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Clinical Investigation

CLINICAL INVESTIGATION

Ultrasound-guided anterior approach to the axillary and intercostobrachial nerves in the axillary fossa: an anatomical investigation

G. Feigl[1,*], E. Aichner[1], C. Mattersberger[1], P. K. Zahn[2,3], C. Avila Gonzalez[2,3] and R. Litz[2,3]

[1]Chair of Macroscopic and Clinical Anatomy, Gottfried Schatz Research Center, Medical University of Graz, Austria, [2]Department of Anesthesiology, Intensive Care Medicine, Germany and [3]Palliative Care Medicine and Pain Management, Berufsgenossenschaftliches Universitätsklinikum Bergmannsheil GmbH Bochum, Bochum, Germany

*Corresponding author. E-mail: georg.feigl@medunigraz.at

Abstract

Background: The posterolateral and medial aspect of the arm is supplied by the axillary (AXN) and intercostobrachial nerves (ICBN), which are not anaesthetised by an axillary brachial plexus block (ABPB). Blockade of the AXN and the ICBN has been reported in the quadrangular space (QS) posteriorly or by serratus plane block, respectively. An anterior ultrasound-guided approach to block the AXN and ICBN would be desirable to complete an ABPB at a single insertion site.

Methods: After a preliminary dissection study in six cadavers, ultrasound-guided AXN and ICBN injection was performed in 46 Thiel embalmed cadavers bilaterally. Key sonographic landmarks to identify the AXN in the QS are the humerus, teres major muscle, and subscapular muscle. With the same probe position, the ICBN was identified in the subfascial axillary space. Then, 2 ml latex was injected at each nerve and confirmed by dissection.

Results: Muscular and bony landmarks were identified in all cadavers. The AXN was seen in 99% in the QS or at the inferolateral margin of the subscapular muscle and surrounded by latex in 96% of cases. Latex spread to the axillary fossa, within the subscapular muscle, or to the radial nerve was noted in 8% of the injections. The ICBN was seen and surrounded by latex in 100% of cases.

Conclusions: We describe a reliable ultrasonographic approach to visualise the AXN and ICBN anteriorly from the conventional ABPB approach as confirmed in this cadaver study.

Keywords: brachial plexus; brachial plexus blockade; nerve blockade; upper limb; regional anaesthesia; cadaver; neuroanatomy

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Editor's key points

- Brachial plexus block for upper limb surgery is effective, but each approach has limitations.
- Feasibility of combining axillary brachial plexus and intercostobrachial nerve block was investigated using Thiel cadavers.
- Ultrasound was used to identify anatomical landmarks to combine these blocks with single site injection.
- Further work is needed to assess its clinical utility.

Brachial plexus (BP) blocks for upper limb surgery have been described by techniques both above (interscalene, supraclavicular) and below the clavicle (infraclavicular, axillary). Each block approach has its inherent benefits, side-effects, and complications.[1,2] Blocks above the clavicle indeed may provide excellent analgesia for shoulder surgery but inconsistently block the ulnar or medial cutaneous nerves of the arm or forearm.[3] Such blocks therefore do not necessarily provide reliable anaesthesia for surgery at the arm. Furthermore, all block techniques near the clavicle carry the inherent risk of respiratory complications such as pneumothorax or phrenic nerve block.

Axillary BP block (ABPB) provides reliable anaesthesia for elbow and hand surgery without risks of pneumothorax or phrenic nerve block. However, the axillary nerve (AXN) providing sensory supply to the lateral and posterior aspect of the upper arm may be missed by ABPB. Also, undesirable arm movement is possible during surgery because the AXN motor innervation to the subscapular, teres major, teres minor, and deltoid muscles may be spared.[4–6] Blockade of the AXN has been described by landmark,[7] nerve stimulation,[8,9] ultrasound,[10–12] or combined ultrasound and nerve stimulation[13,14] methods all approaching from the back of the arm. The posterior ultrasound-guided technique uses the posterior circumflex humeral artery (PCHA) as the sonographic landmark for nerve identification,[10–14] but this artery is not always present.[15] Furthermore, because the AXN branches before entering the quadrangular space (QS),[4,5,15–20] a block by the posterior approach may be incomplete.

The skin of the medial aspect of the arm is supplied by the medial brachial cutaneous nerve (MBCN), the intercostobrachial nerve (ICBN), and variably by cutaneous branches from the intercostal nerves.[1–6,21–23] To ensure anaesthesia in the medial arm, a subcutaneous ring injection at the axillary fold has been described.[24] If surgical anaesthesia to the entire upper limb below the shoulder is required, a combination of blocks has to be performed.

The purpose of the present study is to evaluate the feasibility of identifying sonographic landmarks that help to see the target nerves for AXN and ICBN blocks from a single conventional ABPB injection location.

Methods

Fifty-two bodies donated to science [all Caucasian type; 21 male, 25 female; 68 (standard deviation, 14) kg, 167 (9) cm, 79 (11) yr], which were donated to the Department of Anatomy of the Medical University Graz, were investigated. They were under the approval and the strict rules of the Anatomical Donation Program of the University of Graz and according to Austrian law. All bodies donated to science were embalmed by Thiel's method to preserve tissue flexibility and allow arm movement to mimic live human conditions.[25,26] In a pilot study, sonographic landmarks for both the AXN and the ICBN were defined in six bodies donated to science. They were positioned supine with the arms in 90° abduction. The clavipectoral triangle and the axillary fossa were dissected by two anatomists (G.C.F. and E.A.), and the course of the AXN and ICBN was traced within their respective fascia layers. The contralateral axilla was scanned by two anaesthetists (C.A.A.G. and R.J.L.) experienced in ultrasound-guided regional anaesthesia and scanning bodies donated to science preserved using Thiel's method.

For identification of the AXN, the QS was dissected from the front showing the nerve and the PCHA entering the QS and coursing together to the posterior aspect of the humerus. The AXN was traced proximally to the ventral surface of the subscapular muscle. The subscapular muscle, the upper border of the teres major muscle, and the humerus were key sonographic landmarks leading to the AXN. The ICBN was identified in the subfascial axillary space. In this space, fat, lymph nodes, vessels, and other cutaneous branches of the upper lateral intercostal nerves were found as well (Fig. 1).[5,6] After crossing the subfascial axillary space the ICBN coursed on the surface of the latissimus dorsi muscle covered by the superficial axillary fascia.

For scanning, a linear high-frequency 4–12 MHz transducer of a portable ultrasound machine (LOGIQe; GE Healthcare, Wauwatosa, WI, USA) with a 'small nerves' preset, and a virtual convex mode was used allowing for an extended overview. The ultrasound probe was placed transversally at the lateral border of the pectoralis major muscle in position 1 (Fig. 2) with the arm abducted to identify the brachial plexus in the axilla. In this position, the BP was located anterior to the teres major muscle

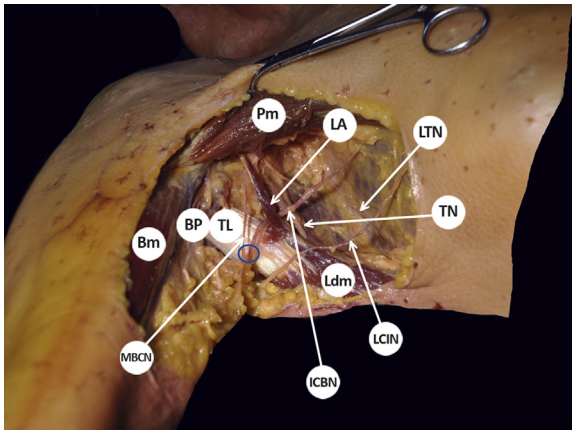

Fig 1. Spatial relationship of the nerves supplying the axilla and the cutis of the medial upper arm. Note that Langer's arch (LA) is present with the intercostobrachial nerve passing underneath forming an anastomosis (blue circle) with the medial brachial cutaneous nerve. LTN, long thoracic nerve; TN, thoracodorsal nerve; LCIN, lateral cutaneous branch of the third intercostal nerve; ICBN, intercostobrachial nerve; MBCN, medial brachial cutaneous nerve; BP, brachial plexus; Ldm, latissimus dorsi muscle; Bm, biceps muscle; Pm, pectoralis major; TL, tendon of latissimus dorsi overlying teres major muscle.