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Original Contribution

Effect of body mass index on angle of needle insertion during ultrasound-guided lateral sagittal infraclavicular brachial plexus block[☆,☆☆]

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Abstract
Study objectives: The aim of our study was to establish the angle of needle insertion from the anterior chest wall during ultrasound-guided infraclavicular brachial plexus block and to examine for any correlation between body mass index (BMI) and insertion angle.
Design: This is a prospective observational study.
Setting: The setting is at an operating room, university-affiliated teaching hospital.
Patients: The patients are 23 American Society of Anesthesiologists physical status 1-3 patients scheduled to undergo elbow, forearm, or hand surgery under regional anesthesia with or without general anesthesia.
Interventions: The intervention is infraclavicular brachial plexus block with or without perineural catheter insertion.
Measurements: The measurement is the angle of needle insertion in relation to the anterior chest wall, BMI, and needle visibility as graded by the anesthesiologist.
Main results: Twenty-three patients were studied. The mean (SD) BMI was 28.5 (5.4). The median (range) of angle of needle insertion was 50 (33-60). The Pearson correlation coefficient for BMI and angle of needle insertion was 0.357. There were no reported complications.
Conclusions: The median (range) angle of needle insertion in relation to chest for our study patients was 50° (33°-60°). The needle visibility was rated difficult, requiring hydrolocation or "heeling-in," in 39% of cases. There was a moderate correlation between BMI and angle of insertion. Despite difficulties with needle visualization, the ultrasound-guided infraclavicular brachial plexus block provided reliable analgesia.

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1. Introduction

The brachial plexus can be targeted at various levels along its course (interscalene, supraclavicular, infraclavicular, and axillary) to provide reliable anesthesia and analgesia for upper limb and shoulder surgery. The infraclavicular brachial plexus block (ICB) is ideal for elbow, forearm, and hand surgery [1]. Compared with other approaches to the plexus, it is useful where the arm is immobile or when a continuous perineural catheter is required. Complications such as phrenic nerve palsy that are associated with more proximal approaches to the plexus are also reduced [1]. However, despite these advantages, it has been described as an ultrasound (US) block "not for beginners" because needle visualization can be difficult [2]. In our experience, this is due to the steep angle of needle insertion, which increases reflective signal losses between the needle and probe [3]. Studies using magnetic resonance imaging (MRI) scans have reported a shallow angle from coronal plane, implicating that needle visualization should not be difficult [4,5]. We were unable to find any studies in literature that have measured the angle of needle insertion from anterior chest wall using US imaging. The primary aim of our observational study was to establish the angle of needle insertion from anterior chest wall using real-time US imaging. Our secondary aims were to establish correlation between body mass index (BMI) and angle of needle insertion and determine the depth of brachial plexus at this level.

2. Methods

The West of Scotland Regional Ethics Committee confirmed in writing that a formal approval was unnecessary for this prospective observational study, as the collection of data was not changing patient care, and US imaging is routinely used for placement of the ICB in our institution (Glasgow Royal Infirmary). Verbal consent was obtained from all patients. Before performing the block, intravenous access was secured, standard monitoring was applied, oxygen was administered at a rate of 2 L/min via nasal sponge, and midazolam was titrated to effect to provide sedation as required. One of the 2 authors (SM or AJM) performed a US-guided ICB in a series of patients undergoing a variety of upper limb procedures. Image/video clip recordings, angle, and depth measurements were performed by another Anaesthesiologist (HPK or VU). A Sonosite S-nerve US machine (SonoSite Ltd, Hertfordshire, United Kingdom) was used. A 38-mm linear probe was placed in the parasagittal plane in the deltopectoral groove medial to coracoid process, immediately below clavicle. The axillary artery was visualized deep to the pectoralis major and pectoralis minor muscles. An attempt was made to identify 3 cords of brachial plexus around the axillary artery. The best image was achieved by optimizing depth, gain, and frequency, always using compound imaging and finally adjusting the tilt of probe. A static image was taken at this point, and callipers were used to measure the distance of axillary artery (at the 6 o'clock position) from the anterior chest wall. The visibility of the 3 cords (lateral, posterior, and medial) was recorded as definitely visible, possibly visible, or not visible. If visualized, the position of each cord was noted in relation to axillary artery.

The length of needle used was determined after this preprocedural scan described above. The distance measured (using on-screen calipers) on the US image from the point of needle entry to the intended needle tip position determined the length of needle used. If this distance was less than 40 mm, then a 50-mm needle was chosen. If this distance was found to be more than 40 mm, then a 100-mm needle was chosen. B Braun 21-G Stimuplex insulated needles with 30° bevel (either 50 or 100 mm) were used for single-shot blocks. Eighteen-gauge (50 or 100 mm) stimulating Tuohy needles (Stimulong Sono; Pajunk, Geisingen, Germany) were used if catheter insertion was required. Techniques to improve needle visibility such as echogenic needles or electronic beam steering were not used. Abduction of the arm was allowed to obtain the best image, though. The needle was inserted in plane to the US beam aiming for the needle tip to be at the 6 o'clock position to axillary artery before local anesthetic injection. This process was recorded. The needle visibility was recorded as clearly visible on static image, only visible on dynamic imaging, or only visible on hydrolocation. If the needle was not visible on static image, the recorded video clip was used to determine needle pathway. "Heeling in", if required to improve needle visualization, was noted [6]. Once the needle tip had reached posterior to the axillary artery at the 6 o'clock position, local anesthetic was slowly injected after negative aspiration for blood. The spread of local anesthetic was observed during injection. The number of needle repositioning attempts needed to optimize the spread of local anesthetic to our chosen optimum spread pattern (between the 3 and 11 o'clock position) was recorded. The anesthesiologist rated the spread of local anesthetic as good, average, or poor. Any changes in the position or visualization of cords, after completion of local anesthetic injection, were noted. All patient identifiers were deleted before storing the above described static images or video clips.

The effectiveness of the block was assessed at every 5 minutes after the local anesthetic injection and after the operation in recovery Post-Anesthesia Care Unit (PACU) area. Sensory assessment for each cord distribution was performed (comparing with nonblocked limb) using ethyl chloride spray. Sensory blockade was graded according to a previously validated 3-point scale using a cold test: 0, no block; 1, analgesia (patient can feel touch, not cold); and 2, anesthesia (patient cannot feel touch) [7]. Sensation of the lateral cord was assessed in the distribution of lateral cutaneous nerve of forearm. The posterior cord was assessed in the distribution of radial nerve by spraying over anatomic snuffbox. The medial cord was assessed in the distribution of ulnar nerve by spraying over the hypothenar eminence and little finger.