Needle placement and injection posterior to the axillary artery may predict successful infraclavicular brachial plexus block: a report of three cases

[La position de l'aiguille et l'injection postérieure à l'artère axillaire peuvent prédire la réussite d'un bloc sous-claviculairedu plexus brachial : présentation de trois cas]

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Purpose: The combined use of ultrasound and nerve stimulation for localization of the brachial plexus during infraclavicular block has not been evaluated. We describe three cases of infraclavicular block where we used ultrasound to place the needle and catheter, observe type of muscle twitch obtained and local anesthetic spread after injection.

Clinical features: Injection of local anesthetic after obtaining proximal muscle stimulation was associated with local anesthetic spread between the axillary artery and pectoral muscle. This resulted in block failure (case 1).

In case 2, proximal stimulation was associated with anterior spread after a test injection. The needle and subsequently the catheter were repositioned posterior to the axillary artery and distal muscle stimulation obtained. Injection through the catheter resulted in local anesthetic spread posterior to the artery and successful block.

In case 3, no distal twitch could be obtained but in light of previous experience the needle and then the catheter were placed posterior to the axillary artery. Posterior local anesthetic spread was observed and successful block ensued despite absence of any muscle stimulation.

Conclusion: Ultrasound guidance during infraclavicular brachial plexus block enables direct visualization of needle/catheter tip location and confirmation of appropriate local anesthetic spread. Our early experience suggests that spread of injectate posterior to the second part of the axillary artery is associated with successful block.

Objectif : *La combinaison d'ultrasons et de neurostimulation pour localiser le plexus brachial lors d'un bloc sous-claviculaire n'a pas été évaluée. Nous décrivons trois cas de bloc sous-claviculaire où les ultrasons ont été utilisés pour placer l'aiguille et le cathéter, observer le type de contraction musculaire obtenue et la diffusion de l'anesthésique local après l'injection.*

Éléments cliniques : *Après l'obtention d'une stimulation proximale, l'injection d'anesthésique local a été associée à la diffusion de l'anesthésique entre l'artère axillaire et le muscle pectoral et elle a entraîné un échec du bloc (Cas 1).*

Dans le cas 2, la stimulation proximale a été associée à une diffusion antérieure après une injection d'essai. L'aiguille et, par la suite, le cathéter ont été replacés en position postérieure à l'artère axillaire et une stimulation du muscle distal a été obtenue. L'injection au travers du cathéter a amené la diffusion de l'anesthésique local derrière l'artère et la réussite du bloc.

Dans le cas 3, aucune contraction distale n'a pu être obtenue, mais fort de l'expérience précédente, l'aiguille et, ensuite, le cathéter ont été placés postérieurement à l'artère axillaire. La diffusion postérieure de l'anesthésique local a été observée et suivie d'un bloc réussi malgré l'absence de toute stimulation musculaire.

Conclusion : *Le guidage par ultrasons lors d'un bloc du plexus brachial sous-claviculaire facilite la visualisation directe de la pointe de l'aiguille/du cathéter et la confirmation de la diffusion appropriée de l'anesthésique local. Notre première expérience suggère que la diffusion de l'anesthésique injecté postérieurement à la seconde partie de l'artère axillaire est associée au succès du bloc.*

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THE coracoid infraclavicular block is a useful technique that allows block of all three cords of the brachial plexus with less risk of pneumothorax than with a supraclavicular approach.

However the infraclavicular approach can be a difficult technique to master using nerve stimulation techniques alone. Proximal muscle stimulation (biceps, pectoralis or triceps) is often encountered initially but injection of local anesthetic at this end-point is associated with success rates as low as 44%.[1] Distal muscle stimulation in the forearm or hand is often more difficult to achieve but is required to optimize block success.[2] Repeated attempts to seek this end-point may be associated with risk of vascular puncture or pneumothorax and patient discomfort.

The use of ultrasound has been demonstrated in a number of studies to facilitate correct needle placement and produce successful infraclavicular block.[3–5] However no information is currently available on which needle position, as demonstrated by ultrasound, correlates with the greatest likelihood of finding a distal twitch with nerve stimulation or of subsequent successful block.

We describe three cases of ultrasound guided infraclavicular block that may help to further our knowledge of what occurs during successful or unsuccessful coracoid infraclavicular brachial plexus blocks.

In all three cases, we used standard monitoring, secured and *iv* access and started an infusion of saline 0.9%. Intravenous midazolam 2 mg and fentanyl 50 µg were administered for sedation.

The block was performed with the patient lying supine and the head turned away from the limb to be blocked. The arm was placed in a neutral position (adducted). After sterile preparation the coracoid process was identified by palpation and a point 2 cm caudal and 2 cm medial to the coracoid process was marked, as previously described by Wilson.[6] Lidocaine 1% 1 to 2 mL was infiltrated at a point approximately 1 cm superior to this point.

Using a sterile technique, a Philips ATL HDI 5000 SonoCT unit (Philips Medical Systems ATL Ultrasound, Bothell, WA, USA; 4–7 MHz probe) was used to scan the infraclavicular area in the parasagittal plane.[3]

The needle was advanced in the long axis of the probe (Figure 1) and in the same plane as the ultrasound beam.[6] A 17-gauge (G) insulated Tuohy needle (Arrow International, Reading, PA, USA) was inserted under direct vision and the needle tip advanced initially towards the superior aspect and then posterior to the axillary artery and distal muscle stimulation sought using an initial current of 1.5 mA. Following insertion of the catheter, 40 mL lidocaine 1.5% with 1:200,000 epinephrine were administered in 5-mL increments via the catheter (with repeated aspiration).

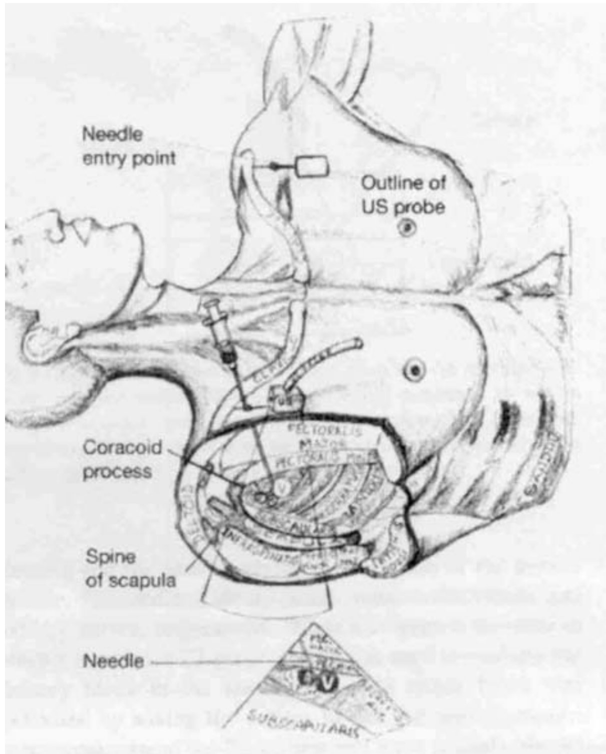

FIGURE 1 Sagittal section of the right deltopectoral region with diagramatic representation of the ultrasound image. The location of the ultrasound probe and the needle insertion point are depicted on the left chest. US = ultrasound probe; A = axillary artery; V = axillary vein; L, P, M = lateral, medial and posterior cords respectively. Reproduced with permission from: *Sandhu NS, Capan LM.* Ultrasound-guided infraclavicular brachial plexus block. Br J Anaesth 2002; 89: 254–9. The Board of Management and Trustees of the British Journal of Anaesthesia. Oxford University Press/British Journal of Anaesthesia.

Case report 1

A 39-yr-old male presented for hand surgery and gave informed consent for coracoid infraclavicular brachial plexus block.

Nerve stimulation with a current of 1.5 mA was performed but no distal muscle stimulation could be obtained by positioning the needle tip at the superior, posterior and inferior aspects of the artery. Insertion of the needle tip inferior to the axillary artery and between the vein and artery produced pectoral muscle

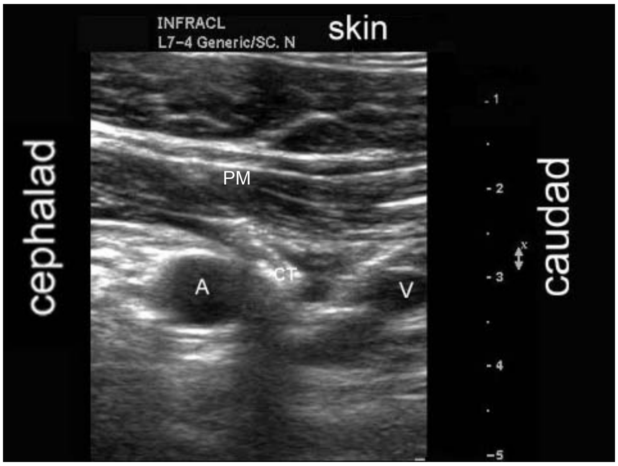

FIGURE 1i Catheter tip positioned between the artery and vein. PM = pectoralis muscle; A = axillary artery; V = axillary vein; CT = catheter tip.

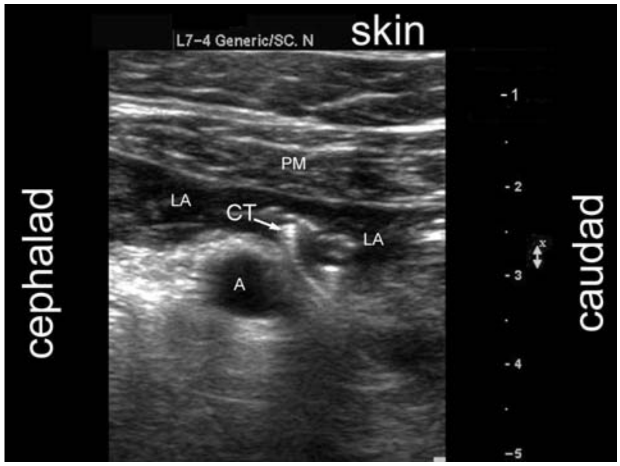

FIGURE 1ii Spread of local anesthetic between vascular structures and pectoral muscle. A distinct tissue barrier appears to divide the plane containing the vessels from that where injection occurs. LA = local anesthetic; PM = pectoralis muscle; A = axillary artery; CT = catheter tip.

stimulation at 0.5 mA. A stimulating catheter was inserted and pectoral muscle stimulation was maintained (Figure 1i). The catheter tip and local anesthetic spread were clearly visualized between the vascular structures and pectoralis muscle on the ultrasound image (Figure 1ii). Complete block failure occurred in this case and general anesthesia was induced for surgery. The infraclavicular catheter was removed in the postanesthesia care unit.

Case report 2

A 40-yr-old female presented for hand surgery and gave informed consent for coracoid infraclavicular brachial plexus block.

Insertion of the stimulating needle at the superior aspect of the axillary artery produced biceps muscle contraction at a current of 1.5 mA. In order to determine if injectate spread would occur around the axillary artery, a test dose of 5 mL was injected. Spread of injectate between pectoralis muscle and axillary artery was observed (Figure 2i). The needle was then advanced to the posterior aspect of the axillary artery (between artery and subscapularis muscle). Distal muscle stimulation in the radial nerve distribution was obtained at this point using a current < 0.5 mA. A stimulating catheter was inserted and distal stimulation was maintained during insertion (Figure 2 ii). Injected local anesthetic could be clearly seen spreading posterior to the second part of the axillary artery (Figure 2iii). Successful motor and sensory block of the upper limb occurred within 30 min of injection. The catheter was also used to provide postoperative analgesia with a continuous brachial plexus infusion of 5 mL·hr^{-1} 0.2% ropivacaine.

Case report 3

A 46-yr-old female presented for hand surgery and consented to infraclavicular brachial plexus block. After insertion of the stimulating needle, musculocutaneous stimulation was obtained at the superior aspect of the artery but no distal muscle stimulation could be obtained at either the superior, inferior or posterior aspects of the second part of the axillary artery using currents up to 1.5 mA. Based on previous experience and anatomical knowledge of the position of the brachial plexus in relation to the axillary artery at this point, the needle tip (and subsequently the catheter) were positioned posterior to the axillary artery. The injected local anesthetic could be clearly seen spreading posterior to the second part of the axillary artery (similar pattern to Figure 2iii). Successful motor and sensory block of the upper limb occurred within 15 min of injection. The catheter was also used to provide postoperative analgesia with a continuous brachial plexus infusion of 5 mL·hr^{-1} 0.2% ropivacaine.

Discussion

Distal muscle stimulation is required for infraclavicular block using existing methods of nerve localization in order to obtain acceptable success rates.[1,2] Proximal

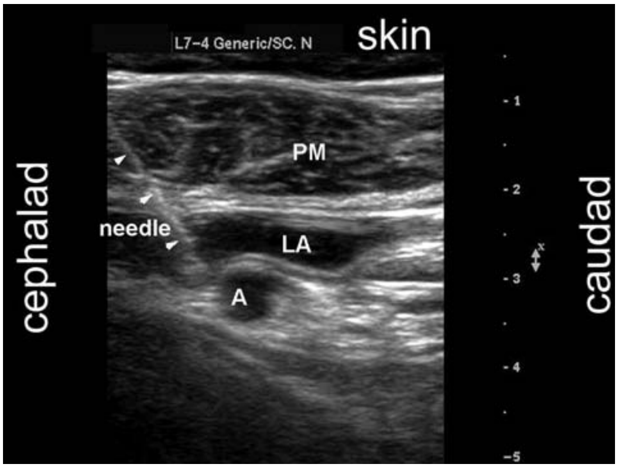

FIGURE 2i Needle positioned superior to the axillary artery associated with musculocutaneous nerve stimulation. A tissue barrier appears to divide the plane containing the vessels from that of the injectate. A = artery; LA = injectate; PM = pectoralis muscle.

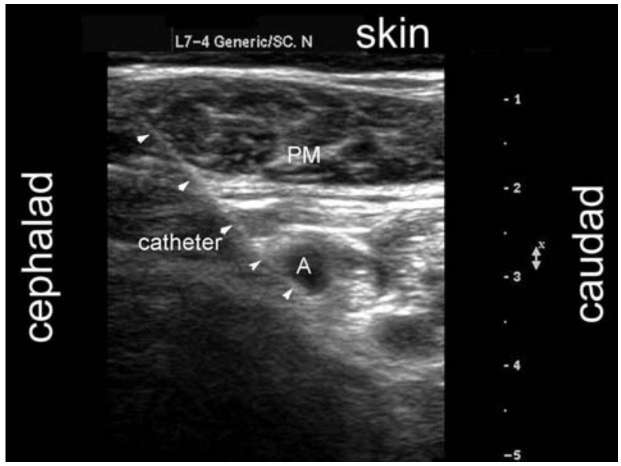

FIGURE 2ii Catheter tip positioned posterior to the artery. A = axillary artery; PM = pectoralis muscle.

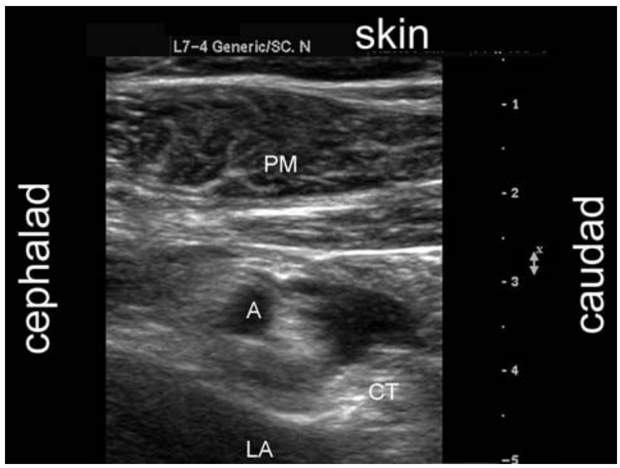

FIGURE 2iii Postero-inferior spread of LA following injection through catheter. CT was inserted posterior to the axillary artery, similar to Figure 2ii. LA = local anesthetic; A = axillary artery; CT = catheter tip; PM = pectoralis muscle.

muscle stimulation (biceps, triceps or pectoralis) is much easier to obtain but associated with a poor rate of successful block.[1,2] In the current report, proximal muscle twitch was initially obtained in two of the three cases. In our first case, only pectoralis twitch was obtained and injection through the catheter at this end-point led to anterior spread of local anesthetic between the axillary artery and pectoralis muscle and block failure. In cases 2 and 3, successful block occurred after visualization of local anesthetic spread posterior to the axillary artery. The anatomy of the brachial plexus is variable at the infraclavicular level. Using ultrasound to visualize the plexus as it passes from its origin in the neck to the axilla, it appears to move from a posterior position in relation to the axillary artery at the infraclavicular level, to the classical anatomical position of the cords (lateral cord superior, posterior cord posterior and medial cord postero-inferior) to the axillary artery (unpublished data).

The musculocutaneous nerve often leaves the lateral cord at or above the infraclavicular level and may explain why injection after biceps stimulation is often associated with inadequate block.[2] In two of our cases, proximal stimulation was associated with anterior spread of local anesthetic, which may fail to reach the brachial plexus leading to block failure. In several of our ultrasound images, spread posterior to the axillary artery appeared to be prevented by a tissue barrier that lay between the needle tip and artery (Figures 1ii and 2i).

In two of the three cases described, we failed to identify distal muscle stimulation despite manipulation of the needle tip to all aspects of the axillary artery. This may be explained in part by the electrical qualities of the arrow 17-G insulated Tuohy needle. However, this also corroborates documented difficulty in obtaining distal muscle stimulation observed by ourselves and by other authors.[2] Repeated blind attempts to seek distal muscle stimulation can be associated with increased morbidity such as vascular puncture and patient discomfort. Pleural puncture is also possible at the infraclavicular level and the distance from skin to pleura using the coracoid technique may be as low as 7.5 cm.[7] The use of ultrasound guidance allows identification and avoidance of vascular and pleural structures as the needle tip is guided in 'real-time' to the point of injection.

The findings of the present case series need to be confirmed with experience in a larger number of cases and by a randomized study to further determine the type of stimulation associated with needle position and spread of local anesthetic during infraclavicular block. In addition, our hypothesis that successful block is associated with spread of local anesthetic posterior to the axillary artery needs to be confirmed in a larger series of patients.

In conclusion, ultrasound guidance during coracoid infraclavicular brachial plexus block may facilitate block success by allowing visualization of the needle/catheter tip location in addition to observation of local anesthetic spread on injection. At the level of the second part of the axillary artery, posterior spread of local anesthetic may increase the possibility of successful block because of the anatomical location of the brachial plexus at this level.

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