Case Report

# Ultrasound-guided Parasagittal Infraclavicular Block for Patients without Neurostimulation Endpoints: A Case Report in Crush Injuries of the Upper Limb

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## Abstract

Evoked motor responses (distal muscle responses) to a specific nerve stimulation are considered an endpoint. Often in crush injuries of the upper limb below the level of the elbow, the distal muscle responses are irrelevant. We report 14 cases of crush injuries of the upper limb that underwent an amputation below the level of the elbow. A parasagittal ultrasound-guided infraclavicular block without neurostimulation was administered in all patients. A reliable local anesthetic (LA) spread either in the perineural or perivascular area is considered adequate. Adequate intraoperative anesthesia and postoperative analgesia were achieved with the deposition of LA beneath the axillary artery.

**Keywords:** Crush injury, infraclavicular block, single-point injection

## Introduction

Infraclavicular block is the brachial plexus block given at the level of cords below the clavicle just medial to the coracoid process. Cords of the brachial plexus lie in the close vicinity to the axillary artery (AA) deep to the pectoralis major and minor muscle and can be easily visualized with parasagittal ultrasound probe placement.[1] For successful infraclavicular block, it is mandatory for local anesthetic (LA) to involve all brachial plexus cords.

Evoked motor responses in the form of extension or flexion of the fingers are the endpoint for LA injections, during an infraclavicular block. In crush injuries of the upper limb, it is impossible to evoke muscle contractions to neurostimulation. With advances in resolution, the use of ultrasound in medicine has been increasing rapidly in dynamic diagnostic studies as well as in interventions.[2,3] With the use of ultrasound visualization of injectate around all cords is plausible. Ultrasound-guided single-point injection below AA at the infraclavicular level ensures adequate drug spread and successful block. Based on this, we report 14 cases of crush injuries who underwent below elbow amputation after blocks were successfully performed with an ultrasound-guided parasagittal infraclavicular approach.

## Case Report

On approval by the Institutional Board (IRB number - IEC-SIOR/Agenda 069), we identified 14 patients with crush injuries of the upper limb at and below the level of the elbow who were administered an ultrasound-guided parasagittal infraclavicular brachial plexus block from January 2018 to June 2020. Of the 14 patients, the American Society of Anesthesiologists Grades I and II, nine were male and five were female patients. All were industrial occupational injuries, eight were right and six were left upper limb injuries [Figure 1a-c]. There were no associated intrathoracic, intra-abdominal, or brain injuries. After securing the intravenous (IV) line in casualty, they were resuscitated with adequate IV fluids and packed cell volumes. To discern the feasibility of the limb salvage procedure, as a

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protocol computed tomography angiography of the upper limb on the damaged side was performed in all patients. Informed consent was obtained explaining the type of surgical procedures and any change of surgical plan depending on intraoperative findings. Anesthesiologist counseled about the possible regional anesthesia interventions in the form of brachial plexus blocks, in particular, the ultrasound-guided parasagittal infraclavicular approach. On arrival in the operation theater, all patients were monitored with electrocardiogram, noninvasive arterial blood pressure, and oxygen saturation. Following the block, all patients were sedated with 0.04 mg/kg of IV midazolam. Amputations were performed in all 14 patients at various levels (above elbow = 2, through elbow = 4, below elbow = 5, and through wrist = 3) as the limbs were nonsalvageable.

### Technique

With the patient in the supine position, the infraclavicular area of the operative side was prepared and draped. A linear probe (13–6 MHz, M-turbo Sonosite) was deployed in the parasagittal plane [Figure 1d] and the infraclavicular area was scanned. AA was identified with the lateral cord at the 10–11 o'clock position and a cord beneath the AA (presumed to be the posterior cord) [Figure 1e and f]. A 22 g 50 mm insulated needle (Pajunk Germany) was introduced from cephalad to caudal under the footprint of the linear probe [Figure 1d], and the tip of the needle was positioned beneath the AA [Figure 2a]. Bupivacaine 20–25 ml 0.5% with clonidine 1 mcg/kg was injected and spread was observed in real-time [Figure 2b-d]. The spread of the injection was assessed during the scan. In five patients, the spread of injectate around the lateral cord was not satisfactory; hence 5 ml of 0.5% bupivacaine was deposited near the lateral cord while withdrawing the needle. Hypoechoic drug spread in close vicinity of hyperechoic cords confirmed successful injection [Figure 2c]. The time to onset of sensory analgesia was a mean of 8.4 min. Postblock adequate analgesia (no pain on tissue handling and requirement of supplemental analgesics) was achieved in all patients.

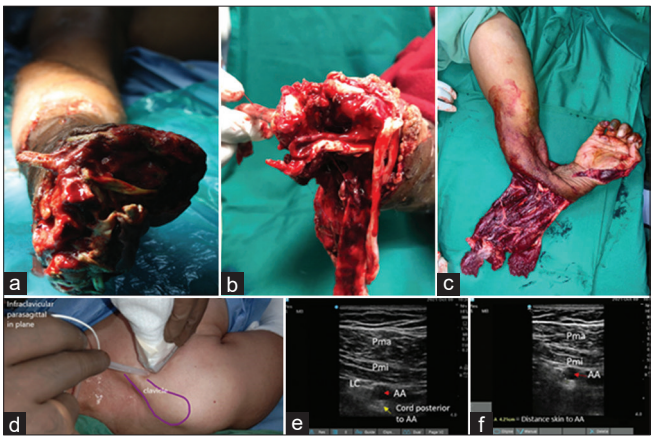


**Figure 1:** (a-c) Crush injuries of the upper limb with loss of neuromuscular units, (d) Ultrasound-guided parasagittal infraclavicular block, (e) Brachial plexus cords posterior to the AA beneath the Pma and Pmi; LC, (f) Distance from the skin to the posterior of the AA. AA: Axillary Artery, Pma: Pectoralis major, Pmi: Pectoralis minor, LC: Lateral cord

Amputations were executed in all patients without supplementation of general anesthesia.

Postoperative all patients received intramuscular diclofenac sodium 75 mg on the first complaint of mild pain and repeated twelve hourlies thereafter. Rescue analgesic was in the form of IV tramadol 50 mg if the visual Analogue scale (VAS) was more than 4 at any point in time

## Discussion

A distal muscle contraction is considered an endpoint during an ultrasound-guided infraclavicular block. It is well established that a posterior cord stimulation (94%) during an ultrasound parasagittal infraclavicular block predicts a successful block and is considered a central placement of LA, in the infraclavicular area.[4] However, intact muscle groups are required to evoke a specific muscle contraction in relation to the brachial cord. In patients with loss of neurovascular and muscle groups as in crush injuries, the role of neurostimulation is ineffectual.

Magnetic resonance imaging description of the location of the infraclavicular brachial plexus, suggests the cords are positioned at a distance of 2 cm from the mid-point of the AA from 3 to 11 o'clock position.[5] The posterior and medial cords are situated between the 4 and 8 o'clock positions. Successful ultrasound infraclavicular brachial plexus block without neurostimulation is reported in a series of three cases with LA spread observed beneath the AA.[6]

The septum was demonstrated during the ultrasound-guided parasagittal infraclavicular block,[7] and penetrating this septum posterolateral to the AA was mandatory to achieve an adequate spread of LA and a successful block.[7] The use of a noncutting (20 g Tuohy) needle, appreciation of a fascial click as the needle tip penetrates the septum and an anterior

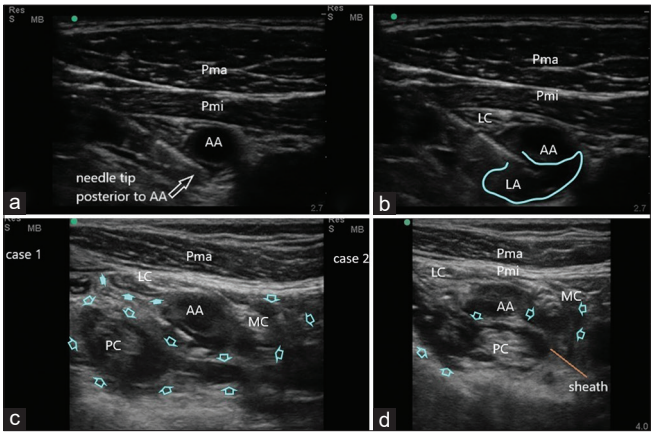


**Figure 2:** (a) Echogenic needle tip positioned posterior to the AA, (b) Initial LA distribution in the vicinity posterior to the AA, (c) Without redirection of the needle, the final volume of LA diffuses at all brachial cord levels. The cords are engulfed in sheath (highlighted with hollow blue arrows), (d) In another case, the topographical arrangements of the brachial cords, engulfed with local anesthetic (highlighted with hollow blue arrows). LA: Local anesthetic, AA: Axillary artery

displacement of AA was considered a hallmark of a successful ultrasound-guided infraclavicular block.[8]

In our case series, 14 patients underwent below-elbow amputations at various levels, and adequate anesthesia and analgesia were secured with ultrasound-guided parasagittal infraclavicular block. The spread of the LA was confirmed in all images, engulfing the three cords, with a separate sheath around each cord.

A cadaveric study observed fascial layers in the posterolateral and posterior area to AA that would impede the diffusion of solution (20–30 ml) in the infraclavicular area and suggested a higher volume of injectate.[9] However, a recent cadaveric study revealed diffusion of 20 ml latex encircling all the cords after a single injection below the AA.[10]

Although septa have been incriminated as a cause for block failure,[9] a little-known anatomical space, provides an anatomical mechanism of action to explain unsuccessful ultrasound infraclavicular block.[11]

In comparison with ultrasound infraclavicular block (40 ml),[12] the supraclavicular is fraught with varying incidences of diaphragmatic paresis, pneumothorax, Horner's syndrome subclavian artery punctures, and sensory sparing reported of at least two nerves in the supraclavicular group. Moreover, it was concluded that the onset of sensory block achieved by infraclavicular was statistically significant compared to supraclavicular.[12] Block efficacy among various studies,[12] has been consistently at 90%–95% with the ultrasound infraclavicular approach. Apart from the shortest performance time, a single injection with a "U" spread of LA around the AA is adequate for a successful block of the musculocutaneous nerve and provides better tourniquet tolerance.[13]

Through this case series, we recommend that with needle tip placement beneath the AA and injection of LA posterior to the AA a spread that engulfs all the cords is accompanied by a successful block in patients who do not have endpoints (evoked motor responses) for neurostimulation.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

There are no conflicts of interest.

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