A Novel Approach to Ultrasound-guided Out-of-plane Lumbar Plexus Block Using the Shamrock Technique: Technical Report

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Abstract: Lumbar plexus blockade can be performed using both the classical landmark technique and ultrasound guidance. Reports suggest that ultrasound-guided blockade may enhance the safety of the procedure. Various approaches can be utilized for ultrasound-guided lumbar plexus blockade, including the paravertebral paramedian transverse scan, the Shamrock approach, and Trident imaging. In these imaging methods, needle guidance can be accomplished using either an in-plane or out-of-plane technique. Each of these application methods has limitations concerning needle imaging and guidance. In this case report, we present the outcomes of five patients who underwent lumbar plexus blockade for hip fracture surgery using an out-of-plane approach with Shamrock imaging, which could serve as a viable alternative to other methods.

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Introduction

Intertrochanteric femur fractures are among the most common conditions requiring emergency orthopedic surgery (Lawrence et al., 2002). Spinal, epidural, or peripheral nerve blocks (such as lumbar plexus and sacral plexus blocks) are preferred because they offer better postoperative analgesia and faster recovery (Kirchmair et al., 2001; Beaupre et al., 2005). Over the years, various methods for performing lumbar plexus blockade have been developed, particularly with the increasing use of ultrasonography (Kirchmair et al., 2001; Sauter, 2013; Sato et al., 2018). However, in ultrasound imaging, the acoustic window may narrow due to reduced vertebral height, especially in elderly patients. This can hinder the visualization of both the needle and the ultrasound on the same axis. In this case series, we hypothesized that the out-of-plane technique might be more effective. Therefore, we present the results of lumbar plexus block applications using the out-of-plane approach in Shamrock imaging.

Case report

This case series included patients aged 18 to 90 years, classified as American Society of Anesthesiologists (ASA) risk classes I to III, who were determined to undergo femoral nailing surgery for intertrochanteric femoral neck fractures during preoperative evaluation (Table 1). Patients who agreed to participate in the study and had no local anesthetic allergy, bleeding disorder, mental status disorder and previous cerebrovascular disease were selected consecutively, and the block was applied.

Out-of-plane lumbar plexus blockage

After sedation with midazolam 1 mg and Fentanyl 25 mcg, and oxygen support with a mask, the patient was placed in the lateral decubitus position with the side to be blocked up. After appropriate site cleaning, a protective clothed Convex (2–5 mhz Esaote MyLab 30, Italy) ultrasound probe was placed in the abdominal flank in the cranial iliac crest in the transverse position. At the top, the abdominal wall muscles (ext. oblique, internal oblique and transversus abdominis muscle) were visualized (Sauter, 2013). Then, under the probe abdominal muscles, the psoas muscle in front of the transverse process of the L4 vertebra under the quadratus lumborum muscle and the erector spinae muscles forming the Shamrock image posteriorly were defined (Sauter, 2013) (Figure 1).

The lumbar plexus was observed as round-oval structures in the psoas muscle 2–3 cm anterior to the transverse process, 6–10 cm deep to the skin. A 100 mm, 21 G peripheral nerve block needle was inserted from the midpoint of the ultrasound probe, with an out-of-plane technique, at a 90-degree right angle. The needle was directed anatomically from the lateral abdomen to the medial side of the psoas muscle on the posterior axillary line. After reaching

Table 1: Patient characteristics and lumbar plexus block details

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age (years)	75.0	80.0	76.0	81.0	72.0
Weight (kg)	79.0	81.0	80.0	67.0	78.0
Height (cm)	173.0	167.0	161.0	155.0	158.0
BMI (kg/m^2)	26.4	29.0	30.9	27.9	31.2
Sex (males – M)/females – F)	M	M	F	F	F
ASA classification	III	III	III	III	III
Duration of surgery (min)	50.0	63.0	48.0	53.0	54.0
Ipsilateral epidural block	–	+	+	–	–
Onset of sensory block (min)	11.0	9.5	10.0	10.0	12.0
Onset of motor block (min)	14.0	13.0	13.0	12.0	12.5
Total sedative drug consumption in peropeative					
Midazolam (mg)	2	3	2	2	2
Fentanyl (mcg)	25	50	50	50	50
Mean arterial pressure (mm Hg)	77.7 ± 3.6	78.2 ± 3.6	79.5 ± 3.4	80.5 ± 3.4	80 ± 2.5
Block performance time (min)	8	9	8.5	9	10

BMI – body mass index; ASA – American Society of Anesthesiologists

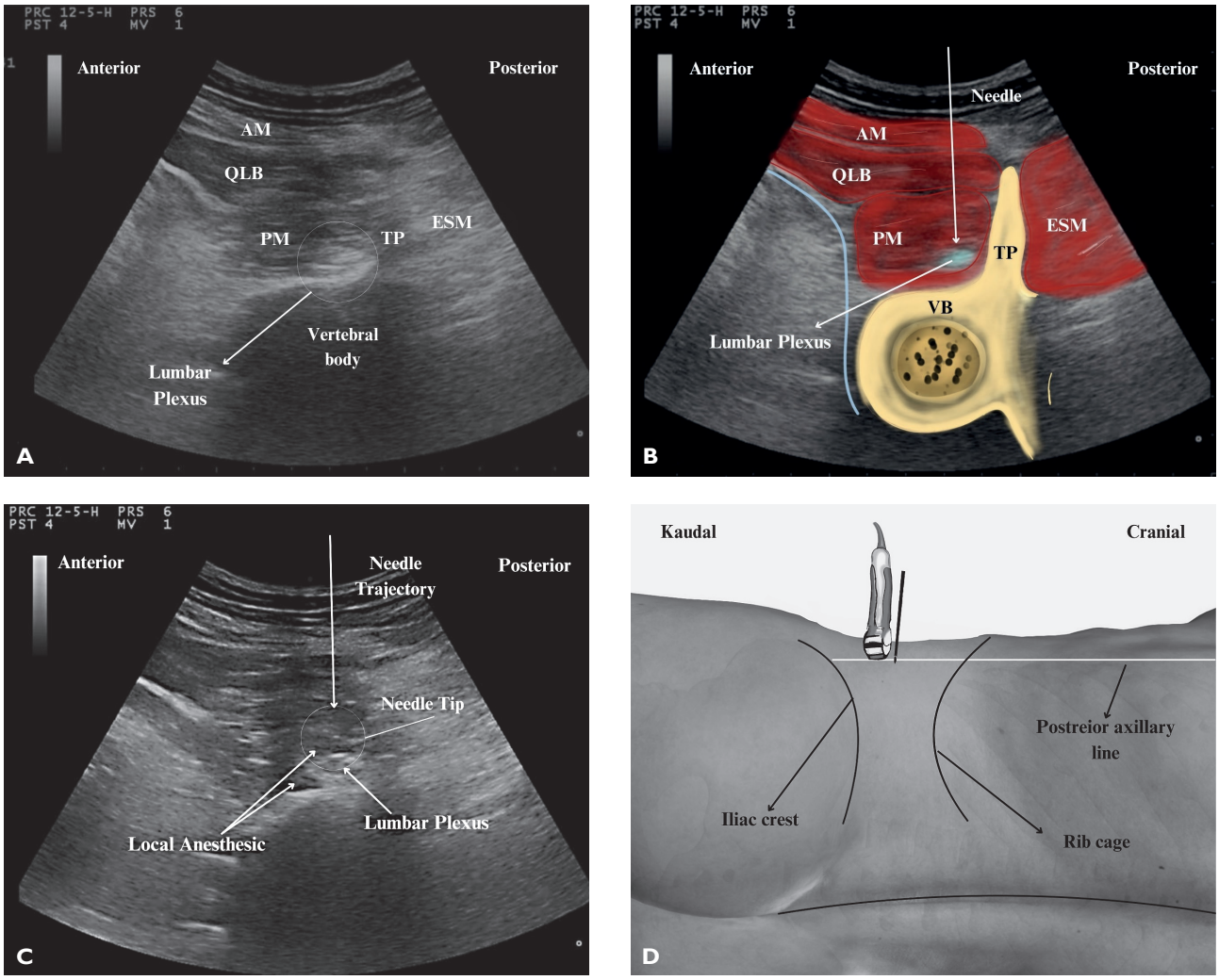

Figure 1: (A) TP – transverse process; AM – abdominal muscle; ESM – erector spinal muscle; PM – psoas muscle; QLB – quadratus lumborum; white circle – lumbar plexus. (B) TP – transverse process; AM – abdominal muscle; ESM – erector spinal muscle; PM – psoas muscle; QLB – quadratus lumborum; VB – vertebral body; blue point – lumbar plexus. (C) Local anaesthetic distribution during injection; white circle – needle tip. (D) Figure showing the ultrasound probe and the entry site of the needle for an out of plane approach.

the injection site in the psoas muscle, the quadriceps muscle response was found with a peripheral nerve stimulator with a 0.3–0.4 mA 0.1 ms impulse and the location was confirmed (Figure 1). After confirming the appropriate site, 25 ml of 0.25% bupivacaine was injected with intermittent negative aspiration with a pressure transducer at a pressure < 15 psi (B-Smart™ Injection Pressure Monitor). Afterwards, ultrasound guided sacral plexus blockade was applied with 15 ml of 0.25% concentration of bupivacaine (Taboada et al., 2004).

The pinprick test for sensory block and the Bromage scale for motor block were used to assess the success of the procedure. These tests were repeated every five minutes after the procedure. If the desired level of sensory and motor block could not be achieved, it was considered a failed block and another procedure was planned. Tests were performed bilaterally to detect contralateral epidural spread. After the procedure, surgery was started if the pinprick test was positive in the dermatomes of the femoral nerve, lateral femoral cutaneous nerve and obturator nerve, and the motor block score was 1 (unable to move against resistance) on the Bromage scale.

Discussion

In this case, a series of five patients underwent out-of-plane lumbar plexus blockade (LPB), which was successfully applied using Shamrock imaging. No complications were observed in the 24-hour follow-up of the patients included in the study.

With the identification of anatomical structures in the lumbar region using ultrasound, the course of the block needle as it passes through these structures during the block, its placement in the psoas muscle, and the spread of local anesthetic can be observed.

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There are also variations for lumbar plexus (LP) visualization and block application using ultrasound. The main ones are the paramedian transverse oblique (transverse or articular process), the paramedian sagittal (trident view), and the Shamrock method (Karmakar et al., 2008, 2015; Sauter, 2013). Although ultrasound-guided LPB has advantages, the depth of the application area and bony structures may make imaging with ultrasound difficult. Today, the in-plane ultrasound-guided LPB method is widely used in short-axis imaging. In this method, it has been determined that the needle entry site is close to the midline, and bone structures can complicate the process by limiting the visibility of the needle. Sauter (2013) described an alternative approach known as the "Shamrock approach". This method provided a good visualization of the LP and surrounding structures. It is advantageous to define the lumbar plexus within the psoas muscle using the Shamrock method and to apply the needle from the exact location with the in-plane technique, employing the classical landmark method (Nielsen et al., 2018).

The technical difficulty with this approach lies in the challenges of imaging and orientation of the block needle due to the distance between the ultrasound scan area and the needle entry site. Aging and obesity can cause difficulties in imaging for all methods in which ultrasound-guided LPB is applied. Decreased fluid content in muscle tissue due to age may cause changes in echogenicity, and an increase in fat content in obesity may cause scattering of sound waves.

On the other hand, in-plane techniques may cause internal organ injuries in front of the psoas muscle if the needle tip is not fully visible or is not aligned along the axis (Eduardo et al., 2021). Due to the decrease in vertebral heights with age in Shamrock imaging, the distance between the iliac crest and the costal margin decreases, which causes difficulties in manipulating the ultrasound probe and providing visibility of the needle. Additionally, increased age-related echogenicity of the psoas muscle may make it challenging to confirm the intramuscular location of both the LP and the needle. The out-of-plane approach may shorten the procedure time and increase the success of the block in Shamrock imaging because the path to reach the lumbar plexus is away from the bony structures and requires a relatively shorter distance. In addition, the fact that the vertebral body is the target of the needle in the out-of-plane approach may reduce the risk of visceral injury and related complications.

Limitations

This method has certain disadvantages. While the needle tip is visible during the procedure, the overall visualization of the entire needle is not as effective as with the plane technique. The limitations of this study include a small sample size and an unclear understanding of the extent of epidural spread. Additionally, the risk of minor artery injury may be similar to that associated with other methods.

Conclusion

Shamrock imaging may benefit from an out-of-plane approach, especially in elderly patients. Large case series and randomized controlled trials may help determine this method's advantages and disadvantages.

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