injectate spreads posterior to the transversalis fascia and into the thoracic paravertebral space (TPVS) posterior to the medial and lateral arcuate ligaments from the site of injection at the level of L3-L4. As a result, the injectate reaches the communicating rami, thoracic ventral and posterior rami of the spinal nerves, and the thoracic sympathetic trunk.[6]

The TQL block has the potential to reduce postoperative pain during intra- and retroperitoneal surgical operations since both somatosensory and visceral pain modalities are anaesthetized. There are numerous ways to block the quadratus lumborum muscle, each of which is identified by the anatomical position of the needle point in relation to the muscle. Due to the local anaesthetic spreading into the paravertebral region, it effectively reduces visceral pain in addition to somatic analgesia. This block's efficiency in reducing pain from T7 to L1 dermatomes has been demonstrated.[6]

Injecting local anaesthetic into the quadratus lumborum muscle's anterolateral junction was how Blanco first described it in 2007. (QLB type 1).

This procedure was further modified to include injections into the quadratus lumborum's posterior portion (QLB type 2), the quadratus lumborum's fascia, and the psoas muscle utilising the transmuscular method (QLB type 3), as well as injections into the quadratus lumborum itself (QLB type 4).[7]

The aim of the study was to compare the postoperative analgesic efficacy of ultrasound-guided quadratus lumborum block with general anesthesia and general anesthesia alone, in patients undergoing percutaneous nephrolithotomy. The primary outcome was to determine the requirement of postoperative narcotic analgesia for both groups in the first 24-h. The secondary outcome was postoperative pain assessment by Visual Analogue Score (VAS) and patient's satisfaction.

2. Materials and methods

Study Design: prospective randomized controlled single-blinded clinical study.

Ethical considerations: The study was performed with the agreement of the Al-Azhar University Hospitals' institutional ethical committee in Cairo. All patients gave written informed consent to participate in the research.

2.1. Sample size calculations

According to the following data using Epi info program, considering a confidence level 95%, power of test 90%. The minimal sample size was required is 98 subject subdivided into two groups (group A 49 patients receive GA and group B 49 patients receive GA + ultrasound-guided quadratus lumborum block).

2.2. Eligibility criteria and assignment

Following informed agreement, 98 patients were randomly divided into two equal groups: 49 patients given GA (General Anesthesia) and postoperative analgesia in the form of paracetamol 1 g/8 h and Morphine as required, 49 patients, in addition to GA, the patient received preoperative ultrasound-guided quadratus lumborum block (iso baric bupivacaine 0.25% 20 ml and dexamethasone 4 mg) +- postoperative paracetamol and Morphine as required.

Both groups received Both groups received GA induced by propofol 2 mg/kg, fentanyl 1 ug/kg followed by atracurium 0.5 mg/kg to facilitate endotracheal intubation. Anesthesia was maintained by isoflurane 1.2 MAC and atracurium 0.1 mg/kg/20–30 min.

We excluded patients with the inability to speak, had a known allergy to local anaesthetics or opioids, regularly used opioids (as determined by the investigators), were abusing drugs or other substances, had a local infection at the injection site or a systemic infection, or had trouble seeing the fascial and muscle components that were required for administering the block successfully., if the patient develop any surgical complication at the end of operation or General anesthesia was already provided or indicated for any reasons, platelets counts less than 80 000, history of inherited or acquired, coagulopathies or any concern about coagulation defect discovered intraoperatively, motor and/or sensory neurological diseases either central or peripheral affecting lower part of the body and may

interfere with pain assessment or postoperative patient motor function and BMI more than 35.

2.2.1. Randomization

Patients have been allocated to one of the study groups at random using a computer-generated table, with the randomized sequence hidden in sealed opaque envelopes.

2.2.2. QL block technique

Ultrasound-guided QLB was performed by placing the patient in a lateral posture with the side that was to be anaesthetized turned upward. Skin and transducer preparation was done. The sterilized gel sufficiently coated the transducer ultrasound. The needle inserted from the posterior to anterior, toward the intersection of the tapering transverse abdominis muscles and the lateral border of the QL muscle. The transverses abdominis muscle's aponeurotic connection was then penetrated, and at the point where the transversalis fascia and the lateral border of the QL muscle meet, local anaesthetic was administered (a possible area medial to the abdominal wall muscles and anterolateral to quadrates lumborum muscle).

2.2.3. Postoperative management

Data was collected and compared at the following times: T base: in both groups before induction of anesthesia, T0: in first group immediately after recovery, T0: in 2nd group immediately after recovery. Definition of (T0); it is a time at end of the surgery when the patient is ready to block or ready to discharge from the operative room (OR). Acute postoperative somatic and visceral pain within the first 24 h postoperatively were assessed by using visual analogue score (VAS) which is a 10-cm line with 0 at one end representing no pain and 10 at the other end representing the worst pain, at PACU and postoperative patient room at 2, 4,8,12, 16, 24 h postoperatively. For all patients of the two groups, paracetamol rescue pain analgesia was given postoperatively for visual analogue score (VAS)≥4 along with morphine (0.05 mg/kg iv). VAS was reassessed 15 min later to any rescue analgesic injection. Incidence of postoperative complications was recorded as number of patients in group B who have hypotension related to block (defined as a decrease in mean arterial blood pressure more than 20% of the basal BP (T0) for more than 10 min within the first hour after performing the block and number of patients in group A who have complication related to GA or surgery. Moreover, number of patients who have any unexpected complication that can be related to the block. Overall satisfaction score as regard quality of pain control was considered as 5-point Likert scale satisfaction, commonly used for customer Satisfaction survey was used to asses satisfaction rate reported by the postoperative observer about overall satisfaction with the quality of pain control. The scale was escalating from 1 to 5 where 1 is very poor and 5 is excellent.

2.3. Statistical analysis

We analyzed these study's data using the software of SPSS software (IBM Corp., Armonk, NY, USA). We used mean ± standard deviation as an expression to normally distributed numerical variables. Regarding comparing means between both groups, we used independent t-test or ANOVA for normally distributed variables. We used median and interquartile range (IQR) as an expression to data without normal distribution; and further test of Mann–Whitney U-test was performed. Regarding qualitative data which was presented as number and percentage, we used chi-squared test. Significance was considered when P value is below 0.05.

3. Results

The following tables show the findings of the current research.

Tables 1–3.

There is a statistically significant difference in postoperative mean arterial pressure or postoperative heart rate between the two groups Tables 4–7.

Regarding pain assessment, there was statistically significant difference between QLB and control group regarding VAS score, morphine consumption, time of analgesia, and patient satisfaction with better analgesia in QLB group.

No complications were reported in the two study groups, like hypotension, respiratory depression, nerve injury, hematoma formation, systemic toxicity of local anesthetics, or intravascular injection.

Table 1. Comparison of the studied groups based on demographic data.

Demographic data	QLB (n = 49)	Control (n = 49)	P value
Age (years)	52.5 ± 7.46	56.28 ± 4.61	0.161
Sex n (%)			
Male	27 (55.1)	31 (63.3)	0.538
Female	22 (44.9)	18 (36.7)	
BMI (kg/m^2)	23.5 ± 2.67	25.8 ± 3.57	0.679
ASA physical status n (%)			
ASA I	18 (36.7)	21 (42.9)	0.278
ASA II	31 (63.3)	28 (57.1)	
Duration of surgery (min)	85.8 ± 13.7	78.2 ± 9.5	0.471

Data presented as mean ± SD and nember (percent).

Table 2. Comparison between the two study groups according to the mean blood pressure (mmHg).

Mean Blood Pressure (mmHg).	QLB ($n = 49$)	Control ($n = 49$)	*P* value
T0	81.06 ± 5.28	85.34 ± 7.29	0.513
T2	78.34 ± 3.99	91.10 ± 5.81	<0.001*
T4	84.44 ± 6.14	93.28 ± 7.08	<0.001*
T8	83.13 ± 6.42	88.14 ± 5.47	<0.001*
T12	75.28 ± 7.45	81.28 ± 5.66	<0.001*
T16	73.16 ± 5.06	78.07 ± 6.45	0.003*
T24	75.88 ± 4.97	82.52 ± 5.79	0.031*

Data presented as mean ± SD.
Using: F-One Way Analysis of Variance.
P value > 0.05 NS (not significant).
**P* value < 0.05 S (significant).

Table 3. Comparison between the two study groups according to the heart rate (beat/min).

Heart Rate (Beat/min)	QLB ($n = 49$)	Control ($n = 49$)	*P* value
T0	108.03 ± 4.67	105.17 ± 5.83	0.059
T2	98.06 ± 6.88	109.97 ± 4.19	<0.001*
T4	102.06 ± 7.01	112.14 ± 3.92	<0.001*
T8	87.84 ± 6.43	93.24 ± 4.68	<0.001*
T12	82.84 ± 6.04	95.72 ± 5.74	<0.001*
T16	76.16 ± 7.04	84.48 ± 6.45	<0.001*
T24	72.09 ± 4.62	80.48 ± 6.38	<0.001*

Data presented as mean ± SD.
Using: F-One Way Analysis of Variance.
P value > 0.05 NS (Not significant).
**P* value < 0.05 S (significant).

Table 4. Comparison between studied groups according to VAS score.

Time	QLB ($n = 49$)	Control ($n = 49$)	*P* value
T2	2.43 ± 0.76	3.26 ± 0.73	<0.001*
T4	3.15 ± 0.84	4.21 ± 0.86	<0.001*
T8	3.64 ± 1.34	3.97 ± 1.21	<0.001*
T12	3.07 ± 1.08	3.95 ± 1.22	<0.001*
T16	2.53 ± 0.99	3.84 ± 0.88	0.021*
T24	2.47 ± 1.08	2.88 ± 0.87	0.002*

Data presented as mean ± SD.

Table 5. Comparison between the two groups according to the number of postoperative morphine rescue analgesia doses which is expressed as number (percent).

Number of Morphine doses (2 mg)	QLB ($n = 8$)	Control ($n = 32$)	*P* value
1 dose	6 (12.2)	18 (36.7)	
2 doses	2 (4.1)	9 (18.4)	<0.001**
3 doses	0 (0)	5 (10.2)	

Data presented as Number (percent).

Table 6. Comparison between studied groups according to time to first postoperative analgesia (minutes) of Morphine.

Time	QLB ($n = 49$)	Control ($n = 49$)	*P* value
Mean ± SD	419.84 ± 95.06	207.34 ± 35.48	<0.001**
Range	289–581	122–253	

Data presented as mean ± SD.

Table 7. Comparison between both groups according to patient satisfaction.

5-point Likert Scale	QLB ($n = 49$)	Control ($n = 49$)	*P* value
Very Satisfied	38 (77.6)	5 (10.2)	
Fairly Satisfied	6 (12.2)	9 (18.4)	
Neutral	4 (8.2)	7 (14.3)	<0.001**
Dissatisfied	1 (2)	16 (32.6)	
Very Dissatisfied	0	12 (24.5)	

Data presented as Number (percent).

4. Discussion

The findings of our study showed that US-guided QLB considerably increased analgesia duration, decreased opioid usage, and decreased post-operative pain scores. Significantly better hemodynamic stability and less changes from baseline were observed in patients in the QLB group.

A substantial network of abdominal sympathetic nerve fibres can be seen in the thoracolumbar fascia. Pain caused by the sympathetic nervous system can be relieved by blocking these nerve fibres. It has been shown to spread to the ilioinguinal nerve, iliohypogastric nerve, T7 (67%), T8 (83%), and more frequently T9-T12 spinal nerve roots.[6]

The spread of the psoas muscle to the lumbar nerve roots has been shown in a previous study.[8]

When compared to the more conventional TAP (Transvrsus Abdominis Plane) block, posterior QLB exhibits extra visceral and somatic block with greater width of analgesia (T7 to L4 dermatome).[9]

Previous investigations have corroborated our findings of improved postoperative analgesia in terms of the lengthier time to the initial analgesic request, lower VAS scores, and decreased necessity of postoperative analgesia by posterior QLB. After PCNL, QLB has been utilised to reduce post-procedure pain.

For patients following PNL surgery, **Dam** et al.[5] carried out a single centre study to examine the analgesic effectiveness of transmuscular quadratus lumborum (TQL) block. They had 60 individuals who were randomly assigned to undergo either a ropivacaine 0.75%, 30 ml (intervention) or saline preoperative QL block. They discovered that giving patients QLB at the conclusion of the PCNL surgery decreased postoperative morphine intake and pain levels while shortening postoperative mobilisation times and hospital stays.

Our study's findings are consistent with those of a different prospective, randomised, controlled trial by **ÖKmen and ÖKmen**,[10] which included 60 patients who had elective PNL surgeries. They used QLB-1 after the conclusion of the PCNL surgery,

and they discovered that it greatly decreased post-operative pain and morphine use.

In a different trial, patients receiving general anaesthesia received preoperative doses of QLB-2 and transmuscular QLB. The patient groups when these two blocks were used consumed less sufentanil during the intraoperative period than the control group did. The groups to which the block was applied reportedly had lower 24-h VAS scores. Muscle strength on the side where transmuscular QLB was used was lower following surgery.[11]

Subsequently, **Kõlõç and Bulut**[12] conducted a prospective, randomized, double-blinded study on 44 patients who were allocated to receive either QLB III or placebo. They concluded that QLB III was effective in pain control and reducing morphine consumption during the postoperative 48 h follow-up after PCNL.

Matching with the findings of this study, **Prabha and Raman**[13] conducted a hospital-based, randomized, double-blind, controlled, prospective study to evaluate the efficacy of posterior QLB for post-operative analgesia in forty patients undergoing PCNL. They found that QLB provide effective postoperative analgesia for a lengthy period of time with good quality., good satisfaction and reduced analgesia consumption, compared to placebo.

Furthermore, Blanco et al. (2015)[7] compared the lower segment caesarean section analgesic efficacy of posterior QLB with placebo in fifty patients. They noticed that VAS was decreased up until 24 h at all time points. At the sixth and twelfth postoperative hours, but not after, morphine consumption decreased.

In fact, when it comes to effecting both the paravertebral block area and the TAP block area, QLB is superior to TAP and paravertebral blocks.[14]

A considerable risk of pneumothorax, hypotension, and vascular damage is related with paravertebral block, despite the fact that it offers effective unilateral analgesia.[15]

However, widespread hypotension, the potential for intrathecal medication administration, intrathecal infection, epidural hematoma, or other neurological problems make epidural block applications appear to be more intrusive than QLB. In individuals receiving PCNL, peritubal infiltration lowers postoperative pain and narcotic usage. It is administered to more ephemeral tissues like the renal capsule, skin, and subcutaneous tissue.[16]

In terms of patient satisfaction, the QLB group had more patients who rated good satisfaction than the control group, which was only 10.2% of patients. This difference was statistically significant. This conclusion is corroborated by **Prabha and Raman's**[13] observation that the posterior QLB group of patients had higher patient satisfaction. The increased satisfaction could be attributed to better post-operative analgesia.

However, when **Baytar** et al.[17] compared the posterior QLB with TAP block in patients undergoing laparoscopic cholecystectomy, they found comparable postoperative satisfaction levels. The postoperative pain in their study was comparable between the two groups.

No complications were reported in the two study groups, like hypotension, respiratory depression, nerve injury, hematoma formation, systemic toxicity of local anesthetics, or intravascular injection. Matching with this result, **Jethava** et al.[18] compared QLB versus TAP for postoperative analgesia in sixty parturients undergoing caesarean section. They found no side effects related to the technique. On the other hand, because sympathetic fibres in the TLF (thoracolumbar fascia) and the paravertebral area were blocked following the posterior QLB, **Cardoso** et al.[19] reported that two patients experienced severe hypotension and tachycardia. Additionally, due to lumbar nerve root blocking, **Fujimoto** et al.[20] found temporary sensory and motor loss in the lower limbs.

4.1. Conclusion

US-guided QLB provided satisfactory analgesia in patients undergoing PCNL. It prolonged the duration of analgesia and reduced opioid consumption and postoperative pain scores. Patients in the QLB group significantly showed more hemodynamic stability and less variations from baseline. No serious complications were reported related to the technique. Accordingly, US-guided QLB is strongly recommended for postoperative pain management in patients undergoing PCNL.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of interest

The authors declared that there were no conflicts of interest.

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