Quadratus Lumborum Blocks

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INTRODUCTION

A variant of the ultrasound-guided transversus abdominis plane (TAP) block (initially termed a no-pops or posterior TAP block) was first described in an abstract, in which local anesthetic injection occurs at the point where the internal oblique and transversus abdominis muscles taper off and abut the lateral border of quadratus lumborum (QL) muscle [1].

The term quadratus lumborum block first appeared in 2 case reports published in 2013, both of which used the term US-guided posterior TAP block but emphasized the importance of the quadratus lumborum muscle as a

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sonographic landmark \[2,3\]. In the same year, a transmuscular approach to the ultrasound-guided QL block (TQL) was described by Børglum and colleagues \[4\]. Development of further variations of the QL block (paramedian sagittal oblique [anterior subcostal]) approach \[5\] and the transverse oblique paramedian transmuscular (TOP TQL) approach \[6\] have been recently described.

**ANATOMY**

The QL muscle is a posterior abdominal wall muscle lying dorso-lateral to the psoas major muscle along the posterior abdominal wall \[7,8\]. The QL muscle originates from the inner lip of the posterior part of the iliac crest and inserts into the lower medial border of the twelfth rib, and by 4 small tendons from the apices of the transverse processes of the L1-L4 lumbar vertebrae. The subcostal, iliohypogastric, and ilioinguinal nerves pass between the QL muscle and transversalis fascia (Fig. 1).

The thoracolumbar fascia (TLF) provides a retinaculum for the paraspinal and posterolateral abdominal wall muscles \[7,8\]. The TLF includes a posterior layer, which is attached to the spinous processes and wraps around the paraspinal

![Fig. 1. QL muscle from the front. On the left side, the psoas muscle is cut away showing the ventral rami of the spinal nerve roots passing in front of QL. QL, quadratus lumborum; TP, transverse process. (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved.)](image-url)
muscles, reaching a raphe on its lateral border. In the 2-layered model, the anterior layer of the TLF separates the paraspinal muscles from the QL muscle. This layer extends medially to the tips of the lumbar transverse processes. In this model, the fascia on the anterior aspect of the QL muscle is also referred to as the transversalis fascia (TF) [7,8]. The TF covers the peritoneal surface of the transversus abdominis muscle and continues postero-medially, covering the anterior side of the investing fascia of both the QL and psoas major (PM) muscles (Fig. 2).

The fascial layers in thoracic and lumbar regions are described separately in anatomic textbooks; however, the thoracic and lumbar paravertebral spaces are in continuity, signifying that this pathway or compartment between the thoracic and lumbar paravertebral spaces is well described [9].

The lateral branches of the thoracoabdominal nerves arise proximal to the angle of the rib and emerge through the overlying muscles in the midaxillary line to supply the skin of the lateral thorax, abdomen, iliac crest, and the upper thigh. The subcostal and iliohypogastric nerves pass over the anterior surface of the QL muscle [10].

Vital structures that are susceptible to injury include the kidney, spleen, and liver.

The left kidney, at the level of eleventh rib to second lumbar vertebra, and the right kidney in a slightly lower position, twelfth rib to the upper part of the third lumbar vertebra are both at potential risk of injury (Fig. 3).

If the block is performed above L3, or if a subcostal approach is used, caution must be taken to avoid kidney injury. The lower pole of the kidneys lies anterior to the QL muscle and can reach as low as the L3 level on the right. The kidneys are separated from the QL muscle by perinephric fat, the posterior layer of renal fascia, and the transversalis fascia [11]. The perinephric space contains a rich network of blood vessels and lymphatics, which facilitate development of perinephric hematoma and the spread of infection if it is penetrated by a needle. The TF is not continuous posteriorly with the posterior layer of the renal fascia. The posterior renal fascia (Zuckerkandl fascia or posterior Gerota fascia) is a thick fascia that continues anterolateral as the lateroconal fascia and fuses with the parietal peritoneum and lies against the transversalis fascia [12] (Fig. 4).

**MECHANISM OF LOCAL ANESTHETIC SPREAD**

There is currently no consensus on the mechanism(s) of action of QL blockade. The endothoracic fascia inferiorly is continuous with the fascia transversalis dorsal to the diaphragm. Saito and colleagues [9] demonstrated spread of dye from the thoracic paravertebral space to the retroperitoneal lumbar paravertebral region through the medial and lateral arcuate ligaments. This pathway has been demonstrated clinically and in cadaver studies [13]. Injection anterior to the QL muscle in the tissue plane between the QL and PM muscles can spread cranially under the medial and lateral arcuate ligaments posterior to the fascia transversalis (anterior layer of the TLF), thereby spreading into the thoracic paravertebral space posterior to the endothoracic fascia. This subendothoracic fascial spread from the retroperitoneal space in relation to the QL.
Fig. 2. (A) Cross-section of the QL muscle and posterolateral abdominal wall and its relation to the ventral rami, lumbar nerve, the abdominal branches of the lumbar arteries; the different layers of the thoracolumbar fascia (TLF), renal fascia, and the anatomic relations of the QL muscle to the anterior, middle, and posterior layers of the TLF. (B) Cross-sectional ultrasound image of the posterolateral abdominal wall and scanning technique to identify QL, psoas, and ES muscles at the level of transverse process (top left, transverse process view) and between 2 transverse processes (bottom left, intertransverse process view) with correlating ultrasound images on the right. AP, articular process; EO, external oblique; ES, erector-spinae (sacrospinalis); IO, internal oblique; LD, latissimus dorsi; QL, quadratus lumborum; TA, transversus abdominis; TF, transversalis fascia; TP, transverse process. ([A, B] Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved.)
muscle to the lower thoracic paravertebral space is believed to be the advantage of the transmuscular (anterior) QL block approach versus other (lateral and posterior) QL approaches and other TAP truncal blocks [14].

The transmuscular approaches target local anesthetic injection between the quadratus lumborum and psoas major muscles, which have been demonstrated to allow cephalad spread via a posterior pathway to the medial and lateral arcuate ligaments (of the diaphragm) and into thoracic paravertebral spaces [14]. However, other cadaveric studies of the transmuscular QL block approach demonstrated injectate spread either only to the lumbar paravertebral spaces [15,16] or in a single cadaveric model, no spread to the paravertebral space [17]. In addition, other studies have demonstrated spread to the lumbar nerve roots within the psoas muscle compartment, suggesting possible efficacy for hip procedures [15,16]. More recently, the subcostal paramedian sagittal approach (with local anesthetic

Fig. 3. Kidneys and their relation to the twelfth rib. Note the lower pole of the right kidney may extend as caudal as the upper third of the L3 vertebra. (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved.)

Fig. 4. Relationship of the kidney with the surrounding fascia. (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved.)
injected anterior to quadratus lumborum just caudal to the twelfth rib) demonstrated injectate spread to the ilioinguinal and iliohypogastric nerves and cephalad spread through the arcuate ligaments to consistently spread to T9-T12 spinal nerve roots, with frequent spread to T8 (83%) and T7 (67%) spinal nerve roots. Thus, the available published anatomic studies suggest that: (1) the location of the local anesthetic injection should be anterior to the QL muscle with the transmuscular approach vs lateral (QL block 1) or posterior (QLB 2) to the QL muscle; (2) a more cephalad (subcostal) injection point enables cephalad spread (via the arcuate ligaments) to the thoracic paravertebral space.

**POINTS OF INJECTION, NOMENCLATURE**

The lack of consensus on the mechanism of spread (and analgesic mechanism) for QL block may be partially attributed to the variable descriptions of the approaches (transducer placement, needle direction, and most importantly, needle tip target location). A recent review article [18] and letter to the editor [19] published in *Regional Anesthesia and Pain Medicine* provided an excellent framework for renaming (classifying) QL blocks based on the anatomic location of needle tip placement in relation to the QL muscle, as this is most likely to influence the pattern of injectate (local anesthetic) spread, and thus clinical effect. Based on the anatomic location of needle tip placement in relation to the QL muscle, QL1 would be named the lateral QL block; the QL2 block

![Diagram](https://example.com/diagram.png)
would be called the posterior QL block, and the transmuscular QL block would be an anterior QL block (Fig. 5). These QL blocks are interfascial plane blocks. Additionally, a recent study described the target location for local anesthetic injection within the substance of the QL muscle (intramuscular or interfascial plane QL block) [20,21].

Lateral quadratus lumborum block
The needle can be directed from anterior to posterior toward the junction of tapered transversus abdominis muscle and lateral border of QL muscle. Local anesthetic will then be deposited in the lateral border of QL muscle at the junction with the transversalis fascia, and penetrate the aponeurotic attachment of the transversus abdominis muscle (potential space medial to the abdominal wall muscles and anterolateral to QL muscle).

Posterior quadratus lumborum block
By advancing the needle more posteriorly (superficially), local anesthetic can be deposited posterior to the lateral edge of the QL muscle, with local anesthetic injection in the interfascial plane between the posterior border of the QL muscle and the middle thoracolumbar fascia (located anterior to latissimus dorsi [LD] and erector spinae [sacrospinalis] muscles).

Anterior quadratus lumborum block (transmuscular quadratus lumborum)
The needle can be advanced either from posterior through erector spinae muscle or anterior through the LD muscle and then through QL muscle (transmuscular approach, type, anterior) to deposit the local anesthetic in the fascial plane between the QL and psoas major muscles.

This includes the transmuscular QL (TQL) block [4,14], the transverse oblique paramedian (TOP) TQL [6,14], and caudal-to-cranial subcostal paramedian sagittal TQL [5,22].

THE ANTERIOR SUBCOSTAL PARAMEDIAN OBLIQUE SAGITTAL TRANSMUSCULAR QUADRATUS LUMBORUM BLOCK
To obtain an oblique sagittal view of QL muscle, the ultrasound transducer is positioned approximately 6 to 8 cm (variable with patient body habitus) lateral to the lumbar spinous process at the L1-2 level with a parasagittal orientation just above the cross-over point of the erector spinae and the QL [5,22]. Using a curvilinear transducer with the orientation marker of the ultrasound cephalad, it is shifted cranially, and the probe is slightly tilted medially. In addition, the cranial part of the ultrasound probe is slightly tilted medially and the caudal part of the probe laterally (thus, the paramedian oblique approach). The needle is advanced in plane with ultrasound in a caudal-to-cephalad direction, through the LD then QL muscles. Local anesthetic is deposited anterior to the QL muscle, between the QL muscle and the anterior layer of the thoracolumbar fascia (ATLF). The needle tip is then advanced more cephalad, and local anesthetic, after negative aspiration, is deposited incrementally, observing spread in
cephalad direction close to the twelfth rib, with a crescent-shaped distribution of local anesthetic with anterior displacement of the ATLIF. Fig. 6.

PATIENT POSITIONING AND EQUIPMENT SELECTION

Ultrasound transducer
Low-frequency (5-2 MHz) curved array ultrasound transducers can be used to provide a simultaneous adequate visualization of the 3 lateral abdominal wall muscle layers, the QL muscle, retroperitoneal space including the kidney, transverse processes, and the adjoining lumbar paravertebral area. A high- or intermediate-frequency transducer may more accurately appreciate the fascial plans, and may suffice in some patients, particularly in children. The orientation marker can be directed laterally for a transverse scan andcranially for parasagittal scan.

Patient position

Lateral
The lateral decubitus position gives more exposure to the neuraxial structures, provides more stability in handling the ultrasound probe and needle, and is often more comfortable when performed in awake patients. All 3 approaches may be performed in this position.

Supine
It is feasible to perform QL block 1 and QLB 2 in the supine position and lateral tilt of the torso with wedge under the lower flank, tilting the transducer probe posteromedially. The disadvantage of the supine position is impaired visualization of the lumbar paravertebral area. The transmuscular (anterior) approaches are not feasible in the supine position.

Prone
The procedure can also be performed in the prone position with a pillow under the abdomen. However, positioning the patient can be logistically difficult, especially postoperatively after abdominal procedures and in the anesthetized-intubated patient.
Sitting
With the TOP TQL [6] and subcostal approach [5], the patient can be positioned in the sitting position, which facilitates bilateral block procedure without patient repositioning. This may be done either preoperatively or postoperatively in the postanesthesia care unit (PACU). It may prove technically difficult to place an anesthetized-intubated patient in the sitting position.

CLINICAL PEARLS
The QL muscle is attached to the apices (lateral tip) of transverse process, which once identified, provides orientation for the operator.

If the QL muscle is small and difficult to delineate, the ipsilateral hip joint is abducted and laterally flexed toward the same side of the block to contract the QL muscle, which will temporarily will thicken the QL muscle. Generally, QL is hypoechoic, in contrast to the more hyperechoic psoas muscle, but similar in echogenicity to the kidney.

While performing the block especially with the subcostal approach, it is common to visualize the lower pole of the kidney and lower lobe of the liver and spleen. Caution should be taken to avoid any visceral injury.

Apply color Doppler before insertion of the needle to detect the abdominal branches of the lumbar arteries on the posterior aspect of the QL muscle or any other vessels close to the transverse process, and on the intended track of the needle.

The tactile feedback (as pops) when encountering different fascial planes is not accurate in QL blocks because of complexity of the anatomic planes, multilayered components of the TLF, muscle, and the approach angle. Therefore, the visual confirmation using ultrasound and hydro dissection should be used.

With the TQL block, the local anesthetic is deposited in the plane between the QL and psoas major muscle. Both during administration of and subsequent to administration of the local anesthetic solution, the transducer should be moved from the transverse to the longitudinal position. With the curvilinear probe in the longitudinal position, the local anesthetic can be seen to spread cephalad from the iliac crest to the twelfth rib.

DOSE AND VOLUME OF LOCAL ANESTHETIC
This is a tissue plane block and thus requires a large volume of local anesthetic to obtain a reliable block. Volumes of 0.2 to 0.4 mL/kg (20–30 mL) unilaterally are usually recommended. The dose of local anesthetic needs to be considered for the size of the patient to ensure maximum safe dose is not exceeded, especially with bilateral blocks. The QL muscle and tissue plans are vascular areas, and as described, the abdominal branches of the lumbar arteries are in the vicinity of the local anesthetic injection.

Murouchi [21] has investigated the local pharmacokinetics with 1 type of the QL blocks (posterior QL), where the QL block resulted in a widespread and long-lasting analgesic effect compared with historical controls after laparoscopic ovarian surgery and resulted in lower peak arterial ropivacaine concentrations.
compared with those of lateral transversus abdominis plane block after 150 mg ropivacaine injection.

INDICATIONS
All the indications described are based on small studies, case reports, and personal communications [2,3,23,24]. Any type of operation that requires intra-abdominal visceral pain to be covered plus abdominal wall incisions as cephalad as T6 and as caudal as L1. Midline incision and laparoscopic procedures require bilateral blocks for adequate coverage: exploratory laparotomy, large bowel resection, ileostomy, open/laparoscopic appendectomy, cholecystectomy, inguinal hernia repair (open or laparoscopic), scrotal surgery, cesarean section (citation), total abdominal hysterectomy, chronic pelvic floor pain, open prostatectomy, renal transplant surgery, percutaneous nephrolithotomy or nephrolithotripsy, nephrectomy, abdominoplasty, iliac crest bone graft, and total hip arthroplasty.

CONTINUOUS QUADRATUS LUMBORUM BLOCKADE
A continuous technique has recently been successfully used for many indications, including major colorectal surgeries, nephrectomy, kidney transplant, (Hesham Elsharkawy, unpublished data, 2016), with infusion of local anesthetic up to 1 week without reported complications.

A 17- or 18-gauge Tuohy needle is advanced utilizing the in-plane needle insertion approach. The needle is advanced until it enters the site of injection. After a negative aspiration is confirmed, 1 to 3 mL of local anesthetic are injected slowly to confirm that the Tuohy needle has penetrated the appropriate fascial layers. A total of 10 mL of the same solution is then injected slowly; a catheter is subsequently advanced 2 to 4 cm past the tip of the needle. For continuous infusions, ropivacaine at concentrations of 0.1% to 0.2% is used with a basal infusing rate of 6 to 8 mL an hour and patient-controlled bolus of 5 to 12 mL every hour.

QUADRATUS LUMBORUM BLOCK IN THE ANTICOAGULATED PATIENT
The risks of bleeding complications are not known, and there are no specific recommendations. Because of the vascularity of the area, the potential for retroperitoneal spread of hematoma, and proximity of the transmuscular approach to the paravertebral area and the lumbar plexus, The American Society of Regional Anesthesia guidelines should be considered in patients on anticoagulants who are receiving QL block (especially the anterior TQL approaches), either single shot or catheter [25]. Risk versus benefits should be carefully considered.

SUPPORTING EVIDENCE
There are few published clinical data, particularly from randomized controlled trials (RCTs); most of the published data are from case report, case series, and small studies. QL blocks result in a wider sensory blockade compared with TAP block when performed using a similar volume of local anesthetic.
anesthetic [18]. The traditional ultrasound lateral TAP block has been shown to provide sensory analgesic coverage from T10 to T2-L1. Thus, it is not indicated for upper abdominal incisions. In contrast, the subcostal TAP approach has been shown to provide sensory analgesic coverage only from T6 to T10. Thus, it is not indicated for lower abdominal incisions. In order to provide complete coverage for extensive abdominal surgery (from T6-7 to L1), 4 injections (catheters) are required, which can be done but may be impractical in daily practice [23].

Kadam described ultrasound-guided QL block with single-shot injection of 0.5% ropivacaine in a patient undergoing laparotomy for excision of a duodenal tumor. The block resulted in appropriate pain control during the first day [3].

Visoiu described a similar block with placement of a catheter in a pediatric patient undergoing colostomy takedown [2]. Other case reports have shown that local anesthetic injection around the QL is effective in providing pain relief after various abdominal operations [21,26,27].

A bilateral continuous QL block was performed as an alternative to opioid analgesia in a patient who underwent colorectal surgery and experienced respiratory arrest on postoperative day 1 because of excessive opioid use. Cases demonstrate that bilateral continuous QL catheters can provide extended postoperative pain control [26]. QL blocks have been used in pediatric patients undergoing pyeloplasty, providing good analgesia [27]. There are case reports of using the posterior approach and continuous transmuscular analgesia after total hip arthroplasty [24,28,29]. An RCT comparing posterior QL block with control (QL block with 0.9% normal saline) after caesarean section demonstrated effective (opioid-sparing) analgesia in combination with a typical postoperative analgesic regimen [30]. In another RCT comparing directly posterior QL block with midaxillary lateral TAP block, the QL block was more effective in reducing morphine consumption and demands than transversus abdominis plane blocks after cesarean section up to 48 hours post-operatively [31]. Bilateral QL catheters have also been reported as a method for analgesia for breast flap reconstruction [32].

**SUMMARY**

There is clinical interest for the QL block as an expanding appealing alternative to neuraxial blocks and possible superior analgesic efficacy compared with traditional TAP blocks. The available limited literature and experiences demonstrate that QL blocks have the potential to produce sensory blockade and analgesia along the lower thoracic and lumbar regions, and can potentially be an analgesic modality for abdominal and hip surgeries. Current limitations must be acknowledged with realistic expectations. Well-designed, larger studies are needed in the future, not only to clarify indications (and contraindications), but also to supports analgesic efficacy (vs placebo, TAP blocks, and neuraxial block), complications, and mechanism(s) of analgesic efficacy.
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References


