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Ultrasound Guided Forearm Nerve Blocks: A Short Review

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Abstract

Nerve blocks of the forearm has been used as standalone anaesthetic technique for surgeries of distal forearm and the fingers, it has also been used as a rescue technique for patchy proximal nerve blocks. The use of ultrasound has helped to identify the precise location of the nerve, avoid discomfort of multiple punctures of landmark based technique and avoids the discomfort of paraesthesia associated with the nerve stimulator. A review of the anatomy and the procedure of performing the block are detailed here.

Keywords: Median Nerve, Nerve Blocks. Pain Relief, Radial Nerve. Ultrasound. Ulnar Nerve

1. Introduction

Anatomical Landmark based blocks of nerves of the forearm with or without the use of peripheral nerve stimulators were limited to the blocks at the level of wrist[1-3] and blocks at the elbow[3,4]. With advent of ultrasound guided blocks of the forearm the nerves could be selectively blocked anywhere in the forearm with greater specificity and avoiding the motor blockade associated with the proximal block[5]. Ultrasound has also been shown to be superior to other techniques for peripheral nerve blocks[6,7]. However, whether this advantage depends on the experience of the practitioner in the technique being used are still unresolved[7].

2. Indications

1. Surgical anaesthesia for hand surgeries including carpal tunnel release[1,2,4,8] and hand trauma[9-12]
2. Rescue blocks for proximal nerve blocks[13]
3. Concomitant distal nerve blocks with proximal plexus block for hand surgries[14,15]
4. Acute pain management in the Emergency room[16-18]
5. Chronic pain[19,20]
6. Post-operative analgesia[21,22]
7. Anaesthesia for treatment of palmar hyperhidrosis[23,24]

3. Anatomical Considerations

A detailed knowledge of the sensory distribution of the nerves of the upper limb is necessary for the use of nerve blocks in clinical practice (Figure 1). It is apparent from Figure 1 that nerve block in the forearm would provide sensory blockade only at the wrist and hand and amore proximal block (preferably at or above the level of elbow) would be required for surgeries in the forearm[25].

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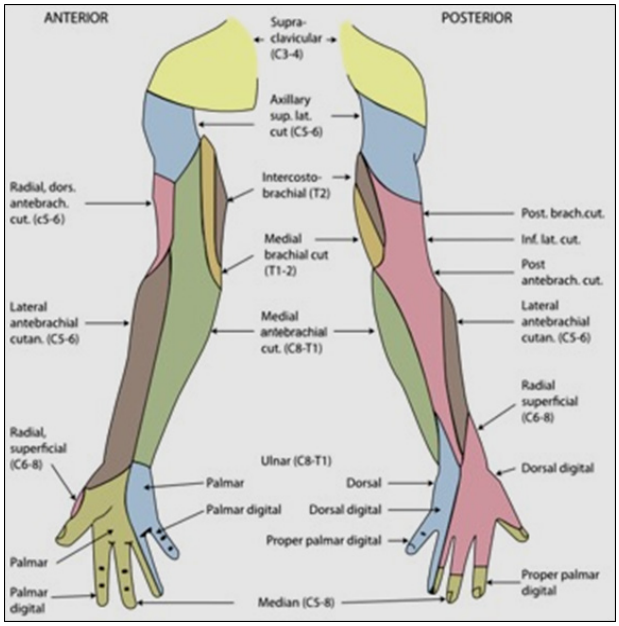

Figure 1. Image showing the sensory distribution of the nerves in the upper limb.

4. Median Nerve

The median nerve enters the forearm by passing between the humeral and ulnar heads of pronator teres and then continues a straight course distally down the forearm in the fascia on the deep surface of the flexor digitorum superficialis muscle. Just proximal to the wrist, it moves around the lateral side of the muscle and becomes more superficial in position, lying between the tendons of the palmaris longus and flexor carpi radialis muscles. It leaves the forearm and enters the palm of the hand by passing through the carpal tunnel deep to the flexor retinaculum.

Ultrasound Anatomy: The Median nerve can be imaged in cubital fossa medial to brachial artery and then for a short distance media to the ulnar artery. Then it lies between two heads of the flexor digitorum superficialis muscle and in the mid forearm between the flexor digitorum superficialis and flexor digitorum profundus, where the nerve typically appears as a round or oval hyperechoic structure (Figure 2). It can be traced to the wrist lying in the midline of the forearm and then among the tendons of the wrist where ultrasound differentiation may be difficult due to similar echotexture of nerve and tendon.

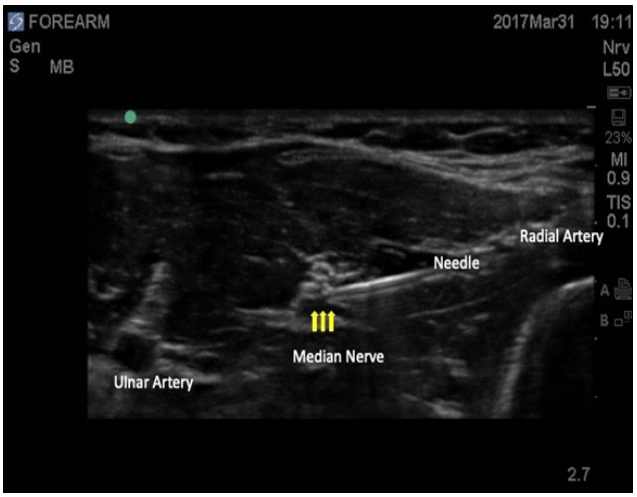

Figure 2. Image shows the median nerve block performed under ultrasound guidance at the level of elbow.

5. Ulnar Nerve

The ulnar nerve enters the anterior compartment of the forearm by passing posteriorly around the medial epicondyle of the humerus and between the humeral and ulnar heads of the flexor carpi ulnaris muscle. After passing down the medial side of the forearm in the plane between the flexor carpi ulnaris and the flexor digitorum profundus muscles, it lies under the lateral lip of the tendon of the flexor carpi ulnaris proximal to the wrist.

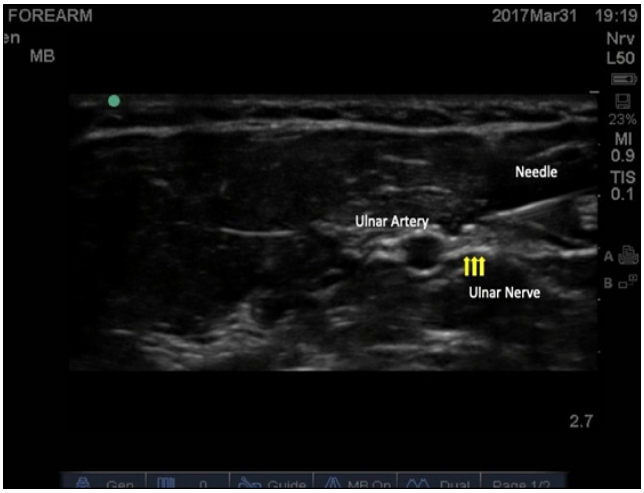

Figure 3. Image shows the ulnar nerve block performed under ultrasound guidance in the forearm.

Ultrasound anatomy: The ulnar nerve can be traced from the distal part of the humerus in the ulnar notch and by sliding the ultrasound probe anteriorly can be seen as a hyperechoic structure that runs medial to the ulnar artery in the mid forearm up to the wrist (Figure 3).

6. Radial Nerve

The radial nerve bifurcates into deep and superficial branches under the margin of the brachioradialis muscle in the lateral border of the cubital fossa and divides into the deep and superficial branches. The superficial branch of the radial nerve is sensory. It passes down the anterolateral aspect of the forearm deep to the brachioradialis muscle and in association with the radial artery. Approximately two-thirds of the way down the forearm, the superficial branch of the radial nerve passes laterally and posteriorly around the radial side of the forearm deep to the tendon of the brachioradialis. The nerve continues into the hand where it innervates skin on the posterolateral surface.

Ultrasound anatomy: The radial nerve is usually blocked in the lower arm where it is seen as a hyperechoic structure exiting the radial groove between the brachioradialis and the brachial muscle. At the level of the elbow joint it is seen dividing into superficial and deep nerve. The superficial nerve then accompanies the radial artery into the mid forearm and separates from it in the distal 1/3 of the forearm Figure 4. It may be difficult to visualise the superficial nerve in the forearm.

Figure 4. Image shows the radial nerve block performed under ultrasound guidance at the level of elbow.

7. Equipment

Anaesthesia equipment as per standards:

- Ultrasound machine with High frequency linear probe preferably 12-15 Mhz
- Nerve block tray
- 20 ml syringe, 5ml syringe
- 25 G hypodermic needle for skin infiltration
- 22g short bevel needle with or without nerve stimulator
- Skin preparation solution
- Sterile cover for the ultrasound probe
- 0.25 % or 0.5% Bupivacaine 2-6ml per nerve blocked

8. Patient Positioning and Ergonomics

The patient is positioned supine with the arm to be blocked on an arm board, abducted at the shoulder at 90 degrees with the palm facing upwards. The ultrasound machine is placed opposite to the operator. For the radial nerve block above the elbow the forearm is either in supination[26] or is placed flexed on the chest[15]. The operator, the site of injection and the ultrasound machine should be in line to maintain the ergonomics.

8.1 Technique

Radial nerve: The radial nerve is usually blocked at the elbow before it branches into the superficial and the deep nerve. In the forearm these branches can be blocked separately[13]. The probe is placed anterior to the elbow towards the lateral epicondyle. The radial nerve is seen between the brachialis and brachioradialis. Inplane technique is used and 3-6ml of local anaesthetic solution is injected. The superficial radial nerve can be visualized up to mid forearm and sometimes up to the distal forearm[27], on the radial side of the radial artery[9,11]. Inplane technique is used to inject the 2-3 ml of local anaesthetic solution. The deep interosseous branch is not usually blocked as it may be difficult to visualize and is mostly motor except

to the wrist joint[27]. Bloc *et al* described[28] a technique to block the posterior interosseous nerve. A more proximal block at or above the elbow is recommended for surgeries of the wrist[13,28,29].

Median nerve: The median nerve is easily blocked in the forearm. With the forearm in the supine position, linear transducer is placed on the ventral aspect of the mid-forearm, where the median nerve is visible in the fascial plane between the flexor digitorum superficialis and flexor digitorum profundus. Singh et al described[30] an "ulnar dive" method especially in the elderly in whom the echo texture of the muscle may make it difficult to visualise the median nerve. The ulnar artery is followed proximally from the distal forearm taking a lateral and deeper course away from the ulnar nerve medially and 'diving' toward the median nerve. Once the median nerve is identified it can be blocked in the mid forearm away from the blood vessels. An in-plane technique is used and 3-6 ml of local anaesthetic solution is injected close to the nerve.

Ulnar nerve: The ulnar nerve is seen on the medial aspect of the forearm. The distal forearm is scanned for the ulnar artery, and the nerve imaged medial to the artery. The nerve is followed proximally into the mid forearm and an inplane technique is used to block the nerve[31, 32]. Hayton et al studied[33] volunteers and suggested a point of blockade to avoid arterial puncture. This was approximately at the junction between the proximal 2/5 and distal 3/5 of the forearm. The dorsal cutaneous branch, which supplies the sensation to the dorsomedial hand and digit may be spared if the block is done in the distal forearm[31]. The authors concluded that the block has to be given above the division of the ulnar nerve which was about 5.7 cm above the ulnar styloid process.

9. Other Sensory Nerves of the Forearm

Lateral cutaneous nerve of the forearm, a continuation of the musculocutaneous nerve has to be blocked for thumb base surgeries[34]. The nerve is blocked on the lateral aspect of the antecubital fossa[35] posterior to the cephalic vein[36].

Medial cutaneous nerve of the forearm, a branch of the brachial plexus and the posterior cutaneous nerve of the forearm, a branch of the radial nerve are best visualised above the elbow[26]. These blocks are outside the purview of this article.

10. Conclusion

Peripheral nerve blocks around the elbow offer a good alternative to either proximal brachial plexus block or general anaesthesia to provide anaesthesia for minor hand procedures; thus, sparing the patient the complications of general anaesthesia . It can also be used to provide excellent postoperative analgesia with a reduced requirement for opioid analgesics.

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