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Identifying the Upper Subscapular Nerve as a Target for Chronic Shoulder Pain

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SUMMARY

Introduction. Shoulder pain is one of the most common etiologies of chronic pain representing roughly 16% of all presenting patients (1). The branches of the subscapular nerve have been suggested as contributing to the sensory innervation of the shoulder and may have clinical value as a therapeutic target for nerve block, ablation, and stimulation.

Methods. Six formalin embalmed willed body donors were used, reflecting twelve shoulders for study. Careful dissection was performed to identify the upper and lower subscapular nerves and respective branches as they approached the shoulder joint. After placing the cadaver in anatomical position, measurements were taken from two landmarks: 1) just proximal to the immediate branch from the upper subscapular nerve (USN); and 2) the medial aspect of the coracoid process (CP). The distance from the medial aspect of the CP directly to USN just proximal to its first branch was taken using a digital caliper in millimeters (**table I**).

Results. The USN sends articular branches that directly innervate the anterior glenohumeral joint (GHJ). The average distance from the medial aspect of the CP to the USN just prior to its branches was 3.76 cm ± 0.62 cm. The average distance from the medial aspect of the CP to an intersecting perpendicular line drawn directly superior from the USN just proximal to its first branch was 0.94 cm ± 0.03 cm.

Conclusions. Our findings of the USN and LSN add to prior quantitative neuroanatomical relationships of these nerves and potential targets for therapeutic intervention.

KEY WORDS

Pain; subscapular nerve; intervention; chronic pain; therapy.

INTRODUCTION

Of the patients presenting with chronic musculoskeletal pain, chronic shoulder pain represents roughly 16% of the patient population (1). The direct and indirect costs of chronic shoulder pain have been estimated to be roughly 7 billion dollars and include the direct cost of medical management in addition to the estimated opportunity cost of reduced functionality (2, 3). Etiologies of chronic shoulder pain are numerous and diverse. These include rotator cuff tendinopathy or tear, sub-acromial bursitis, osteoarthritis, adhesive capsulitis, and nerve impingement (1, 3, 4). Many nerves have been found to innervate the shoulder joint and include the upper and lower subscapular nerves as well as the supra-scapular, axillary, and lateral pectoral nerves (7). Numerous techniques have been employed for the management of chronic shoulder pain including nerve radiofrequency ablation (RFA), intra-articular joint injection therapy, and bursal injection therapy. Understanding the location of articular nerves which supply the gleno-humeral joint (GHJ) could have therapeutic benefit and allow for more approximate interventional targeting (7).

The upper and lower subscapular nerves most commonly originate from the posterior cord of the brachial plexus. The upper subscapular nerve (USN) and lower subscapular nerve (LSN) insert proximal to the myo-tendinous junction of the subscapularis muscle to provide motor innervation (9), after which sub-muscular (10) articular branches emerge. The USN has been found to produce multiple articular branches (USNAb) that traverse or pierce the superior border of the subscapularis muscle beneath the coracoid process, then dive deep to the muscle to innervate the anterior-superior GHJ capsule (10, 11).

Although the use of regional anesthesia for shoulder pain has been reported for use during the peri-operative period, there has been limited data discussing the use of such techniques in the chronic shoulder pain population. In the article, "Suprascapular nerve block in chronic shoulder pain: are the radiologists better," authors Shanahan and Ahern discuss the use of a single shot injection of methylprednisolone ± the inclusion of bupivacaine around the supra-scapular nerve (13). Although their results demonstrate significant pain improvement scores in all of their selected participants, a supra-scapular block does not include the articular branches from the anterior-medial portion of the shoulder and thus the block may not be as comprehensive in its nerve inclusion. That being said, nerve blocks targeting both the subscapular nerve as well as the suprascapular nerve in combination have already begun to be implemented in the clinical setting. Within the article, "Effectiveness of new nerve blocks method on the articular branches of the suprascapular and subscapular nerve to treat shoulder pain" authors Lee *et al*. performed a study whereby 52 patients with chronic shoulder pain underwent a combined suprascapular and subscapular nerve block. All of the included patients reported reduced disability index scores which persisted for greater than 6 months in much of the patient population. This demonstrates that inclusion of articular branches from the anterior aspect of the shoulder play a significant role in patient improvement and should be included during interventional management of chronic shoulder pain (12).

The USN and LSN innervate the superior and inferior portions of the subscapularis muscle, respectively; therefore damage to the nerve can have debilitating effects during medial rotation of the shoulder joint (9). Interventional methods such as RFA require understanding of the likely motor portion of the USN and LSN as well as other nearby critical structures. We aimed to quantify the location of the USN and LSN relative to anatomic landmarks to advance locational understanding of these nerves as a potential targets for regional anesthesia and interventional shoulder pain management.

METHODS

Cadavers

Six formalin embalmed willed body donors were used, reflecting twelve shoulders for study. Three of the cadavers were men and three were women. Specimens were embalmed using a 2.5% Formaldehyde, 5% Phenol, and 35% alcohol embalming fluid. The care, handling, storage, dissection, and imaging studies of all body donors were performed in compliance with the rules and regulations of the State Anatomical Board of the State of Texas and the policies, procedures, and ethical guidelines of the University of Texas Health Science Center at San Antonio's Body Donation Program.

Dissection

Each shoulder was carefully removed from the preservative fluid. The skin, adipose, and connective tissue of the antecubital fossa was removed with dissection proceeding proximally toward the posterior cord of the brachial plexus. The anterior-medial aspect of the deltoid and the lateral aspect of the pectoralis major and minor were reflected in opposing directions to expose the axilla and its underlying structures. Relevant vascular structures such as the brachial artery, axillary artery, and subclavian artery were

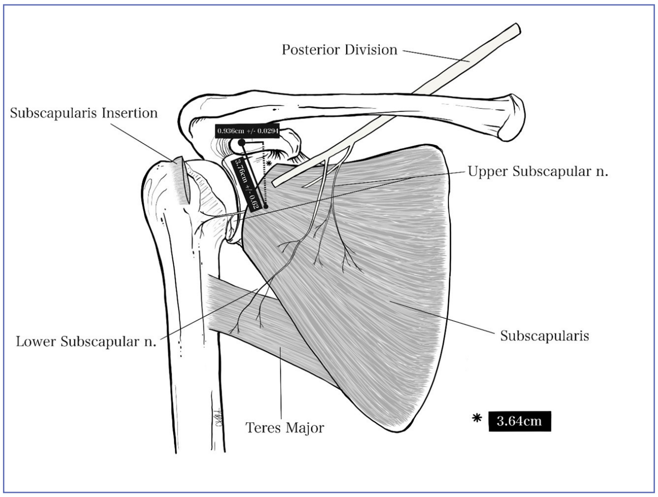

Figure 1. Visual representation of the cadaveric dissection with labeling of the USN, LSN, and relevant musculoskeletal structures. The USN sends glenohumeral articular branches laterally distal and deep to its insertion into the subscapularis muscle. On average, this point was 3.64 cm inferior to the medial border of the coracoid process.

dissected from adipose while the individual components of the brachial plexus were identified. Once the posterior cord was found, the three most immediate branches were traced, namely the LSN (**figure 1 B**), thoracodorsal nerve, and USN (**figure 1 A**). Occasionally the LSN branch branched from the axillary nerve. Care was taken to identify the end targets of the individual branches of the posterior cord to confirm their identity. The nerves were traversed towards their expected location as a form of confirmation.

Once the nerves were identified, they were individually tagged. A metal pin was used to tag the USN immediately proximal to the first glenohumeral articular branch. After placing the cadaver in anatomical position, measurements were taken from two landmarks: 1) just proximal to the immediate branch of the USN; and 2) the medial aspect of the coracoid process (CP). The distance from the medial aspect of the CP directly to USN just proximal to its first branch was taken using digital caliper in millimeters (**table I**). Measurements from the medial aspect of the CP were taken in the transverse plane to an intersecting perpendicular line drawn directly superior from the USN just proximal to its first branch (**table II**). Fluoroscopic imaging was additionally employed to evaluate the relationship of the tagged upper subscapular nerve, just before its bifurcation into the shoulder (metal pin), to bony landmarks (**figure 2**).

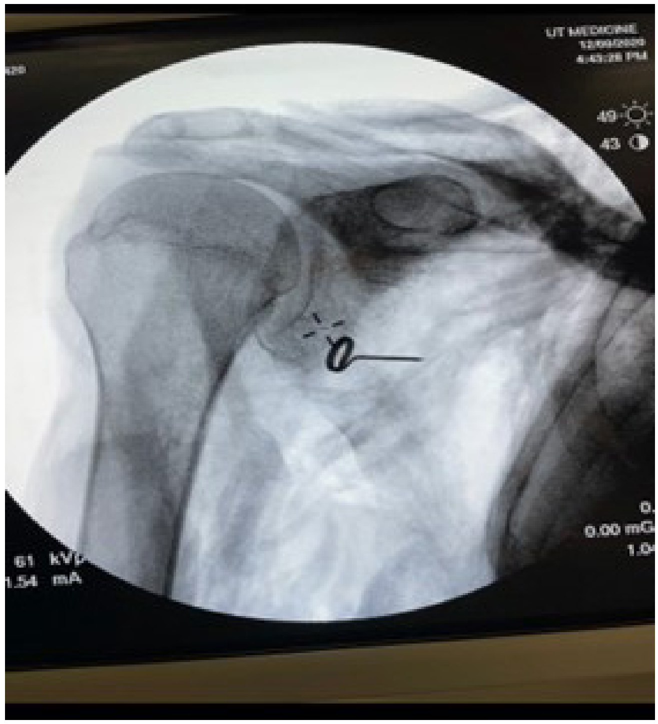

Figure 2. C-arm X-ray Image of the right shoulder with pinpoint identification of the upper subscapular nerve. A total of 12 shoulders (6 of the right shoulder, 6 of the left) were taken to provide radiographic insight into the location of the upper subscapular nerve.

Table I. Measurements from medial aspect of the coracoid process to the Upper subscapular nerve just proximal to glenohumeral articular branches.

	Right	Left
Cadaver 1	27 mm	45 mm
Cadaver 2	23 mm	39 mm
Cadaver 3	35 mm	62 mm
Cadaver 4	46 mm	37 mm
Cadaver 5	35 mm	25 mm
Cadaver 6	49 mm	28 mm

Table II. Measurement from the medial aspect of the coracoid process to an intersecting perpendicular line drawn directly superior from the Upper subscapular nerve just proximal to its first branch.

	Right	Left
Cadaver 1	8 mm	7 mm
Cadaver 2	10 mm	6 mm
Cadaver 3	20 mm	18 mm
Cadaver 4	5 mm	6 mm
Cadaver 5	0 mm	10 mm
Cadaver 6	10 mm	13 mm

Figure 3. USN Identification.

Figure 4. The lower subscapular nerve identified proximally to the bifurcation of the axillary and radial nerve.

RESULTS

Relationships are summarized in **figure 3**. The USN send articular branches that directly innervate the anterior glenohumeral joint (GHJ). The average distance from the medial aspect of the CP to the USN just prior to its branches was 3.76 cm ± 0.62 cm. The average distance from the medial aspect of the CP to an intersecting perpendicular line drawn directly superior from the USN just proximal to its first branch was 0.94 cm ± 0.03 cm. In our specimens we did not find articular contribution to the GHJ from the LSN (**figure 4**).

DISCUSSION

Identification of anatomic landmarks to be used as neuroanatomical targets for shoulder pain is continuing to improve. Our findings of the USN and LSN add to prior quantitative neuroanatomical relationships of these nerves (6, 9). The USN appears to be more promising than the LSN as an interventional target for shoulder pain as it consistently innervates the GHJ while the LSN does not. A recent review (7) postulated that the USN articular branches may be targeted in a zone near the base of the coracoid process at anterior, superior portion of the glenoid neck based on analysis of limited available prior anatomic studies. However, we found the point of origin of articular branches of the USN to be over 3.5 cm inferior to the coracoid process, and generally overlying the inferior one-half of the glenoid. Based on our findings, fibers of the USN may not be present near the base of the coracoid process nor superior glenoid, suggesting a more inferior nerve branch target than was suspected prior. While the proposed anterior upper glenoid zone may have clinical utility, further study is needed to identify a safe zone that better incorporates articular branches of the USN specifically to better comprehensively incorporate nerves from the anterior shoulder which may be contributing to the patients' symptomatology.

We would propose, for the purposes of nerve block, a location just medial to the glenohumeral joint line, approximately 3.5 cm inferior to the base of the coracoid process, as a theoretical target for USN articular branches. Subscapular nerve blocks in this region have potential clinical benefit for acute analgesia of the anterior shoulder (9). This can supplement other known peripheral nerve blocks (suprascapular, axillary) for providing analgesia of the shoulder with less risk of phrenic nerve block than interscalene plexus block. Ultrasound guidance affords the identification of critical neurovascular structures during block performance. Nerve ablation may present potential safety challenges, namely that targeting the USN may require trajectories and end-points in very close proximity to the brachial plexus and to the axillary artery. Further anatomic and clinical studies are needed to validate the concept of USN as a safe and effective target for chronic shoulder pain and for perioperative shoulder analgesia.

CONCLUSIONS

Shoulder pain is one of the most common etiologies of chronic pain and represents roughly 16% of all presenting patients. Indirect costs of chronic shoulder pain are significant and play a major role in reduced quality of life for patients. Moreover, direct costs are also substantial and have been measured on a scale of billions of dollars in medical expenses and lost compensation and productivity. The upper subscapular nerve has been postulated to contribute sensory branches to anterior-superior portion of the glenoid neck. Many cadaveric studies have been performed to better understand the articular branches of the shoulder joint, however our cadaveric studies suggest that the articular branch targets of the anterior shoulder may be more inferior-medial than previously described in the literature.

Through our anatomic dissections, it was evident that the articular branches of the upper subscapular nerve were in actuality inferior to the coracoid process and overlaying the inferior one-half of the glenoid. The newly identified location of the articular branches of the upper subscapular nerve will help re-direct physicians performing interventions on the shoulder for chronic shoulder pain

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None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

KB: study design. KB, JF: anatomic dissection, writing manuscript. SP, OR: anatomic dissection. KH: anatomic artistry. MMcC: study design. ME: study design, anatomic dissection, writing manuscript, primary investigator.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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