Anterior quadratus lumborum block analgesia for total hip arthroplasty: a randomized, controlled study

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ABSTRACT

Background and objectives Quadratus lumborum (QL) block is a new regional analgesic technique for upper and lower abdominal surgeries as part of a multimodal analgesic regime. It has also been reported to relieve pain after total hip arthroplasty (THA). In this prospective, randomized, double-blind study, we compared QL block with control (no block) in patients undergoing primary THA.

Methods Eighty patients undergoing primary THA surgery under spinal anesthesia were randomized into two groups, one with and one without QL block. The patients in both groups were randomized after sedation, positioning and ultrasound scanning. Both the patient and the researcher collecting data were blinded to the patient’s group assignment. Opioid consumption and visual analog scores (VAS) pain scores were measured at 12, 24, and 48 hours after surgery. Also, the ambulation distance, patient satisfaction, and length of stay were recorded.

Results The study analysis included 36 patients in the QL group and 35 patients in the control group. Both VAS pain score at 24 hours (difference −1.76, 95% CI −2.87 to −0.64) and cumulative opioid consumption were significantly lower in the QL group at 12, 24, 48, and 48 hours after surgery as compared with the control group (difference at 48 hours −36.13, 95% CI −62.89 to −9.37) (p<0.05). However, there was no difference in pain score at 12 and 48 hours, nor in the ambulation distance and duration of hospital stay between the two groups. The patient satisfaction score was significantly higher in the QL group.

Conclusions Our preliminary data show that the QL block provided effective analgesia and decreased opioid requirements up to 48 hours after primary THA.

Trial registration number NCT03408483

INTRODUCTION

Total hip arthroplasty (THA) is now the second most common joint replacement surgery in the USA due in part to an aging population.1 Opioid-sparing analgesic treatments, such as lumbar plexus and femoral nerve blocks, are effective but they carry a high risk of undesirable lower limb motor or muscle weakness. Fascia iliaca block, on the other hand, does not consistently provide adequate pain relief.2 4 Today, early mobilization, rehabilitation, and participation in physical therapy (PT) is an integral part of enhanced functional recovery program after THA. Because innervation of the hip joint is complex and preservation of lower extremity motor function is paramount, optimal regional analgesic intervention for THA has yet to be defined.4 5

Quadratus lumborum (QL) block is a relatively new truncal regional block technique that provides effective pain control after upper and lower abdominal surgeries.6 7 The QL muscle is encased between the middle and anterior thoracolumbar fascia that communicates with fascia of psoas major (PM) muscle medially and with transversalis fascia laterally.8 The anterior QL block was also classified as transmuscular approach (in between QL and PM muscles) in earlier studies.9 Local anesthetic injected between the QL muscle and anterior layer of the thoracolumbar fascia can potentially spread to the thoracic paravertebral (PVB) space,10 rendering this block an indirect PVB block. The pathway of anterior QL (transmuscular) block injectate can potentially spread to the iliohypogastric, ilioinguinal, genitofemoral, and lateral femoral cutaneous nerves as demonstrated in a recent cadaveric study.11

Case reports have reported the preliminary analgesic benefit of QL block for hip surgeries without associated muscle weakness.12 13 A retrospective cohort study also reported shorter hospital length of stay after THA when QL block was administered.14 Another retrospective cohort study comparing QL and lumbar plexus blocks for THA showed equivalent analgesia with similar postoperative opioid requirements, pain scores and length of hospital stay.15 A recent prospective randomized study concluded that both ultrasound-guided lumbar erector spinae plane block and transmuscular QL block improve analgesia in patients undergoing hip and proximal femur surgery when compared with standard intravenous analgesia regimen.16

We hypothesized that QL block can reduce visual analog scale (VAS) pain scores and opioid consumption at 12, 24, and 48 hours after THA. We also measured secondary outcomes, such as distance ambulated during PT, patient satisfaction and time to hospital discharge after surgery.

METHODS

This double-blind randomized clinical trial was registered with the US National Clinical Trials Registry prior to the enrollment process started in December 2017. After institutional review board approval, and written informed consent, 80 patients were enrolled in the study. Inclusion criteria were ≥18 years of age, ASA class I–III, and primary unilateral THA, and exclusion criteria were allergy or intolerance to local anesthetics, pre-existing...
neurologic or anatomic deficits in the lower extremity on the side of surgery, coexisting coagulopathy, and contraindications to peripheral nerve block or neuraxial anesthesia. Patients were randomized in a 1:1 ratio into two groups, group QL and group Control, using a random number generator. This allocation was written and stored in an opaque, secure envelope. Both the patient and the investigator doing follow-up interviews and extracting data from the electronic medical records were blinded to group allocation and treatment interventions.

All study patients received 1000 mg of acetaminophen and 400 mg of celecoxib by mouth in the preoperative holding area. After placement of standard monitoring, premedication with 1 mg midazolam and 50 μg fentanyl intravenously and positioned lateral decubitus with the operative side up, all patients were scanned with a curvilinear probe (2–5 MHz) placed anterior and superior to the iliac crest to identify the anterior abdominal muscle layers. The transversus abdominis and internal oblique muscles were identified and traced posteriorly until the QL muscle was identified. The allocation envelope was then opened to determine the randomization group. For the patients in the QL block group, a 22-gauge, 10 mm Quincke-type SonoPlex needle (Pajunk, Geisingen, Germany) was advanced inplane in the lateral-to-medial direction until the needle tip reached the anterior margin of the QL muscle (figure 1), between the QL and PM muscles, before 30 mL of 0.25% bupivacaine with 1:400 000 epinephrine was injected incrementally over 1 min. Local anesthetic (LA) spread deep to the anterior thoracolumbar fascia between the QL and PM muscles is considered the ultrasound endpoint of a good injection in the QL group. For the patients in the control group, scanning was performed to identify the QL muscle in a similar fashion, but without needle insertion or local anesthetic injection. Thereafter, all patients received spinal anesthesia with 2.5 mL of 0.5% bupivacaine and routine perioperative care in the operating room. The periaortic local anesthetic was not injected during surgery.

The primary outcome measures were pain scores using the VAS (0=no pain and 10=excruciating pain) at 12, 24, and 48 hours, opioid consumption (reported in oral morphine equivalents (OMEs)) at 12, 12–24, 24, 24–48, and 48 hours, and ambulation distance during PT on postoperative day 1 and 2 (POD 1 and 2). Secondary outcomes were patient satisfaction and duration of hospital stay (ie, from the time of study randomization to time of hospital discharge). We used Stanford palliative care and Agency Medical Directors’ Group opioid conversion tool to calculate OMEs. During rehabilitation, the physical therapist who was blinded to the randomization group measured patient’s ambulation distance with minimal assistance on POD 1 and 2.

**Sample size calculation and statistical analysis**

This study was powered to detect a mean difference of 3 in pain scores between patients undergoing QL block procedure versus those not receiving QL block, assuming a SD of three. Using a two-sample t-test, a sample of 70 participants (35 patients per group) would have approximately 98.5% power to detect a clinically significant reduction in pain score with a significance level alpha of 0.05. Continuous data were summarized as mean and standard error (SE) and categorical data were summarized as frequency and percentages. Assumptions of normality for continuous variables were assessed using normal probability plots. SAS V9.4 was used to conduct all analyses. Two sample t tests (for continuous variables), χ² tests (for categorical variables), and the log-rank test (for time to the first opioid) were used to compare subjects receiving a QL block to those not receiving a block. A p value of <0.05 was considered statistically significant.

**RESULTS**

After screening and randomization, three patients in each group were excluded for failed spinal anesthesia and three patients excluded in the “QL block” group for missing data due to early discharge. The final analysis included 71 patients. The CONSORT flow diagram is shown in figure 2. The groups were comparable with respect to patient demographics (sex, age, race, ethnicity, and surgical approach, table 1). Opioid requirements were measured as cumulative OMEs for the first 12, 12–24, 24, 24–48, and 48 hours postsurgery. The VAS pain scores were significantly lower by 45% at 24 hours in the QL block group (p=0.003) when compared with the no block group (figure 3). No significant differences were found between the groups regarding 12 and 48 hours pain scores.

The cumulative opioid requirements were significantly lower in the treatment group at 12, 12–24, 24, 24–48, and 48 hours (p<0.05) as compared with the control group (figure 4). The time to the first opioid intake was not significantly different between the groups (table 2).

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Figure 2 Flow diagram of screened, randomized, and excluded patients. QLB, quadratus lumborum block.

The ambulation distance during PT was comparable in both groups on POD 1 and 2 (table 2). There were no significant statistical differences in the ambulation distance and the duration of hospital stay between two groups (table 2). The patient satisfaction scores were significantly higher in the “QL” group (p=0.001).

DISCUSSION

To the best of our knowledge, this is the first prospective, randomized, double-blinded study to report the effectiveness of QL block for pain relief after primary THA. The main findings of this study are superior analgesia with QL block for primary THA resulting in lower pain scores and less opioid consumption with no difference in distance walked during PT when compared with control. Findings of the opioid-sparing analgesic effect of QL block in the era of opioid epidemic and preservation of lower limb muscle strength in the era of accelerated PT after THA are, therefore, encouraging.

Different QL block approaches have been described referring to different anatomic sites of local anesthetic injection relative to the QL muscle, the thoracolumbar fascia, abdominal wall muscles, latissimus dorsi, PM, and erector spinae muscles. The optimal site of injection was discussed by Blanco and McDonell19 in earlier studies and they observed PVB spread with either anterolateral or posterior QL block approaches using MRI dye studies. In this study, we have used the anterior lumbar QL block technique, where the local anesthetic is deposited deep to the anterior thoracolumbar fascia between the QL and PM muscles, and in close proximity to the lumbar plexus with potential local anesthetic spread to the PVB region to achieve effective analgesia in the desired dermatomes. The femoral and obturator nerves from lumbar plexus innervate the anterolateral and anteromedial hip capsules, respectively.20 21 The anterior QL block aims to block the lumbar plexus branches, including the lateral femoral cutaneous nerve, which innervates the surgical incision site commonly used in THA approach.

Table 1 Demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>QL block (n=36)</th>
<th>No block (n=35)</th>
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<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20 (55.56%)</td>
<td>15 (42.86%)</td>
</tr>
<tr>
<td>Male</td>
<td>16 (44.44%)</td>
<td>20 (57.14%)</td>
</tr>
<tr>
<td>Age, years, mean (SE)</td>
<td>58.61 (2.74)</td>
<td>58.00 (2.09)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black or African–American</td>
<td>17 (47.22%)</td>
<td>17 (48.57%)</td>
</tr>
<tr>
<td>White</td>
<td>19 (52.78%)</td>
<td>18 (51.43%)</td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Hispanic or Latino</td>
<td>36 (100.00%)</td>
<td>35 (100.00%)</td>
</tr>
<tr>
<td>Surgical approach, n (%)</td>
<td>16 (44.44%)</td>
<td>13 (37.14%)</td>
</tr>
<tr>
<td>Anterior</td>
<td>20 (55.56%)</td>
<td>22 (62.86%)</td>
</tr>
<tr>
<td>Posterior</td>
<td></td>
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</tbody>
</table>

Figure 3 Postoperative pain scores at 12, 24, and 48 hours after total hip arthroplasty. Pain scores were lower in the QL group at each time point, and pain scores are significantly lower (p<0.003) at 24 hours. Bars represent SE of the mean. QL, quadratus lumborum.

QL block for pain relief after primary THA. The main findings of this study are superior analgesia with QL block for primary THA resulting in lower pain scores and less opioid consumption with no difference in distance walked during PT when compared with control. Findings of the opioid-sparing analgesic effect of QL block in the era of opioid epidemic and preservation of lower limb muscle strength in the era of accelerated PT after THA are, therefore, encouraging.
Another important anatomical consideration is that the PM muscle lies in close proximity to the QL muscle and is ventromedially located. The PM muscle, while housing the lumbosacral plexus, may be commonly split by a fascial layer between the posterior one-third and anterior two-thirds of the muscle, thereby allowing a continuity with the transversalis fascia over the ventral aspect of the QL muscle. This may be a potential path of local anesthetic spread from QL block to the lumbar plexus. The QL block provides a wider coverage of dermatomes as compared with transverse abdominis plane block, which can be explained by spread along the thoracolumbar fascia to the PVB region. A recent cadaveric study and case series concluded that the supra-iliac approach to the anterior QL block involved T10–L3 dermatomal coverage and provided effective analgesia for total hip surgery.

Postoperative pain management after THA has always been a challenging goal to achieve. Multiple regional techniques have been used in the past, but there is not a “best-proven intervention” for THA analgesia. The main regional techniques for THA include lumbar plexus block, lumbar epidural, femoral nerve block, sciatic nerve block, fascia iliaca block, percutaneous injection, or obturator nerve block. Unfortunately, all the aforementioned blocks provide either inconsistent or partial analgesia, or are associated with lower extremity weakness that may interfere with PT or increase the risk of fall. Use of a lumbar epidural catheter or inadvertent epidural spread of lumbar plexus block can result in hypotension, leg weakness, and related adverse effects. The peripheral nerve blocks have been shown to be associated with falls after knee and hip arthroplasty. However, the anterior QL block, in this study, did not reduce ambulation with PT, as there was no difference in ambulation distance between two groups at 24 and 48 hours postsurgery.

Postoperative opioid requirements after THA vary depending on the type of regional anesthesia technique used. One study of continuous femoral nerve blocks for THA showed opioid requirement of approximately 160 mg of OMEs and another study of continuous lumbar plexus block showed approximately 114 mg of OMEs in the first 48 hours. In this prospective study, the 48 hours OME in the QL block group was 54±8 mg, which is significantly lower than the two aforementioned regional block techniques. Persistent pain after THA (more than 3 months) is reported in 27% of patients and is reported to be correlated with the intensity of early postoperative pain rather than preoperative pain levels. Long-term follow-up is needed to evaluate the effect of the QL block on the incidence of persistent pain after THA.

**Limitations**

In this study, we did not check sensory dermatomal levels after local anesthetic injection to confirm the QL block effectiveness as we felt this might affect blinding. We could not accurately assess the duration of the QL block to explain the block effect lasting for approximately 48 hours. Our main objectives were to compare pain scores and opioid consumption between two groups. Despite being a prospective, randomized study, we did not blind the patients completely, as the block was performed preoperatively while the patients were awake. Also, our institutional review board did not approve a “sham” injection in the control group. Nevertheless, 90% of the study patients believed that they received the QL block, which suggests sufficient blinding in a majority of the patients. This is a procedure-based study; thus, the anesthesiologist performing the block was not blinded. However, a blinded investigator collected all the postoperative data. Finally, we did not assess quadriceps muscle strength objectively, thus could not address the potential spread of local anesthetic to the lumbar plexus after the anterior QL block approach. The surgical approach for THA may affect the severity of postoperative pain and functional recovery. More patients in the QL block group had anterior THA surgical approach of the QL block.

**Table 2  Study endpoints**

<table>
<thead>
<tr>
<th>Endpoint</th>
<th>QL block</th>
<th>No block</th>
<th>Effect size (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain scores, mean (SE)</td>
<td>2.34 (0.46)</td>
<td>3.33 (0.56)</td>
<td>−0.99 (−2.44 to 0.46)</td>
<td>0.179</td>
</tr>
<tr>
<td>12 hours</td>
<td>2.31 (0.37)</td>
<td>4.06 (0.42)</td>
<td>−1.76 (−2.87 to −0.64)</td>
<td>0.003</td>
</tr>
<tr>
<td>48 hours</td>
<td>3.33 (0.43)</td>
<td>4.11 (0.64)</td>
<td>−0.77 (−2.31 to 0.76)</td>
<td>0.316</td>
</tr>
<tr>
<td>Oral morphine equivalents, mean (SE)</td>
<td>16.64 (2.80)</td>
<td>26.60 (3.47)</td>
<td>−9.96 (−18.86 to −1.06)</td>
<td>0.029</td>
</tr>
<tr>
<td>12 hours</td>
<td>12.99 (1.65)</td>
<td>20.54 (2.22)</td>
<td>−7.55 (−13.06 to −2.04)</td>
<td>0.008</td>
</tr>
<tr>
<td>24 hours</td>
<td>30.05 (3.80)</td>
<td>47.14 (4.72)</td>
<td>−17.09 (−29.14 to −5.04)</td>
<td>0.006</td>
</tr>
<tr>
<td>48 hours</td>
<td>24.26 (4.48)</td>
<td>40.52 (6.31)</td>
<td>−16.26 (−31.52 to −1)</td>
<td>0.037</td>
</tr>
<tr>
<td>48 hours</td>
<td>54.63 (8.25)</td>
<td>90.76 (10.65)</td>
<td>−36.13 (−62.89 to −9.37)</td>
<td>0.009</td>
</tr>
<tr>
<td>Hours to the first opioid, median (IQR)</td>
<td>6.8 (3.78–19.05)</td>
<td>5.10 (3.00–20.90)</td>
<td>0.9 (0.53 to 1.51)</td>
<td>0.679</td>
</tr>
<tr>
<td>PT ambulation distance, mean (SE)</td>
<td>114.51 (10.39)</td>
<td>100.85 (10.60)</td>
<td>13.66 (−15.97 to 43.3)</td>
<td>0.361</td>
</tr>
<tr>
<td>POD 1</td>
<td>127.75 (17.33)</td>
<td>106.69 (23.37)</td>
<td>21.06 (−36.82 to 78.94)</td>
<td>0.465</td>
</tr>
<tr>
<td>POD 2</td>
<td>53.17 (4.99)</td>
<td>55.97 (3.78)</td>
<td>−2.8 (−6.35 to 18.74)</td>
<td>0.731</td>
</tr>
<tr>
<td>Patient satisfaction, mean (SE)</td>
<td>9.14 (0.28)</td>
<td>7.46 (0.41)</td>
<td>1.68 (0.71 to 2.65)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

P values less than 0.05 are considered statistically significant. Continuous data were summarized as mean and SE, categorical data were summarized as frequency and percentages, and time-to-event data were summarized as median and IQR. All effect sizes are differences in means except for hours to the first opioid; effect size for hours to the first opioid is HR.

POD: postoperative day; PT: physical therapy; QL, quadratus lumborum.


approach when compared with “no block” group, which might have impacted pain scores and opioid consumption.

CONCLUSIONS
The anterior QL block enabled adequate postoperative analgesia for patients undergoing THA. The QL block for THA reduced pain scores and had opioid-sparing effects postoperatively. The single-shot QL block preserved the patient’s ability to ambulate and participate in PT for enhanced functional recovery. More studies are needed to support the role of QL blocks in providing analgesia for THA and other hip surgeries. Further studies are warranted to determine the optimal dose and volume of LA required for an effective and safe QL block. Also, it would be interesting to investigate and objectively measure muscle strength in the lower extremity after the QL block. Further research regarding the best QL block technique for THA analgesia is warranted.

Contributors PK, LM, EG, HK, and VWSC contributed to the study design. PK, LM, and HK recruited study patients after randomization. AS collected study data. CJM, LA, PK, LM, EG, HK, and VWSC drafted the manuscript. All the authors reviewed and approved the final manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study got ethical approval from the Institutional Review Board of the University of Alabama at Birmingham.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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