Brief Report

Ultrasound-guided retroclavicular approach infraclavicular brachial plexus block for upper extremity emergency procedures

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1. Introduction

Emergency practitioners (EPs) routinely manage patients with painful upper extremity injuries, fractures, dislocations, large wounds or abscesses. Reliance on procedural sedation and opioids for peri-procedural pain control often results in inadequate analgesia while risking the complications of unintended sedation, hypotension, nausea, vomiting, and respiratory depression [1]. Procedural sedation involves assembling a team of additional staff and equipment, often impeding ED patient throughput, and potentially exposing the patient to rare but serious complications. Commonly performed emergency procedures of the upper extremity such as fracture and dislocation reduction, wound debridement, and abscess incision and drainage are ideal candidates for ultrasound-guided (USG) regional anesthesia of the brachial plexus. However, adoption of regional anesthesia by emergency practitioners has been limited by concerns for potential complications and perceived technical difficulty. The Retroclavicular Approach to The Infraclavicular Region (RAPTIR) is a newly described USG brachial plexus block technique that optimizes sonographic needle visualization as a means of making regional anesthesia of the upper extremity safer and easier to perform. With RAPTIR a single well-visualized injection distant from key anatomic neck and thorax structures provides extensive upper extremity anesthesia, likely reducing the risk of complications such as diaphragm paralysis, central block, nerve injury, vascular puncture, and pneumothorax. Additionally, patient positioning for RAPTIR is well suited for the awake, acutely injured ED patient as the upper extremity remains adducted in a position of comfort at the patient’s side. Thus, RAPTIR is a potentially ideal combination of infraclavicular targeting, excellent needle visualization, single injection, safety, comprehensive upper extremity analgesia, rapid performance, and comfortable patient positioning. Herein we present the first description of the RAPTIR utilized in the ED. Our initial experience suggests this is a promising new technique for brachial plexus regional anesthesia in the ED setting.

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For extensive upper extremity anesthesia in the ED setting, ICB has several advantages over ISB and SCB including more reliable blockade of the ulnar nerve, and fewer adverse events such as diaphragm paralysis, central block, pneumothorax, or Horner’s syndrome [6-11]. This makes ICB a better choice for ED patients with pulmonary comorbidities or respiratory depression secondary to opiates administered prehospital and in the ED, who may not tolerate the potentially significant compromise of respiratory function from phrenic nerve blockade and resulting diaphragm paralysis.

Like the ICB, the AXB targets the brachial plexus a safe distance from the neck and pleural dome. However, for an AXB the arm must be abducted, which is poorly tolerated by ED patients with an acutely injured upper extremity [7,8]. Furthermore, early branching of the medial cutaneous nerve of the forearm, musculocutaneous nerve, and axillary nerves requires multiple needle passes and redirections for an AXB to achieve the extensive arm anesthesia that can be achieved by a single injection ICB [6-8]. Each needle pass and redirection adds time to the procedure and increases risk of needle to nerve contact or vascular puncture.

Another advantage of the ICB over other brachial plexus blocks is the simplified sonoanatomy of the infraclavicular space. The primary landmarks, the axillary artery and second rib, are easily identified and avoided. Even the individual cords of the plexus need not be identified sonographically, as a larger volume of LA can be injected within the sheath at the infraclavicular location with minimal risk of adverse effect. This permits reliable blockade of all the cords with a single injection, eliminating the need to target them individually [12-17].

Despite all these advantages, wider adoption of the ICB has likely been hindered by the poor needle visualization associated with the ICB. Passing a block needle from the traditional insertion site just below the clavicle to the brachial plexus requires a steep trajectory. This places the needle and the ultrasound beam at an acute angle to one another, resulting in the ultrasound beam reflecting off the needle and away from the transducer, greatly reducing needle visibility [18].

![Ultrasound technique for finding the injection target. A. Position A: With the transducer marker cephalad, the transducer is placed on the medial clavicle in the parasagittal orientation with the clavicle and infraclavicular region in view. B. Position B: Maintaining the same orientation and keeping the clavicle at the cephalad edge of the view, the transducer is moved laterally to the deltopectoral groove, placing the transducer lateral to the thoracic cage and medial to the coracoid process. While moving the transducer, the axillary artery is sonographically observed emerging from beneath the clavicle, traversing the 2nd rib, then coursing away from the thoracic cage. When the 2nd rib drops out of view the injection target is identified. The transducer is then rotated slightly so that the caudad portion aims towards the axilla. C. Ultrasound image at Position A. Axillary artery visible emerging from under the clavicle. The 2nd rib is also visible. D. Ultrasound image at Position B. Axillary artery and clavicle still in view, but the 2nd rib is no longer visible as the transducer has moved lateral to the thoracic cage. The injection target posterior to the axillary artery is now in view. With experience an alternative position can be used between position A and position B, in a location where the axillary artery has emerged far enough from the clavicle to have a sufficient view of the approaching needle, but where the 2nd rib is still in view and used to shield the pleura from the needle. This can be helpful in patients with a “full” supraclavicular fossa, but is not advised for novice practitioners. Dotted line = clavicle, C = acoustic shadow of the clavicle, PecMa = pectoralis major, PecMi = pectoralis minor, AxA = axillary artery, AxV = axillary vein, R2 = 2nd rib, CV = cephalic vein, green dot = injection target location. (AxV and CV may not be visible on ultrasound due to compression from transducer pressure on the chest wall).
For the non-specialist, navigating a poorly visualized needle to a peri-vascular injection target can be a formidable task.

The RAPTIR was developed to overcome this limitation by approaching the brachial plexus “retroclavicularly,” i.e. from behind the clavicle, placing the block needle at an angle parallel to the ultrasound transducer. At this angle, the ultrasound beam strikes the needle perpendicularly and reflects directly back to the transducer, greatly enhancing needle visibility. Thus, the operator can maneuver the needle to the injection target assured that the needle tip is avoiding adjacent neurovascular and thoracic structures [20-22].

Since the ultrasound beam cannot penetrate the clavicle, the RAPTIR block needle initially passes through an approximately 3 cm “blind zone” before emerging from the clavicle’s acoustic shadow and becoming visible on ultrasound in the infraclavicular space. This presents the novel experience of passing a needle behind a bone while performing a regional block. To safely transverse this “blind zone,” the transducer is positioned lateral to the thoracic cage and aimed towards the axilla, then the advancing needle is simply aligned with the long axis of the ultrasound beam. By staying close to the underside of the clavicle and advancing at an angle parallel to the surface of the gurney bed, the block needle passes safely through muscle and loose connective tissue [20-25].

3. Cases

Patient 1: A 16-year-old male needed reduction and splinting of a closed distal radius fracture and ulnar dislocation (Galeazzi fracture) after his gloved hand was caught in a drill press.

Patient 2: A 56-year-old male required reduction and splinting of a closed posterior elbow dislocation after a fall.


In all patients, a RAPTIR was performed using 30 mL of 1%–1.5% lidocaine with epinephrine. All patients had complete upper extremity anesthesia within 30 min permitting comfortable, awake completion of needed procedures.

4. Description of technique

4.1. Pre-assessment

Inspect the patient’s pectoral region, clavicle, supraclavicular fossa, and neck length. Patients with a thick pectoral region, deformed clavicle...
(such as from prior fracture), “full” supraclavicular fossa, or a short neck are poor candidates for the RAPTIR and another technique should be considered.

4.2. Positioning

Place the patient in a semi-recumbent supine position with the affected extremity adducted at their side in a position of comfort. Rotate the patients head away from the injured limb, and place a folded towel under the ipsilateral shoulder. Stand at the head of the bed with the ultrasound system in direct line-of-sight on the side of injury.

4.3. Scanning

Place a high-frequency linear transducer in parasagittal orientation over the medial portion of the clavicle with the transducer marker facing cephalad (Fig. 1A). Slide the transducer laterally along the clavicle to the deltopectoral groove, then rotate the transducer slightly so that it aims towards the axilla (Fig. 1B). While sliding laterally, sonographically visualize the axillary artery in cross section as it emerges from under the clavicle (Fig. 1C), traverses the 2nd rib, then courses away from the thoracic cage (Fig. 1D). The extrathoracic portion of the axillary artery will be apparent on ultrasound when the 2nd rib drops out of view. At this location, identify the injection target which lies just posterior to the axillary artery.

4.4. Injection

Keeping the transducer fixed over the injection target and aimed at the axilla, identify a block needle insertion site aligned with the long axis of the ultrasound beam and approximately 2 cm cephalad to the clavicle (Fig. 2). This will ensure a safe needle path and allow adequate room for the needle to clear the posterior surface of the clavicle without angling posteriorly.

Place a LA skin wheal at the insertion site using a 25–27 g needle, then insert a block needle (e.g. Tuohy 20 g 90 mm epidural needle) through the skin wheal and advance the needle beneath the clavicle towards the ultrasound beam at angle parallel to the gurney bed. When passing through the “blind zone” created by the clavicle, the needle should never be angled posteriorly as this increases the risk of

![Fig. 4](image-url)
pneumothorax. After penetration through the approximately 3 cm “blind zone,” the operator may feel a slight “fascial click” theorized to correspond with penetration of a fascial septum within the axillary sheath [12,15]. Aspirate to check for inadvertent vascular puncture, and then inject small aliquots of LA. Anechoic anesthetic fluid should be seen spreading just posterior to the axillary artery, confirming needle tip location within the sheath [Fig. 3B] [12-17]. Once satisfied with the needle position, gradually inject LA until a total of 20–35 ml is deposited within the sheath. In our experience, total needleling time is usually less than 5 min and dense arm anesthesia develops within 30 min.

5. Discussion

Brachial plexus regional anesthesia is an effective alternative to procedural sedation for painful emergency procedures [2]. Despite its efficacy, brachial plexus regional anesthesia remains relatively uncommon in the ED due to perceptions that it is technically difficult, time consuming, and associated with complications. The RAPITIR may provide an easily mastered, safe, and practical technique for brachial plexus regional anesthesia. Advantages of the RAPITIR include: infraclavicular injection point (comprehensive anesthesia of the upper extremity, greater distance from the neural axis, reduced risk of phrenic nerve blockade or pneumothorax); “one and done” injection (single injection blocks the entire plexus without multiple needle passes decreasing needleling time and minimizing risk of needle to nerve contact or vascular puncture); and comfortable patient positioning (requires no special manipulation of injured extremity).

The traditional approach to the TCB (TICB) with the insertion point caudal to the clavicle shares many of these advantages with the RAPITIR. However, the physical barrier of the clavicle forces the TICB needle into a steep trajectory, resulting in poor needle visualization [Fig. 4A & C] [18-22]. By moving the insertion site cephalad and passing the needle underneath the clavicle in the RAPITIR, the needle emerges from beneath the clavicle nearly parallel to the ultrasound transducer surface [20-22]. Because the smooth, straight surface of the needle acts as a specular reflector, when the needle and transducer are thus aligned the beam reflects directly back to the transducer, markedly improving needle visualization [Fig. 4B & D] [18-22]. The nearly horizontal trajectory of the RAPITIR also minimizes the risk of puncturing deep into the thoracic cavity and pleura and avoids the thoracoacromial artery, cephalic vein, and lateral cord, all of which lie near the TICB needle path [3]. Additionally, the retroclavicular approach does not require the patient to move or abduct their arm, in contrast to the TICB where both visualization of anatomy and ease of needle trajectory are improved with arm abduction [26].

6. Conclusion

Single-injection USG regional anesthesia of the brachial plexus can be an ideal method of analgesia for painful upper extremity ED procedures including fracture and dislocation reduction, wound debridement, complex laceration repairs, and l&d. The flat needle angle, distance from critical neck and thoracic structures, comprehensive upper extremity anesthesia, and minimal manipulation of the injured upper extremity are clear benefits of the RAPITIR, making it an appealing technique for EPs to rapidly integrate into the clinical care of the acutely injured patient. Our initial experience suggests that the RAPITIR is technically feasible and highly effective in providing arm anesthesia, eliminating the need for procedural sedation or excessive opiates in these patients. Further study in a larger patient population is needed to evaluate if the RAPITIR results in improved efficacy, increased safety, and more rapid acquisition of skill for novice providers.

Prior presentations

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References