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Research Article

Ultrasound Guided Quadratus Lumborum Block for Post-Operative Analgesia in Patients Undergoing Total Hip Arthroplasty: A Prospective, Double Blind, Placebo Controlled Study

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ABSTRACT

Background: Primary objective: Is to identify the duration of block, post operative pain score and consumption of rescue analgesic by the patient.
Secondary objective: To observe patient satisfaction score and Occurrence of post-operative complications if any.
Methods: A total of 60 patients, aged between 18-60yrs, belonging to ASA I & II with hip osteoarthritis requiring total hip arthroplasty (THA) were divided into two groups of 30 each. Patients were randomized into two groups and were given ipsilateral USG guided anterior QLB in the fascial plane between QL and psoas major muscles after surgery. Group C received 30ml NS and group T received 30ml of inj. Ropivacaine 0.2%. Post operatively patient received inj. PCM 1G TDS. Duration of block, requirement of rescue analgesia, VAS score and side effects were the parameters those were monitored and compared.
Results: Mode pain score by VAS was significantly lower in T group($p<0.05$) than C group which required more analgesia. (The chi-square value-5.9341, p=0.0148). Duration of block was more in T group. Patient satisfaction was noted to be better in T group.
Conclusion: Use of post-operative USG guided Ant. QLB reduced VAS score in patient undergoing THA. It also significantly decreased the requirement of post-operative rescue analgesia and improved patient satisfaction.

In the field of post-operative analgesia, regional anesthesia especially peripheral nerve block techniques are increasingly preferred than intravenous techniques. With the advent of ultrasound, visual identification of anatomical landmark, precision of technique with reduced complication, regional anesthesia has become the choice of analgesia [1]. Quadratus Lumborum block (QLB) is a fascial plane block in which local anesthetic is injected adjacent to QL muscle to anaesthetize the thoracolumbar nerves with the help of ultrasound guided technique.

Quadratus lumborum, a posterior abdominal wall muscle lying dorsolateral to psoas major muscle, and originates from the postero-medial part iliac crest and iliolumbar ligament and inserts on the medial border of the 12th rib. QLB was first described by Blanco in 2007 [2].

QL Block may extend from T7 to L2 level, as drug is deposited between psoas muscle and QL muscle. QL block can provide somatic as well as visceral analgesia to abdomen [3].

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USG has made identification of quadratus lumborum muscle easy. Three layers of abdominal wall muscles, i.e., transverse abdominis is traced more posteriorly until the transversus aponeurosis appears. QL is usually medial to the aponeurosis of transversus abdominis muscle. Five approaches of QLB including type 1 (QL1), type 2 (QL2), trans-muscular approach (QL3), intramuscular approach, and paramedian sagittal oblique approach according to injection location, have been described. Previous studies have shown that QL1 and QL2 blocks may generate analgesia from T7 to L2, and the QL3 block may cause caudal spread to the L2–L3 dermatomes [3].

The interesting feature of QL3 is its extension to the lumbar dermatomes; hence, it can be used for hip surgery. In 2016, H. Ueshima, S. yoshiyama and H. otake, described first QLB in total hip arthroplasty (THA) patients3. However, to draw conclusions we need to have controlled trials. Recently Jian He et al (2020) has described USG guided QL block in total hip arthroplasty patients.

Patients who have undergone THA have described the post operative pain as severe (6%) and moderate to severe (26%) [4]. So, we designed this prospective, randomized, double-blind, placebo-controlled study to investigate whether the QL3 block can be used for analgesia after THA.

The aim of this placebo-controlled trial was to investigate the effects of the QL3 block on pain intensity in patients undergoing THA, to assess rescue opioid requirement, and to observe if early mobilization of patients undergoing THA is possible. We hypothesized that the QL3 block would reduce pain intensity and opioid requirements in patients following THA.

Methods

The prospective double-blind placebo-controlled study was conducted after taking written informed consent and institutional ethical committee approval. Sixty six patients aged 18–60 years, classified as the American Society of Anesthesiologists (ASA) class I or class II and presented for Total hip arthroplasty surgery during study period of April 2021 to September 2021 were taken for the study, out of which 5 patients were excluded. Patients with allergy to local anesthetic, bleeding disorders, anticoagulation therapy, local infection, obesity and refusal were excluded from the study. Revision cases were also excluded. Sealed opaque envelope method was used for randomization and allocation of patients in two groups. Control group (C group) where patients received ipsilateral shams ultrasound guided QLB using 30 ml of normal saline in the fascial plane between QL and psoas major (PM) muscle after surgery and Test group (T group) where patients received an ipsilateral ultrasound guided QLB using 30 ml of plain ropivacaine 0.2% postoperatively.

Blinding was done with the help of fellow anesthesiologist who prepared syringes of either 30 ml of plain inj. Ropivacaine 0.2% or 30ml of normal saline. The participant, attending anesthesiologist, surgeons, evaluators and researcher was unaware of random allocation sequence. The random allocation sequence was not revealed until the final data analysis was completed.

Upon patients' admission to the operating theatre, ASA standard monitors; including a pulse oximeter, 5-lead electrocardiogram, non-invasive blood pressure monitor and temperature monitor were attached. After establishing intravenous access, co-loading was done with ringer lactate 10 ml/kg. All the equipment required for spinal, general anesthesia, nerve block, and resuscitation was kept ready.

Under all aseptic conditions, spinal anesthetic with 3-4 ml Bupivacaine heavy 0.5 % was injected at L3–L4 or L4–L5 intervertebral space using 26-gauge spinal needle. Patient was monitored using ASA standard monitor throughout the surgery. Sensory block was evaluated using pinprick test from caudal to cephalic direction until the sensory level reached T10. Motor block was assessed every 5 min by the Bromage score (Grade 0: No paralysis, Grade 1: Unable to raise an extended leg but able to move the knees and ankles, Grade 2: Unable to flex knees but able to flex ankle and Grade 3: No movement) until reaching a score of 3. Patients were excluded from study in case of failed/ inadequate spinal anesthesia or if general anesthesia was administered. A decrease in the heart rate below 50 beat/min was managed by administering atropine 0.3 mg intravenous (I V), while a decrease in the mean arterial pressure below 65 mmHg was managed by administering Inj. Mephenteramine 3-6mg IV and intravenous fluid.

Surgical procedure was performed in a standardized manner through the posterolateral approach. Bone cement was not used in any of the subjects included in the study. Surgeons too were blinded to the patient group allocation.

At the end of surgery, QL Block was performed, using a low-frequency (2–5 MHz) curvilinear ultrasound probe. Patient was in a lateral decubitus position; ultrasound probe was placed transverse to the abdominal flank in the anterior axillary line just above the iliac crest till all the three abdominal muscle layers were identified

. Then, we gradually moved probe posteriorly to identify thoracolumbar fascia and back muscles till 'Shamrock sign' was appreciated. It can be seen as the transverse process of the lumbar vertebra as the thumb, and QL, PM and erector spinae muscles forming the three leaflets. Using in-plane technique, under absolute aseptic precaution, the needle was inserted from the posterior end of the ultrasound probe, using the trans muscular approach. Ropivacaine 30 ml 0.2% in case of T group and 30 ml NS in case of C group, was deposited in the fascial plane between the QL and PM muscles.

As a part of multimodal analgesia, all patients were given analgesic inj. paracetamol 1 gm IV TDS post

operatively. Patients were explained about Visual Analogue Scale (VAS) of 0–10, which was used for pain assessment. Pain was assessed every 2 h till 12 h, then every 4 h till 24 h. Inj. Tramadol 50mg IV was given as rescue analgesic if VAS score was 4 or more Time from the administration of QL block to administration of first rescue analgesic was noted as duration of the block. Side effects and complications like nausea, vomiting, rash, dizziness, hypotension, pruritus, pain at the site of block, local infection, hematoma formation, injury to internal organs and local anesthetic systemic toxicity (LAST) were also watched for.

The patients were asked to grade their degree of satisfaction regarding post-operative analgesia using a 4-point scale where 4 = very satisfied, 3 = satisfied, 2 = dissatisfied and 1 = very dissatisfied, 24 hrs post block. The post-operative care and physiotherapy regime was followed to all patients in both the groups.

Sample size

Calculation of sample size was done on the primary outcome basis. The minimum QoR-40 is clinically important which is estimated at 10 points on the basis of previous studies and our clinical experience. The standard deviation (SD) for the QoR-40 was 14 in previous study. Therefore, we have estimated an SD for the QoR-40 of 20. A total of 60 patients was required to detect a 10 point difference, with an alpha error of 0.05 and a beta error of 0.2 (i.e., power of 0.80). Considering dropouts, we plan to enroll 33 patients in each group.

Statistics

Descriptive statistics was done for all data. Statistics analysis was done using statistical package for social sciences (SSPS) version 16.0 (SPSS Inc., Chicago, IL, USA). Parametric data was expressed as mean ± standard deviation after analysis using the unpaired t-test, while categorical data was expressed as a number and percent after they were analysed by Fisher's exact test. The Mann–Whitney U-test was used for statistical analysis of the post-operative VAS score and patient's satisfaction. A linear mixed-effect model was used to analyse the repeated measurements of post-operative pain score to detect the relationship between the visual analogue score over time and the technique of intervention. The statistically significant difference was considered as $P< 0.05$.

Results

Enrolment of 66 patients was done for study. Out of which 6 patients were excluded; 2 due to inadequate subarachnoid blockade converting to GA, and other 4 due to denial.

Demographic parameters were comparable in both the groups. Mean age of T group was 53 yrs and C group was 55yrs. (Table 1) shows patient characteristics and perioperative variables.

Mean heart rate was comparable in both the groups. ($p > 0.05$) (Figure1) Mean systolic pressure in T group was lower (81 and 83 mm Hg) in comparison with C group (83 and 84 mm Hg) at 15 & 30 min after injection respectively ($p> 0.05$) but there was no significant difference between them throughout ($p>0.05$). There was no significant difference between mean diastolic pressure, mean arterial pressure and heart rate in both the groups during 24 hrs period. (Figure 2) Mean duration of surgery was comparable in both groups (C- 2.29 hour, T-2.46 hour, $p = 0.201$).

Mode pain score by VAS method in study group was significantly lower than control group at 12, 16, 20 and 24 hours ($p <0.05$) (Figure 3).

There was significant association of C group with rescue analgesia in comparison with T group (The chi-square value - 5.9341, $p = 0.0148$) (Figure 3). Twenty one out of sixty patients received rescue analgesia. (Contro-15, Test-6) Mean satisfaction score in T group was higher than C group with statistically significant difference between them. ($p = 0.005$) (Figure 4, Table 2) Rescue analgesia in T group was given required at 16th hr. None of the patients from both the groups had any side effects or complications.

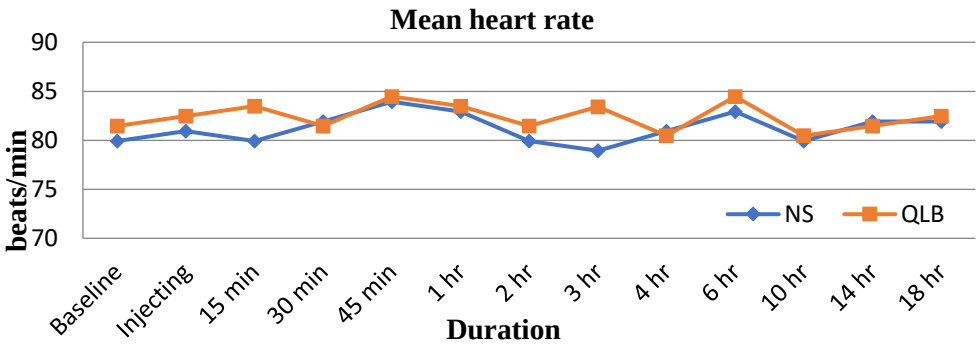

Figure 1- Mean Heart Rate of control and test group

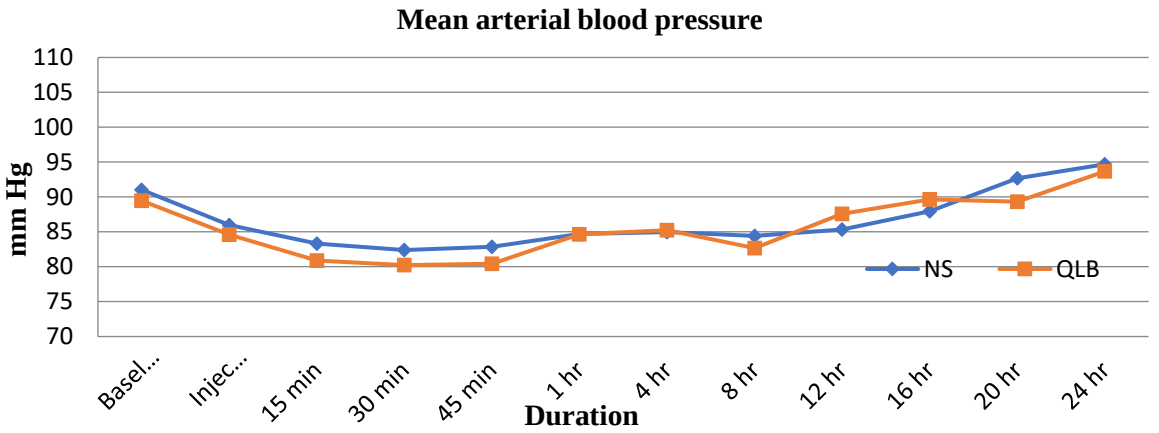

Figure 2- MAP of control and test group

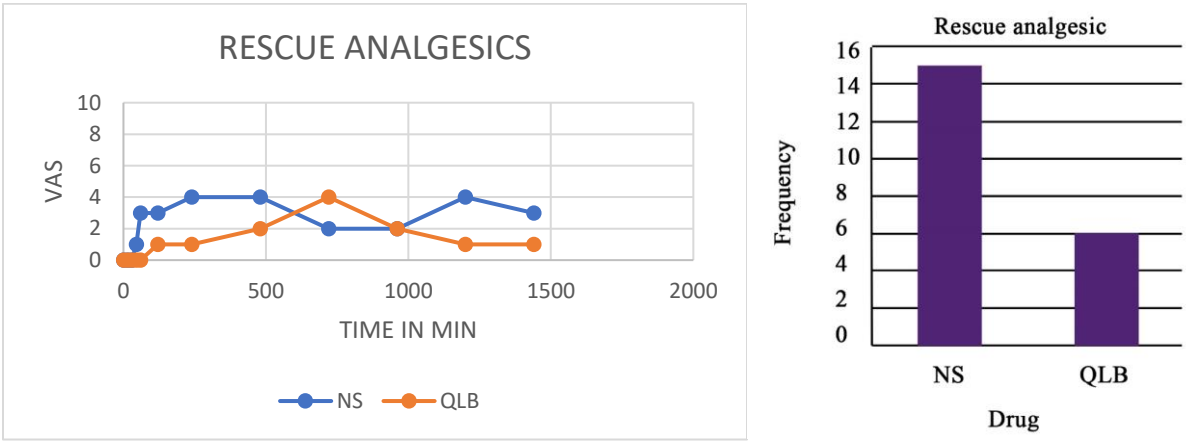

Figure 3- Pain score and rescue analgesic in control and test group

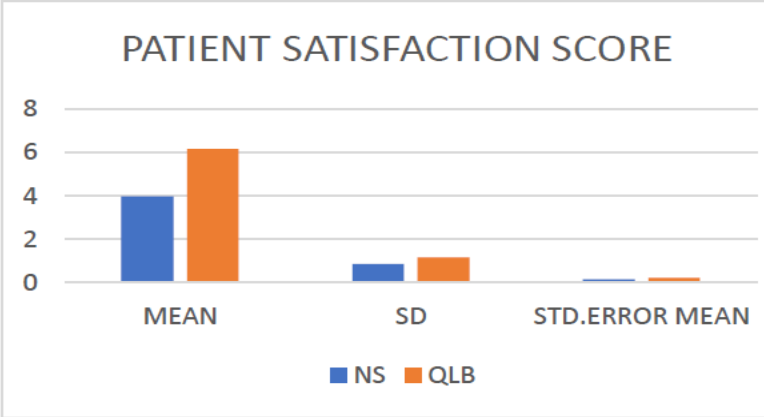

Figure 4- Patient Satisfaction Score

Table 1- Patient Characteristics and perioperative variables

	QLB	Control	P Value	SMD
AGE (yrs)	45.3±10.3	53.8±16	0.015	0.298
GENDER, Male	23	17	0.0178	0.158
BMI (Kg/m²)	25.5±3.6	24.5±3.9	0.037	0.245
Duration of sx (min)	84.94±26	86.31±30	0.888	0.016
Duration of block	364±25.48	147±28.2	0.006	0.217

Table 2- Patient Satisfaction Score

Group		Mean	Std. Deviation	Std. Error Mean	P value
Patient satisfaction score	NS	3.97	0.850	0.155	0.00
	Ropivacaine	6.17	1.147	0.209	

Discussion

The hip is the second most common joint affected by osteoarthritis leading to pain, disability and requirement of surgical correction (THA) in almost 30 to 50% [1,5-6].

Pain delays ambulation and prolongs recovery, so must be addressed. Postoperative analgesic management in THA is indeed challenging with a variety of options like spinal and epidural analgesia. The nerve block options include femoral block, sciatic block, posterior lumbar plexus block, fascia iliaca block, and periarticular local anesthesia infiltration [12-13]. Quadratus lumborum block (QLB) is a newly introduced technique for analgesia for THA [7,11,16-17]. This double-blind study was conducted to assess the effectiveness of QLB in THA with a placebo-control design.

QLB, first described by Blanco (2007) was demonstrated by USG for abdominoplasty [8-9]. Out of different approaches, the anterior (type 3), although used for abdominal surgeries, can be also used in lower limb surgeries because of the spread of local anaesthetic around the psoas major muscle and lumbar nerve roots [10]. It blocks the femoral, obturator and lateral femoral cutaneous nerve thus providing better analgesia than individual nerve blocks. Also, because the needle tip is away from the lumbar nerves, there is less chance of nerve injury.

The results of our study show that quadratus lumborum block type 3 (QL3) using Inj. Ropivacaine 0.2% can significantly reduce the intensity of postoperative pain in THA.

The surgical incision is the main source of postoperative pain in THA. The nerves involved during the incision of the THA mainly include the lateral femoral cutaneous nerve, femoral nerve, obturator nerve, and sciatic nerve [10]. Many studies have shown that the blockade of any of these nerves can reduce pain scores and opioid use in patients undergoing THA. These techniques have their own disadvantages. In nearly 50% of patients, the accessory obturator nerve 1innervated the hip at the position where the obturator nerve had just emerged [10]. Therefore, the conventional method of blocking the femoral and obturator nerves in the inguinal region may not completely block the femoral nerve branches and the accessory obturator nerve that dominates the hip joint. Lumbar plexus block may be an ideal postoperative pain management strategy after THA; however, it requires more expertise and is riskier than single nerve blocks.

Blanco first reported that the QL block was an extremely effective method of postoperative pain control in 2007 [8,18]. There are several approach methods: type 1 (QL1), type 2 (QL2), trans-muscular / anterior approach (QL3), intramuscular approach, and paramedian sagittal oblique approach4 [8]. The spread of local anaesthetic varies with each approach [19]. Previous case reports have shown that both QL1 and QL3 can provide good pain relief in patients following THA [20].

A prospective controlled study by Paras and Blanco indicated that QL1 provided better pain relief than femoral nerve block in patients with femoral neck fractures19. The most suitable approach of QL block for analgesia undergoing THA is yet to be determined. A cadaver study showed that after the QL3 block, the injectate spread consistently to L1, L2, and L3 nerve roots, which are important components of the lumbar plexus [14]. Therefore, the QL3 block may provide analgesia covering the dermatomes extending caudally to L2 or L3 and is an effective pain management strategy in hip surgeries.

However, the mechanism of the QL3 block for postoperative analgesia is still controversial. A cadaver study by Dam et al. showed that after QL3 block, the injectate could spread into the thoracic paravertebral space and the intercostal spaces to surround the somatic nerves and the thoracic sympathetic trunk through the thoracolumbar fascia [14]. Moreover, the QL3 block is less invasive, safer, and easier to perform than a lumbar plexus block, which requires injection within the psoas muscle adjacent to the roots of the account for these results.

First, the QL3 block acts on the muscular fascia, and its duration of action is possibly longer than that of other nerve blocks. Since nerves are often accompanied by blood vessels, local anaesthetic injected along the nerve is absorbed more quickly than local anaesthetic injected in the muscular fascia. QL block can effectively inhibit pain in 24 hours postoperatively and reduce postoperative pain sensitization, while patients in the C group had higher VAS score at 24–48 hours after surgery.

Good postoperative analgesia and lower incidence of opioid-related side effects made patients more willing to perform rehabilitation exercises. These reasons likely accounted for the better physical performance in the Test group than in the control group. Effective analgesia and no opioid-related side effects played a pivotal role in improving satisfaction in patients receiving the QL3 block. This study did not find QL3 block-related hypotension or respiratory depression.

A randomized, controlled study by Promil Kukreja et al concluded that anterior QL block provided effective analgesia and decreased opioid requirements up to 48 hours after primary THA [5-6].

Randomized, Double-Blind, Placebo-Controlled Trial by Jian He et al concluded, that ultrasound-guided Trans-muscular QLB3 block is an effective pain management technique after THA [15].

Conclusion

Use of post- operative USG guided Ant. QL block using 0.2% Inj ropivacaine reduced VAS score in patients undergoing THA with improved satisfaction score and reduced requirement of rescue analgesics than that in control group.

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