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Anatomical variation of the brachial plexus roots identified during pre-procedural ultrasound for an interscalene block

Federico Tamburi,[1] Giorgio Ranieri,[2] Aneurin Moorthy[1,3,4]

[1]National Orthopaedic Hospital Cappagh, Dublin, Ireland; [2]Complex Operational Unit of Anesthesia and Operating Units, Department of Emergency and Internal Medicine, Isola Tiberina Hospital - Gemelli Isola, Rome, Italy; [3]Mater Misericordiae University Hospital, Dublin, Ireland; [4]University College Dublin, Ireland

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Correspondence to: Dr. Aneurin Moorthy, National Orthopaedic Hospital Cappagh, Cappagh Rd, Cappoge, Dublin 11, D11 EV29, Ireland.
E-mail: aneurin.moorthy@gmail.com

Dear Editor,

In shoulder surgery, the interscalene brachial plexus block (ISB) remains the most frequently employed technique. At this level, the brachial plexus roots are known to display several anatomical variations. In this letter, we report an anatomical variant of the brachial plexus roots observed during an ultrasound scan prior to performing an ISB. We illustrate the observed sono-anatomy features of the variant seen, offer an explanation as to why targeting this variant may clinically result in a failed block, and describe a rescue strategy.

A 69-year-old male patient was scheduled for left shoulder arthroscopy for rotator cuff repair. The anesthetic plan included an ultrasound-guided ISB with 10 mL of 0.5% levobupivacaine.

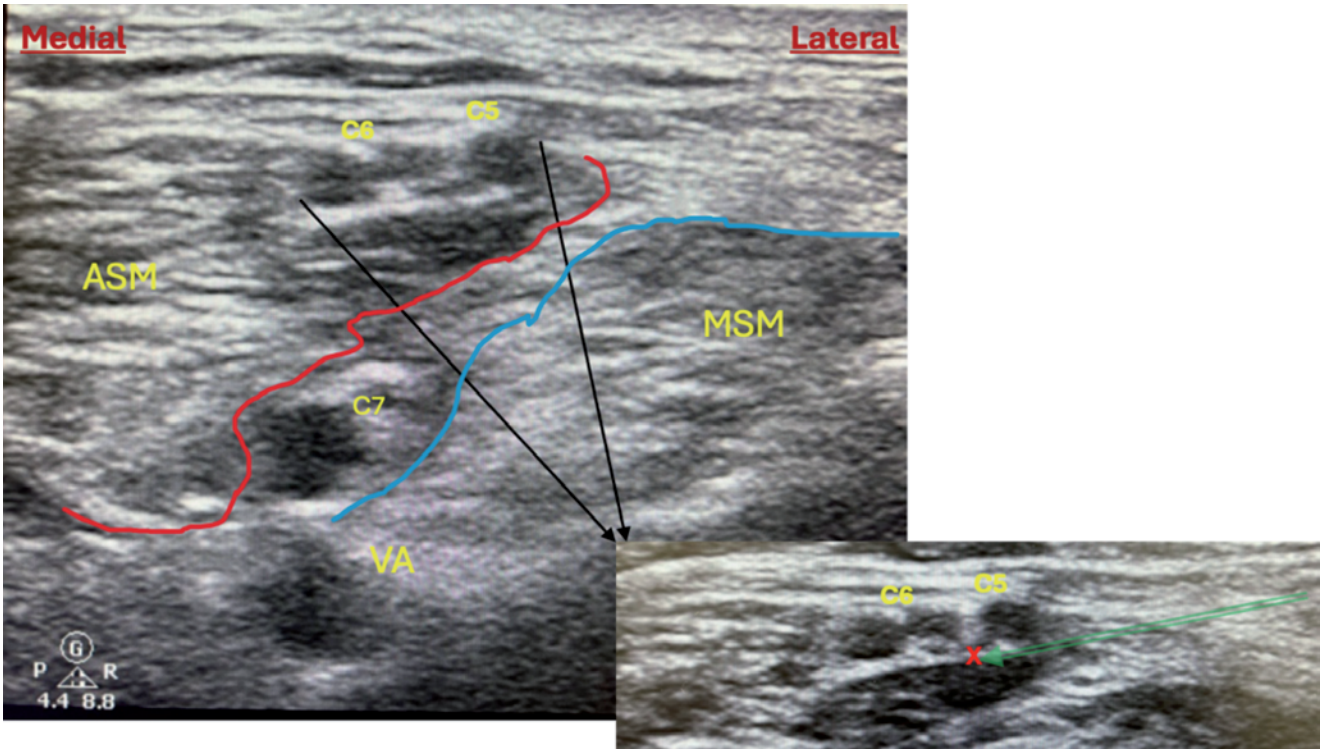
A pre-procedural ultrasound scan was performed using a high-frequency linear ultrasound probe (GE Venue™ 50 Portable Ultrasound) to identify the brachial plexus at the supraclavicular level, where the trunks run parallel to each other and lateral to the subclavian artery. The location nerve roots of C5-C7 within the interscalene groove was subsequently attempted by using the "traceback" method. This involved sliding the ultrasound probe from the supraclavicular fossa cephalad while continuously maintaining visualization of the plexus up to the interscalene groove. However, it became immediately apparent that the C5 and C6 nerve roots were not located within the typical interscalene groove between the anterior and middle scalene muscles. Instead, both roots were found within the anterior scalene muscle (ASM), and only C7 was typically positioned within the interscalene groove adjacent to the vertebral artery (Figure 1).

Using an in-plane approach, a 22 G 50 mm stimulating needle (Stimuplex ultra-360 needle, B. Braun Milano S.p.A., Italy) was slowly advanced in a lateral-to-medial direction, parallel to the C5 and C6 nerve roots, and shoulder abduction was observed when stimulated between 0.5-1 mA at 2 Hz, 100 µs. The needle tip was then carefully advanced to the desired position in this anatomical case – midway and inferior to C5 and C6, but not within the plexus sheath. At this point ("X" on Figure 1), shoulder abduction was observed at 0.4 mA but was not elicited at ≤ 0.3mA. Because the needle tip was close to the nerve plexus, we did not advance it further, and we injected 10 mL of 0.5% levobupivacaine. We assessed the spread of the injected local anesthetic (LA) by scanning the brachial plexus from the interscalene groove towards the supraclavicular fossa and back. We did not observe any LA spread around the C7 nerve root, and we did not appreciate satisfactory spread of LA around C5 and C6 or displacement of these nerve roots from their original position.

After 15 minutes, we clinically assessed the ISB. We found that our patient had no motor block (shoulder abduction was observed) and no sensory changes were noted in the C5-C6 distribution, suggesting sparing of the C5-C6 roots and clinically a failed block.

As a result, we decided to repeat the brachial plexus block by conducting a targeted superior trunk block. We performed this by tracing what we believed to be the C5 and C6 nerve roots (located within the ASM; Figure 1) caudally towards the supraclavicular fossa, where the brachial plexus was seen lateral to the subclavian artery. During this dynamic scanning process, the superior trunk was identified once we observed that C5 and C6 roots merged. Using an in-plane approach, a 22 G 50 mm stimulating needle (Stimuplex ultra-360 needle) was used to stimulate the superior trunk. Shoulder abduction and elbow flexion were observed between 0.3-0.5 mA at 2 Hz and 100 µs. After confirming that no motor response was elicited at <0.3 mA, 10 mL of 0.5% levobupivacaine was administered. This resulted in a satisfactory block, evidenced by sensory changes in the C5-C6 distribution and weakness in arm abduction. The patient had an uneventful surgical procedure with satisfactory post-operative analgesia.

The literature reports that the brachial plexus at the interscalene groove level is rich in anatomical variations.[1-3] Keet *et al.*[3] analyzed 158 interscalene dissections and found the standard root configuration in only 31.6% of cases. Similarly, Kilicaslan *et al.*[4] reported that 9 out of 110 specimens (9.1%) exhibited aberrant positioning of C5 and/or C6 passing through or within the ASM. According to the classification proposed by Keet,[3] our



ASM, anterior scalene muscle; MSM, middle scalene muscle; VA, vertebral artery.

Figure 1. Transverse ultrasound image at the interscalene level. Medial (M) and lateral (L) orientation markers are shown. C5 and C6 nerve roots are visualized abnormally within the ASM, while C7 lies in the expected interscalene groove between ASM and MSM. The "X" indicates the final needle tip position; the red color highlights the border of the ASM, while the blue color highlights the border of the MSM; the green arrow indicates the trajectory of the needle tip.

case corresponds to Type 2, in which both C5 and C6 traverse the ASM. Type 1 represents the standard root position; Type 3 involves only C5 passing through the ASM; Type 4 includes C5-C6 together with the subclavian artery; and Type 5 describes C5-C6-C7 all passing through the ASM.

We postulated that our initial failed brachial plexus block was due to inadequate spread of the LA agent around C5 and C6 as a result of unintentional intramuscular injection of LA within the ASM (since the C5 and C6 were located within the ASM). An explanation for this is as follows: during the procedure, we did not notice the usual tactile changes in the fascial planes as the needle advanced toward the roots, which are typically felt when approaching the interscalene groove. We observed motor responses in C5 and C6 (shoulder abduction) at 0.4 mA, but not at 0.3 mA. This may suggest the fascia of the ASM may not have been penetrated and prevented diffusion of the LA to the desired nerve. In addition, it is worth noting that during the procedure, prior to the injection of LA, we accepted the motor response (shoulder abduction) at 0.4 mA, and we decided not to further advance the needle to obtain a more desirable nerve stimulation to avoid possible inadvertent nerve injury. Hydro-dissection was attempted with 1-2 mL of 0.9% normal saline before the injection of the LA, to separate the nerve roots from the anterior muscle planes. In comparison, at the superior trunk level, neurostimulation was achieved at 0.3 mA, and a satisfactory spread of the injectate around the nerve bundle was observed.

This case highlights that when performing an ISB, the absence of the classic ultrasound sign (the "traffic light sign") should alert the operator to the possible presence of an anatomical variation. Anatomical variations of the interscalene brachial plexus can be challenging and can be an "anatomical trap", particularly for less experienced practitioners. Furthermore, accurate anatomical identification is essential to ensure both the efficacy and safety of the block.

In conclusion, clinicians should recognize that standard ultrasound landmarks may be unreliable in common anatomical variations of the brachial plexus at the interscalene groove. In such cases, a rescue strategy, as described in this report – namely, a superior trunk block – may be more feasible to reduce the risk of incomplete anesthesia, intraneural injection, or injury to adjacent vascular and neural structures in patients undergoing shoulder surgery.

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