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CLINICAL REPORT

Subcostal approach to anterior quadratus lumborum block for pain control following open urological procedures

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Abstract

In the case of open urological surgeries, analgesic coverage at mid thoracic dermatomal levels is required. As shown in cadaveric studies, the site of QL block injection is an important determinant of the extent of dye spread and presumably local anesthetic dermatomal coverage. In this case series, we evaluated dermatomal blockade and analgesic efficacy of a subcostal approach to anterior QL block following open urological surgeries. Twenty-two adult patients undergoing renal transplant surgery (60%) and open nephrectomy (40%) received unilateral ultrasound-guided subcostal anterior QL block with catheter insertion. Sensory level, pain score (numeric rating scale, NRS), local anesthetic consumption, and opioid consumption (morphine equivalent dose, MED) were assessed daily for 3 days. The block achieved sensory blockade between T6-7 and L1-2. The most frequently affected dermatomes were T8 -T12 and the number of blocked segments was 3 (mean 2.8). The median (interquartile range Q1, Q3) of NRS pain score was 3.7 (2.8–5.5), 3.3 (2.4–4.7), 2.9 (1.9–3.6), and 2.3 (1.0–4.2) on POD0, POD1, POD2, and POD3, respectively. Our preliminary data showed that the subcostal approach to anterior QL block provides appropriate thoracic dermatome level needed for analgesia following open urological surgical procedures between T6-7 and L1-2.

Keywords Quadratus lumborum block · Regional anesthesia · Urological procedures

Introduction

Post-operative pain following urological surgeries contributes to post-operative morbidity and extended hospital stay [1, 2]. A transmuscular anterior quadratus lumborum (QL) block at L4 and L2 levels {called the Transverse Oblique Paramedian (TOP) anterior QL approach} and subcostal approach has been described [3, 4]. The mechanism of action relies on local anesthetic spread cranially towards the thoracic paravertebral space [5, 6]. In a cadaveric study [5], dye spread was noted to be no higher than the T10 paravertebral space even with L2-level injection thus unlikely to provide analgesia above the umbilicus. Because the site of QL injection may have an

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impact on the extent of cephalad local anesthetic spread, we evaluated another variation of the anterior QL block approach, termed subcostal approach to anterior QL block, by moving the injection site more cephalad (just below the 12th rib) [4], and observed dye staining between T6-7 and L1-2 in a cadaver study [6]. We hypothesize that similar extent of dermatomal analgesia in the mid thoracic level can be achieved in the clinical setting as in the cadaver study following the subcostal approach to anterior quadratus lumborum block.

Methods

After Cleveland Clinic Institutional Review Board (IRB) approval, this retrospective review of case series included all adult patients who received subcostal anterior QL block catheter for pain control following urological procedures involving renal transplant and open nephrectomy between March 2015 and March 2017. Requirement for written informed consent was waived by the IRB (IRB 15–573). Data were obtained from the electronic medical record. Pain scores were assessed and recorded every 15 min in the post-anesthesia

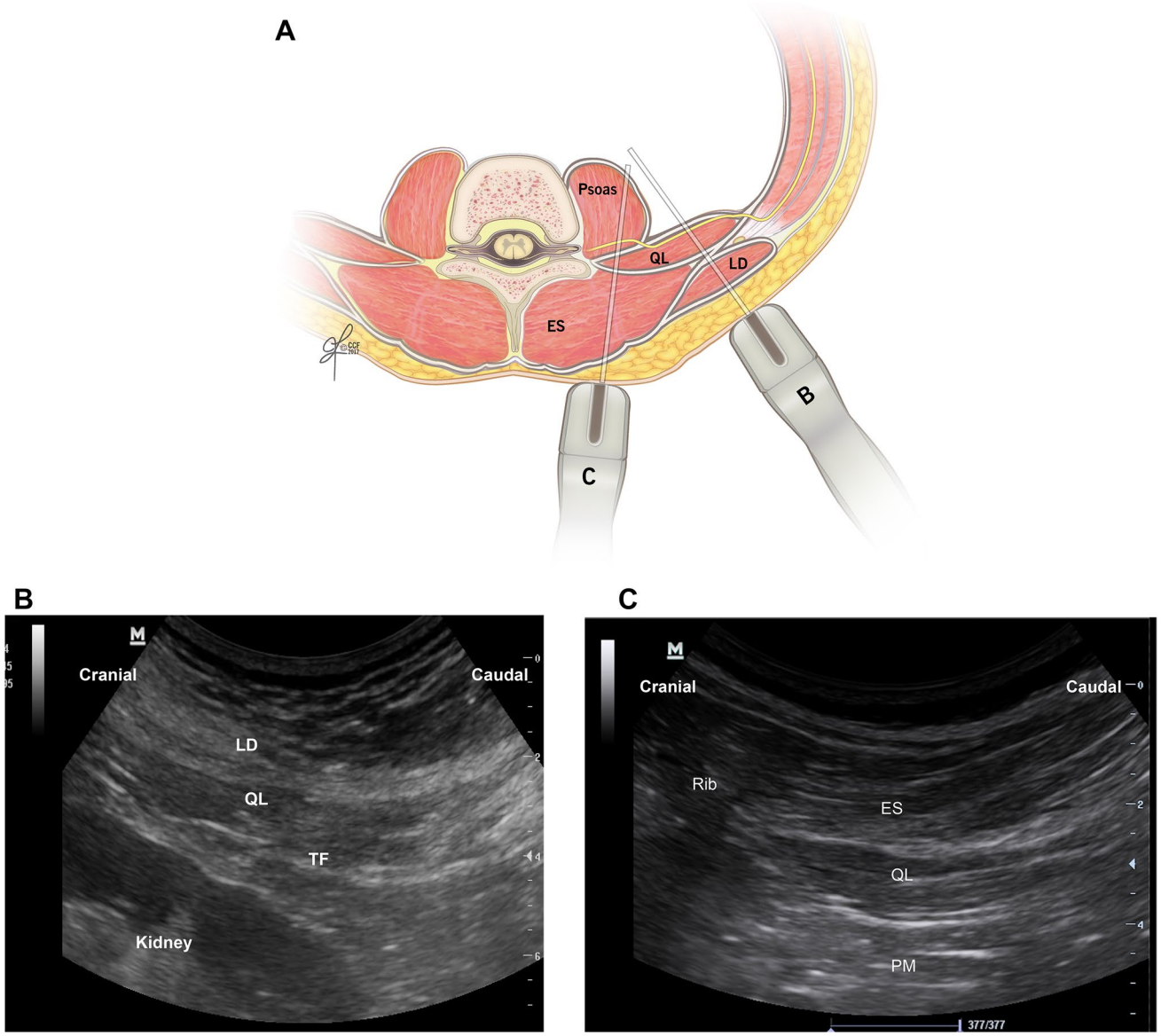

Fig. 1 **a** Transverse section at level of L 1–2 with 2 parasagittal probe locations (**b** lateral, **c** Medial). **b** Parasagittal ultrasound image showing the sonographic landmarks of the lateral probe location, including latissimus dorsi muscle, quadratus lumborum muscle, transversalis fascia, kidney, and perinephric fat. **c** Parasagittal ultrasound image showing the sonographic landmarks of the medial probe location, three muscles (EM, QL, and PM) in relation with the last rib. *QL* quadratus lumborum muscle, *LD* latissimus dorsi muscle, *ES* erector spinae muscle, *PM* psoas major, *TF* transversalis fascia

recovery unit (PACU) and every 4 h on the ward thereafter. The extent of sensory dermatomal block as determined by a loss of cold sensation to ice was assessed daily around 9 AM by the acute pain team. Pain scores and opioid consumption expressed in mg of morphine equivalent doses (MED), in the first 96 h following surgery, were recorded.

Subcostal approach to anterior quadratus lumborum (QL) block technique

The patients were positioned in lateral decubitus with the spine flexed. A curvilinear 2–5 MHz ultrasound transducer (SonoSite S-Nerve, Bothell, WA or Mindray M7, DS) was placed posteriorly below the 12th rib approximately 6–8 cm from the spinous process in a parasagittal oblique plane tilted medially at L1-2 level (Fig. 1a–c). The QL muscle could be visualized at its point of insertion on the lower border of the 12th rib, and the latissimus dorsi (LD) muscle was noted posterior (superficial) to the QL muscle, while the diaphragmatic zone of apposition, the kidney, and perinephric fat and fascia were anterior (deep) to the QL muscle and transversalis fascia. (Fig. 1b), When the ultrasound transducer was moved further medially, the LD muscle became thinner and could no longer be visualized. At this location, the erector spinae (ES) muscle could be visualized posteriorly, and the psoas major (PM) muscle anterior to the QL muscle (Fig. 1c). We performed the block at either of those ultrasound probe locations (Fig. 1b, c).

A 18 G Tuohy needle was advanced in plane in the caudal-to-cranial direction under ultrasound guidance until the needle tip was positioned anterior to the QL muscle and between the investing layer of the QL muscle and the transversalis fascia (anterior layer of the thoraco lumbar fascia, ATLF) or between the QL and PM muscles. The distance between these two-needle tip final locations was very small

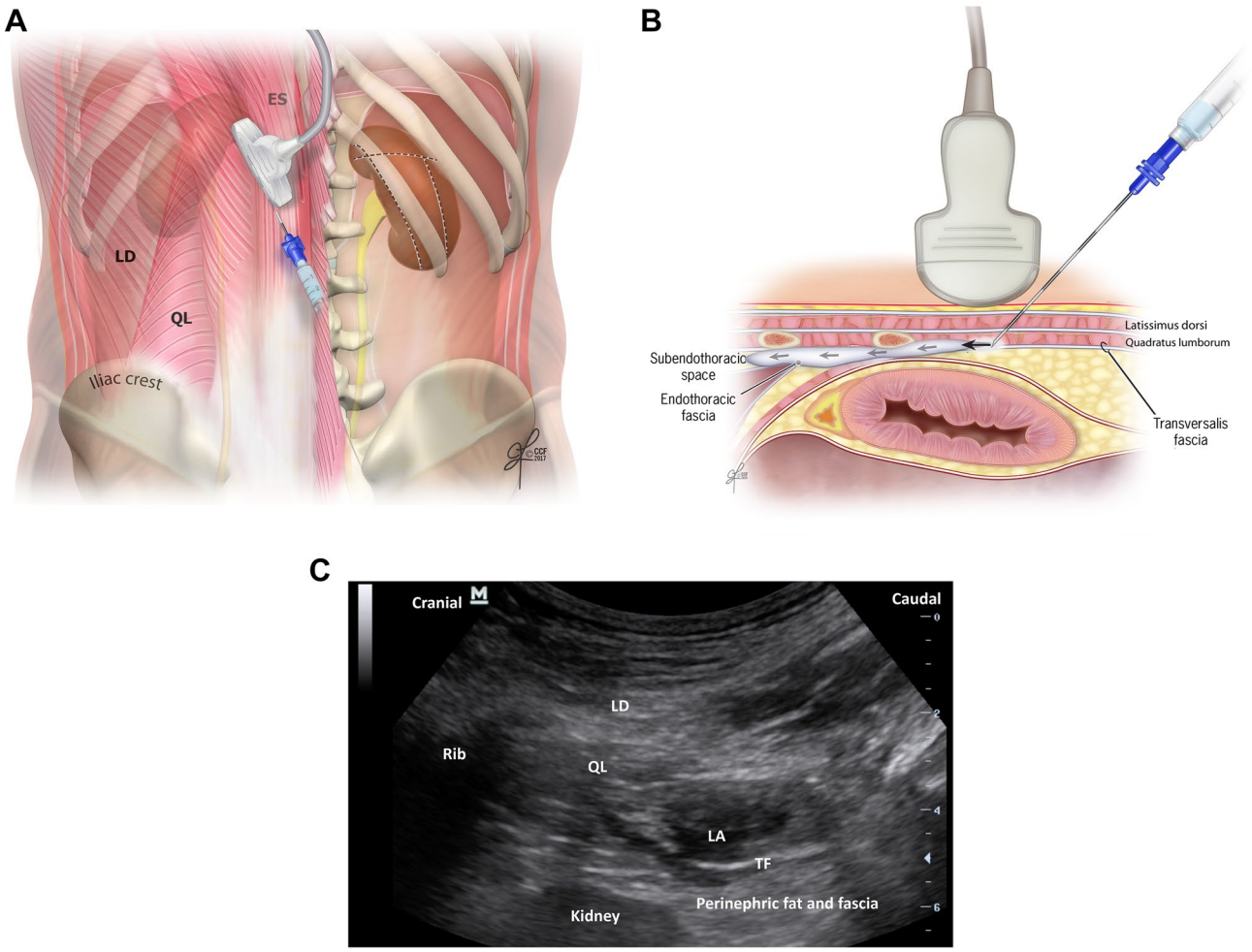

Fig. 2 **a** Ultrasound probe location from the back in lateral position, the trajectory of the needle, and the back muscles. **b** Sagittal section illustrates the needle trajectory and LA spread in cranial direction posterior to the transversalis fascia. **c** Ultrasound image showing the local anesthetic spread between the QL muscle and transversalis fascia. *QL* quadratus lumborum muscle, *LD* latissimus dorsi muscle, *ES* erector spinae muscle, *TF* transversalis fascia, *LA* local anesthetic

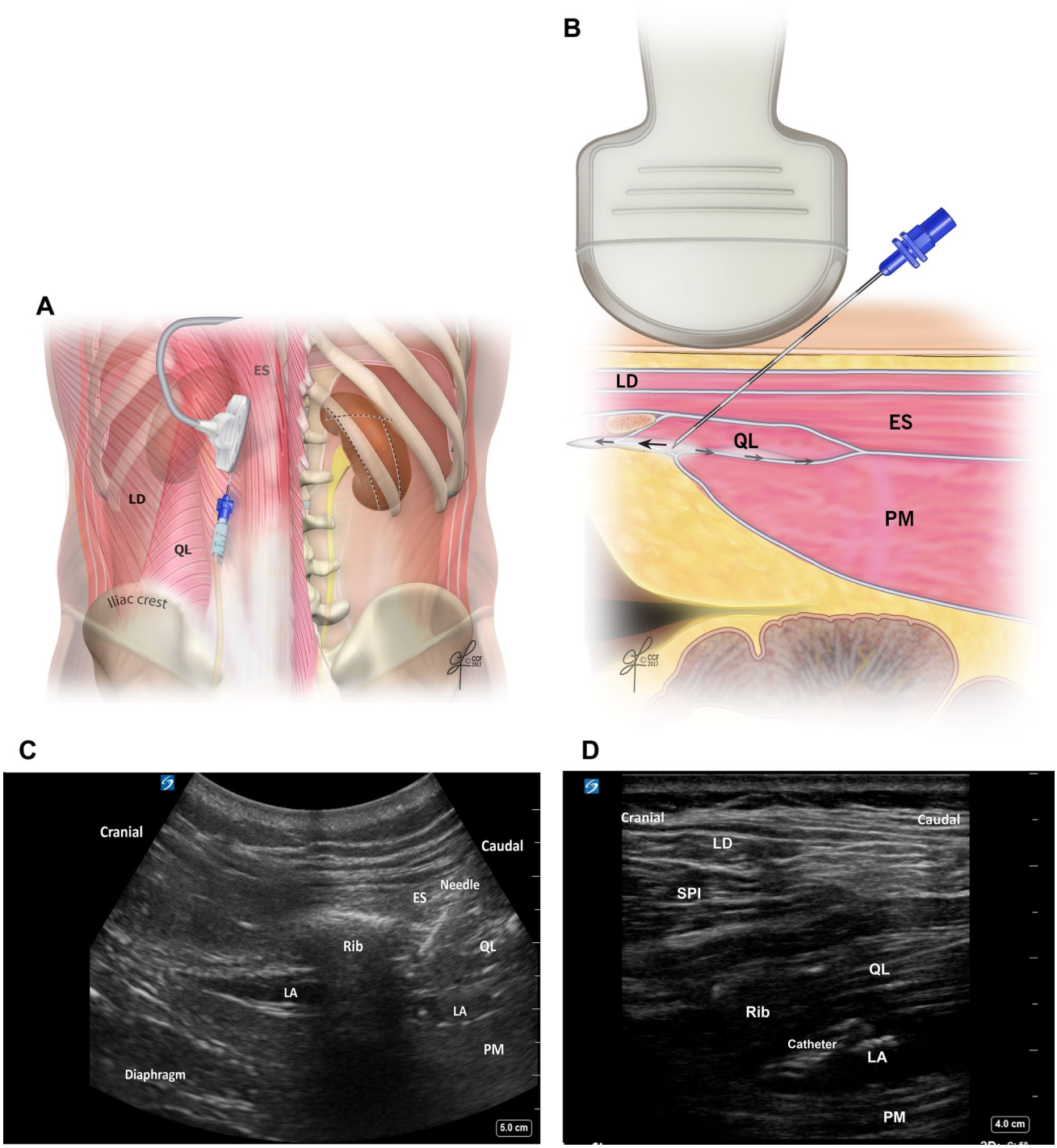

Fig. 3 **a** Ultrasound probe location from the back with medial direction, the trajectory of the needle, and the back muscles. **b** Cross-sectional sagittal view of the needle trajectory and LA spread in cranial direction between QL and PM. **c** Long-axis ultrasound image of LA (local anesthetic) spread between QL (quadratus lumborum muscle) and PM (psoas major) muscle. LA was seen in this patient spreading cephalad to the last rib and superficial to the diaphragm. **d** Ultrasound showing the LA and catheter in the anterior subcostal location (the catheter under last rib). *QL* quadratus lumborum muscle, *ES* erector spinae muscle, *PM* psoas major, *TF* transversalis fascia, *LA* local anesthetic, *LD* latissimus dorsi muscle, *SPI* serratus posterior inferior

and clinically insignificant in interfascial plane blocks (Figs. 2, 3). A click could often be felt as the needle tip penetrated the anterior investing fascia of the QL muscle. Hydrodissection using local anesthetic (LA) further helped to confirm the final needle tip position, anterior to the QL muscle at close proximity to the 12th rib. After a negative

aspiration, 1–3 mL of bupivacaine 0.25% was injected to produce LA spread cranially between the QL and PM muscles towards the 12th rib. The corresponding ultrasonographic sign was a lunar-shaped hypoechoic fluid collection observed between the long axis of the PM and QL muscles accompanied by an anterior displacement of the ATLF. In some patients, LA was seen spreading cephalad to the 12th rib (between the 12th and 11th rib) and superficial to the diaphragm (Fig. 3c) (Video 1).

After incremental injection of a total of 15 mL of bupivacaine 0.25%, an indwelling catheter (InfiltraLong Catheter—PAJUNK—Germany) was advanced until 2–4 cm had passed the needle tip (Fig. 3d). An additional 10 mL of bupivacaine 0.25% was injected through the catheter to produce a similar LA spread pattern as the needle injection. Continuous QL block was maintained by a ropivacaine 0.2% infusion at 8 mL/h and patient-controlled bolus 12 mL/h.

Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS for Windows, version 15.0; SPSS 2015 Inc., Chicago, Illinois). The median numeric pain rating scale (NRS) was calculated for every post-operative day (POD 0) through (POD 3). The daily opioid medication administration was obtained during the same timepoints and converted to (MED). Pain scores and opioid medication intravenous and oral use recorded between the time of emergence and 24 h were grouped as POD 0. This time period included patient's stay in PACU. The blocked dermatomes (mean) were recorded during the study period.

Table 1 Demographic and clinical data of the patients

Patients baseline characteristics	Value
Age in years	53.0 ± 16.2
Sex	
Male (%)	12 (54%)
Female (%)	10 (45%)
BMI (Kg/m^2)	29.1 ± 5.5
ASA physical status	
2	4 (18%)
3	12 (54%)
4	6 (28%)
History of chronic pain (%)	3 (13.6%)
Average consumption of Ropivacaine (mg)	1512 mg ± 533

Data are presented as mean ± standard deviations or number (%)

BMI Body Mass Index, *ASA* American Society of Anesthesiologists

Results

This case study included 22 patients; open renal allotransplantation in 14 patients (60%), partial nephrectomy in 6 (30%), and radical nephrectomy in 2 (10%). The QL block was administered according to patient's preference (not to have neuraxial analgesia) or at the discretion of the anesthesiologist.

The demographic data of the patients are illustrated in Table 1. Dermatomal sensory loss (as shown in Fig. 4) ranged from T6 (highest) to L2 (lowest) with T8–T12 being the most frequently affected dermatomes and the number of blocked segments was 3 (mean 2.8).

The data for median pain scores at rest and mean opioid consumption measured in morphine equivalent dose (MED) are presented in Fig. 5. The median (interquartile range Q1, Q3) of NRS pain score was 3.7 (2.8–5.5), 3.3 (2.4–4.7), 2.9 (1.9–3.6), and 2.3 (1.0–4.2) on POD0, POD1, POD2, and POD3, respectively. The mean (standard deviation) of daily oral MED was 219.2 mg (SD 183.5 mg) on POD 0, and 92.3 mg (SD108.3 mg), 44.0 mg (SD 45.5 mg), and 34.0 mg (SD 35.5 mg) on POD 1, POD2, and POD3, respectively. Other supplemental pain medications administered were not standardized thus varied among patients. There were no complications reported.

Discussion

Subcostal approach to anterior QL block has been used effectively for analgesia following hip arthroplasty [7], lower abdominal surgery [8], and nephrectomy [9] with reported sensory loss between T 8 and L 2. In contrast, other anterior transmuscular QL block approaches could only reach a peak sensory level at T11 [10, 11]. In this study, we observed sensory loss between T6–7 and L1–2 following the subcostal anterior QL block injection in consistent with our cadaveric study findings [6]. Local anesthetic injected in a cephalad direction posterior to the fascia transversalis likely gains access to the thoracic paravertebral space through a communication pathway posterior to the arcuate ligaments [12].

In this case series, we were able to block many of the dermatomal levels responsible for visceral and somatic pain transmission from the kidney and subcostal incision, i.e., T6-7 to L1-2. The mean number of dermatomes covered were 3 (mean 2.8) during the post-operative period and mainly varied between T8 and T12.

Subcostal anterior QL approach may offer some theoretical advantages over other anterior QL approaches.

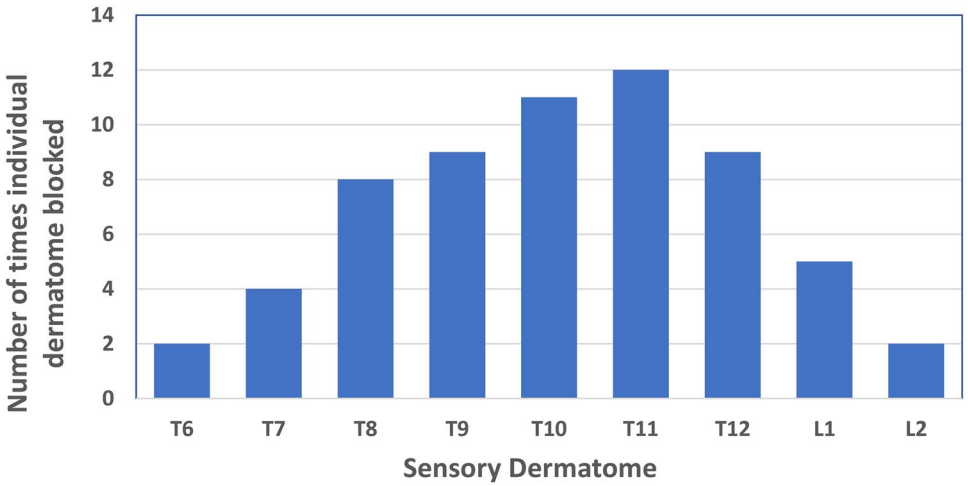

Fig. 4 Bar graph showing the number of times each individual sensory dermatome was blocked (*Y*-axis) and *X*-axis represents sensory dermatomes range from T6-L2

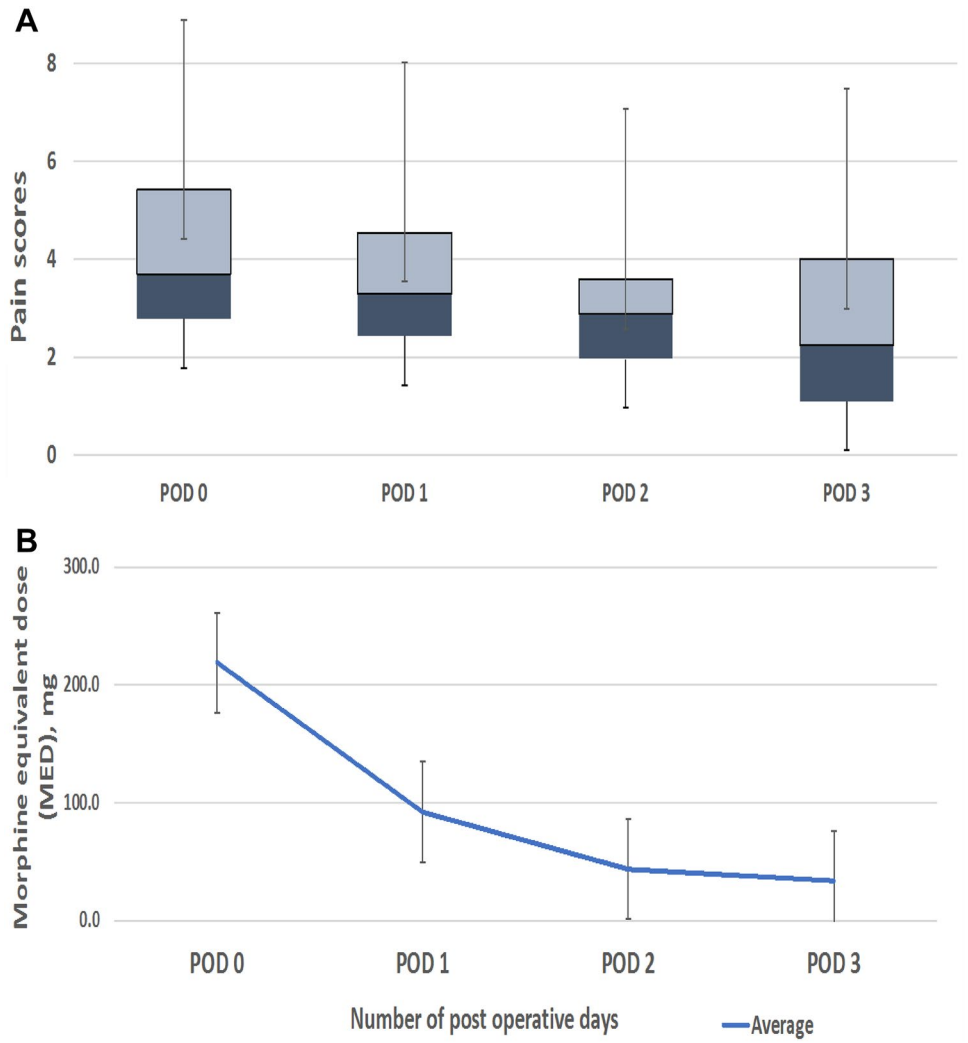

Fig. 5 **a** Box-and-whisker plot demonstrating the upper and lower extremes of pain scores. The ends of the box are the upper and lower quartiles of pain scores among each post-operative day, and the box spans represent the interquartile range. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the highest and lowest observations. *Y*-axis represents pain scores and *X*-axis each post-operative day. **b** Line plot demonstrates average daily opioid consumption in mg of morphine equivalent doses (MED) for each patient in the study on *Y*-axis for each post-operative day as indicated on *X*-axis. The values reported were the average opioid consumption of all patients for each timepoint. Error bars represents variability of data to indicate one standard error (SE) in measurement

1. Provide a higher sensory blockade up to the mid thoracic dermatomes. The needle insertion site is more cephalad, and we were able to visualize the LA cephalad to the last rib and superficial to the diaphragm in some patients. Although we were unable to visualize the arcuate ligament in all patients, we were able to

guide the needle and observe LA in close proximity to the 12th rib in real time at the caudal end of the QL muscle.
2. Observe LA spread in the craniocaudal direction in the longitudinal plane anterior to the QL muscle towards the 12th rib. This ensures that the LA is not injected intramuscularly or confined to small area. In comparison, it may be more difficult to evaluate the extent of local anesthetic spread with the (TOP) anterior QL approach, because scanning is in the transverse plane unless the ultrasound transducer is rotated to the parasagittal plane during or after injection.
3. Placement of the catheter tip more cranial near the T 12 level by catheter threading in the cranial direction. In addition, the final catheter tip position is likely higher than the needle insertion site (L1) thus potentially closer to the arcuate ligament which favors LA spread in the cranial direction.

This case series has a number of limitations. The overall postoperative pain scores remained high in the 4–5/10 range. This is possibly due to 3 patients with a history of chronic pain with high baseline pain scores and pain in other parts of the body. We reported the blocked dermatomal levels as a mean during the study period.

This retrospective analysis included only a small sample size thus limits the value of statistical analysis. Furthermore, technical challenges encountered were difficulty in distinguishing the attachment of the QL muscle to the 12th rib in patients when BMI exceeded 30 and failure to visualize the lateral arcuate ligament in all patients. In addition, needle manipulation was challenging in thin and short patients, because the low frequency ultrasound transducer is big thus occupying the entire space between the iliac crest and the 12th rib. Future prospective studies comparing outcomes in patients with QL versus placebo, and other blocks are warranted.

Conclusion

Subcostal anterior QL block provide dermatomal blockade between T6-7 and L1-2. Future trials are needed to compare the analgesic efficacy of this approach with other QL block approaches.

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Conflict of interest The other authors declare no conflicts of interest.

Ethical approval Dr. Vincent Chan received honorarium from BBraun, Aspen Pharma, and SonoSite and was on the medical advisory board of Smiths Medical.

Figures' permissions Permission to use images was obtained from the Cleveland Clinic Department of Art Photography.

Clinical reports This report describes human research. Cleveland Clinic Institutional Review Board (IRB 15–573) (date of approval—12 May 2015). The requirement for written informed consent was waived by the Institutional Review Board.

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