CASE REPORT

Novel use of combination of electromyography and ultrasound to guide quadratus lumborum block after open appendicectomy

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SUMMARY

The quadratus lumborum (QL) block facilitates the administration of anaesthesia to the anterior abdominal wall. The use of ultrasound (US) improves the accuracy of the QL block and reduces the risk of adverse events. Electromyography (EMG) in combination with US for muscle plane blocks has not been described previously. We postulated that the addition of EMG-guided needle positioning might assist the execution of this block. This case report describes the first use of combined needle EMG and US to carry out a QL block performed for postoperative analgesia following an open appendicectomy.

BACKGROUND

Modalities that improve the accuracy of needle positioning reduce the risk of complications such as puncture of intra-abdominal structures, femoral nerve palsy or local anaesthetic toxicity when carrying out abdominal plane block.[1] Needle electromyography (EMG) has not been used to assist in needle positioning for these blocks to date. This case report demonstrates the first described use of needle EMG to assist needle positioning in combination with ultrasound (US) for a quadratus lumborum (QL) block for postoperative analgesia after an open appendectomy.

CASE PRESENTATION

A 19-year-old boy presented to the emergency department in a university teaching hospital with acute onset of central abdominal pain migrating to the right iliac fossa. He was of slim build and had no medical history. Airway examination was normal. A clinical diagnosis of acute appendicitis was made and the patient was brought to theatre the following morning for an open appendicectomy.

TREATMENT

The patient consented to receive general anaesthesia (GA) and QL block for postoperative analgesia. GA was induced with 100 μg intravenous fentanyl and 250 mg propofol. Endotracheal intubation (size 8.0 cuffed endotracheal tube) was facilitated by 70 mg rocuronium bromide (Esmeron) and anaesthesia was maintained using sevoflurane 2%–3% in 40% oxygen in air. Surgery was performed using an open approach via a Lanz incision and a standard electrocautery technique. Intraoperative analgesia consisted of intravenous paracetamol 1000 mg, dexketoprofen 50 mg and 4 mg morphine. Dexamethasone 4 mg was administered for prophylactic antiemesis. Following surgical closure, muscle relaxation was measured using a train-of-four monitor and four twitches were noted with no fade. The patient was positioned in the left lateral decubitus position for a QL block. Dantec Klavis (Natus Neurology, Middleton, Wisconsin, USA) EMG was connected to a Miobot 27G concentric needle EMG (Spes Medica, Genova, Italy) and a ground electrode was placed on the patient's skin. Ultrasound Macro Maxx (Sonosite, Bothell, Washington, USA) was prepared and a 6–13 Hz linear probe was covered with a sterile plastic sheath. The skin was prepared using a sterile technique and the US transducer was placed on the lateral abdominal wall to visualise the three layers of abdominal muscles: transversus abdominis (TA), external oblique (EO) and internal oblique (IO). The probe was then moved posteriorly in order to visualise the QL muscle. The needle was introduced and advanced using an in-plane technique with the needle tip visualised on US. As the needle approached the EO muscle, 'scratches' could be heard on the EMG speaker as the needle came into contact with the muscle, representing the muscle's electrical activity (see video 1). As the needle was inserted into the EO muscle, a loud burst of noise was audible on the EMG speaker. This corresponded with a palpable 'pop' sensation as the needle entered the EO muscle layer, confirmed on the US image. The process was repeated when penetrating the IO muscle—with a 'scratching' sound and subsequent burst of noise as the needle pierced this muscle to lie in the TA plane, adjacent to the QL muscle. Following negative aspiration, 20 ml of 0.25% levobupivacaine was injected into this space and an US image of an expanding space beside the QL muscle in the TA plane was demonstrated. This process was repeated on the other side to provide a bilateral block.

The patient had muscle relaxation reversed using sugammadex (Bridion) 200 mg and was extubated after emerging from anaesthesia.

OUTCOME AND FOLLOW-UP

The patient was recovered in the postanaesthesia care unit (PACU) where his level of pain control was assessed. He reported no immediate pain postoperatively in the PACU. Sensory assessment of the

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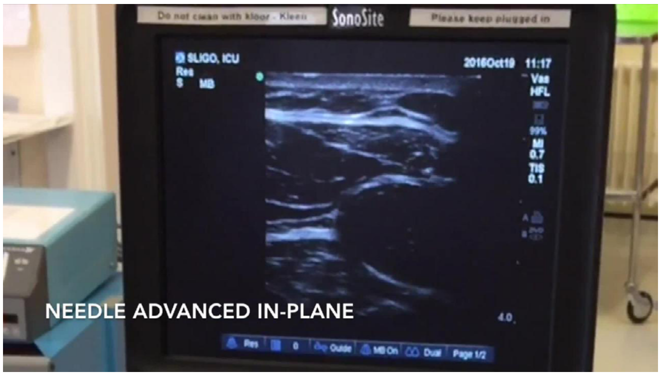

Video 1 Video of ultrasound and electromyography-assisted quadratus lumborum block performed for postoperative analgesia following open appendicectomy.

anterior abdominal wall was performed using ethyl chloride spray and demonstrated a sensory block from T6 to L2. This persisted for approximately 18 hours following surgery. Pain was well controlled in the first 24 hours (0–3/10 on the numerical rating score; 0=no pain, 10=worst pain imaginable). He received regular paracetamol 1000 mg at 6-hour intervals and a single dose of oral tapentadol immediate-release (Palexia FC) 50 mg in the first 24 hours at 8 hours postoperatively. He was discharged on the second postoperative day and had an uneventful recovery. He was followed up over the telephone 5 days after surgery and he reported that his pain was well controlled (0–2/10) postdischarge.

DISCUSSION

This case report demonstrates for the first time the use of needle EMG combined with US for accurate needle positioning for QL block.

The anterior abdominal wall is supplied by the anterior rami of the lower six thoracic nerves (T7–T12) and the first lumbar nerve (L1). These nerves leave the intervertebral foramina to pierce the muscles of the lateral abdominal wall and travel in the plane between the IO and TA muscles. After the lateral cutaneous nerves branch off, at the level of the midaxillary line, the nerves continue anteriorly and perforate the abdominal muscles to supply the skin to the midline.[2]

The transversus abdominis plane (TAP) block was the first description of a standard reliable approach for blockade of these nerves.[3] It was traditionally accessed via the lumbar Triangle of Petit that provides an ideal anatomical window for accessing this plane.[3 4] It was initially performed using a loss of resistance 'double pop' technique, which represented the needle penetrating the fascial layers—the first pop representing the needle traversing the fascia between EO and IO muscles and the second pop the fascia between IO and TA muscles.[4]

Due to the inconsistency of confirming the correct location[5–7] of the needle and the possibility of damage to underlying structures, an US-guided technique was developed. This ensured greater accuracy of the block due to direct visualisation of the TAP and the needle positioning.[2 8] A study that used MRI and contrast was able to demonstrate that a posterior approach to the TAP block resulted in accumulation of injectate at the QL and psoas muscle with posteromedial spread to the paravertebral region. This produced a greater extent of analgesia, covering dermatomal segments T4–L2 and greater duration of analgesia of up to 48 hours following a single injection.[9 10] This new block had a wider coverage of dermatomes,[11] included visceral blockade and lasted longer than TAP block, and became known as the QL block. More recently, it has been reported that bilateral continuous QL blocks can provide extended postoperative analgesia,[12] even after major abdominal surgery.[13]

EMG is a modality that gives insight into the electrical activity present within muscles.[14] This can be carried out using a surface electrode or, more accurately, from within the muscle with a needle electrode, known as needle EMG. We can gain information on the anatomical location and firing patterns of individual muscle fibres and entire motor units by the use of needle EMG.[15] Its primary utility is in the diagnosis of neuromuscular disorders, which yield characteristic changes in the EMG signal, and for administering intramuscular botulinum toxin injections.[16] The electrical potential measured between the needle and a reference can be displayed as a graph or transmitted via a speaker with an accompanying LED display, as in this case.[15]

Traditionally, EMG technicians assess muscle units for insertional activity, spontaneous activity, voluntary activity and abnormal movements such as myotonia or neuromyotonia in order to investigate and diagnose neuromuscular disorders. Insertional activity represents the brief burst of electrical activity from the mechanical distortion caused by the needle entering the muscle and on subsequent movement of the needle.[15] In our case, the first and second noises are normal insertional activity, which is audible on the EMG oscilloscope when entering a muscle. It is caused by muscle depolarisation due to the mechanical irritation of the needle and when there is normal innervation, the burst of activity lasts less than 0.3 ms. This is very helpful in localising muscle. It was first described by Weddell *et al* in 1944[14] and further characterised by Kugelburg and Petersen in 1949.[17] If denervated, the insertional activity (also called spontaneous activity) lasts longer than 0.3 ms and is associated with pathological potentials such as positive sharp waves, fibrillation potentials, complex repetitive discharges and fasciculation potentials, which are helpful in identification of patterns of denervation.[14 17] In the above case, the insertional activity provides useful feedback to the operator and complements the US image to more accurately determine the exact position of the needle tip at all times.

The EMG auditory output was the sole EMG signal used in this case. However, this can be complemented with a graphical or visual LED display. We felt this was unnecessary as the auditory output provided sufficient EMG feedback to the operator and we did not wish to distract from the US image providing accurate visual information on needle position. If US were not available, the EMG graphical/visual display could be used to complement the auditory signal. Alternatively, a second operator could assess the EMG LED display during needle insertion.

EMG can be used for detecting residual neuromuscular blockade under anaesthesia.[18] Accordingly, the use of EMG for the purposes of nerve blockade under anaesthesia requires that neuromuscular transmission be present. In the above case, a non-depolarising neuromuscular blocking agent was administered at the start of the case and the degree of blockade was assessed by train-of-four peripheral nerve stimulation prior to the block being performed. This demonstrated four complete twitches with no fade, which provided a satisfactory level of neuromuscular recovery for the use of EMG. We recommend that the degree of neuromuscular blockade be assessed prior to the use of EMG under anaesthesia.

The described block was performed with the use of a 27G concentric needle EMG. While this particular needle was visible under US, it was not developed for this purpose. A dedicated needle for combined-use with US and EMG may better support the use of both modalities. Also, considering this block has been traditionally performed using a loss of resistance technique, a wider bore needle may allow the operator a superior tactile appreciation for traversing the muscle/fascial layers involved.

Needle EMG has also been used to aid piriformis muscle injection for piriformis syndrome.[16] While movement through fascial layers during piriformis intramuscular injections is associated with artefactual evidence on the EMG, the signal produced may be useful when combined with US for these injections. The EMG feedback may allow the operator to better assess movement through fascial layers that are not easily appreciated with a palpable 'pop' of the needle but associated with an EMG signal.

The combination of US and EMG has not been described for any nerve blocks prior to our reported case. We recommend that this novel technique be further assessed, ideally in a randomised controlled trial to determine its possible superiority for QL block over the standard technique. We also suggest that this combined approach should be assessed for other muscle/fascial plane blocks, or peripheral nerve blocks where muscle layers are traversed, as it may provide additional safety regarding needle tip position.

Learning points

- ► This case report demonstrates for the first time the use of needle electromyography (EMG) combined with ultrasound (US) for accurate needle positioning for quadratus lumborum (QL) block, resulting in anaesthesia of the T4–L2 segments for 18 hours and very effective postoperative analgesia.
- ► This case demonstrates the utility of additional auditory feedback from EMG for confirming needle location. This could potentially further improve the accuracy of the block and reduce the chance of adverse events.
- ► EMG in combination with US could be used for the purposes of other muscle/fascial plane blocks or peripheral nerve blocks where muscle layers are traversed.
- ► If being performed under anaesthesia, return of neuromuscular transmission should be assessed prior to the use of EMG.
- ► Further investigation is required in randomised controlled trials to validate this novel technique.

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Competing interests None declared.

Patient consent Obtained.

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