

Usefulness of Ultrasound in Procedures at the Suprascapular Notch Region

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ABSTRACT

Currently developments in high-frequency ultrasound transducer technology have enabled precise investigation of several anatomical structures on small areas (nerves, vessels small band-shape fascicular structure). Accurate ultrasonographical visualization of the nerve may also increase the success rate of it block procedure. Also ultrasonographical investigation is a useful tool for identifying some painful clinical conditions and preventing possible complications. The suprascapular notch is a depression located on the superior border of the scapula, medially to the coracoid process. Morphology of the suprascapular notch region is important from clinical point of view because it is the most common place of the suprascapular nerve compression and injury. The problem of suprascapular nerve entrapment formation is complex and depends also on factors such as the morphological variations of the structures in this region. Suprascapular nerve block close to the nerve was more effective than blind injection in the suprascapular fossa.

Specificity of this area makes ultrasound important in investigation, especially to recognized suprascapular nerve. Visualization of the suprascapular artery and vein is also important to prevent not expected blinding during procedures. The aim of this chapter was to describe the usefulness of sonographic examination at the suprascapular notch region.

Keywords: Ultrasound; Suprascapular Notch; Suprascapular Nerve Neuropathy; Suprascapular Nerve Blockade

INTRODUCTION

Developments in high-frequency Ultrasound (**US**) transducer technology have enabled precise investigation of several anatomical structures on small areas where nerves and vessels exist, including even small band-shape fascicular structure [1-3]. Accurate ultrasonographical visualization of the nerve may also increase the success rate of it block procedure [4]. What is more, ultrasonographic investigation is a useful tool for identifying some painful clinical conditions and preventing possible complications [5,6].

During fluoroscopy and CT-guided nerve blockades, the patient and the medical personnel are exposed to harmful to health radiation [7]. Ultrasound is known to provide significant advantages with its characteristics, such as availability, cheapness and repeatability. By the use of ultrasound in regional anesthesia interventions, the success rate of the applied technique may increase, the application time decreases and it may be possible to avoid several probable complications [8,9]. Also, according to current bibliography search ultrasonographic examination have from good even to excellent intra-patient, intra-examiner, and inter-examiner reliability in quantifying peripheral nerves of the upper extremity [10,11].

SUPRASCAPULAR NOTCH REGION

The Suprascapular Notch (**SSN**) is a depression located on the superior border of the scapula, medially to the coracoid process (Figure 1).

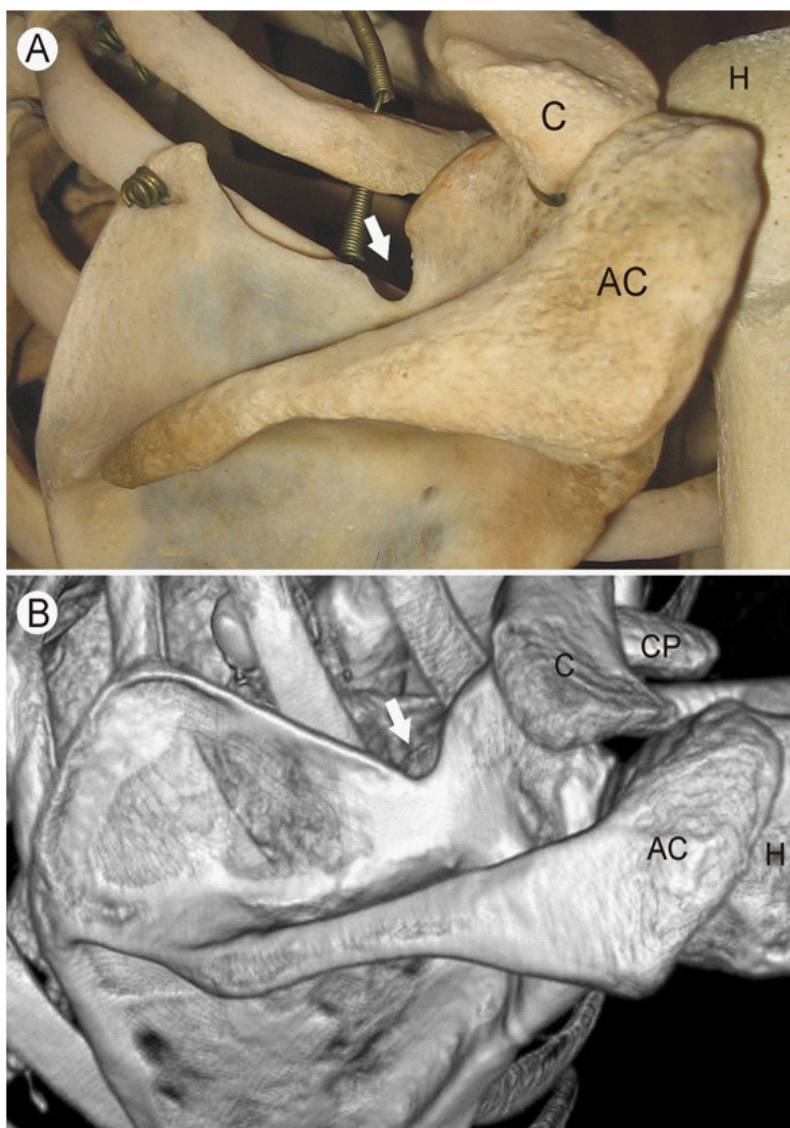


Figure 1: Posterior surface of the scapula: arrow - suprascapular notch, AC - acromion, C - clavicle, CP - coracoid process, H - humerus. A) The dry scapula, B) Three-dimensional Volume Rendering (VR) Multidetector Computed Tomography (MDCT).

The notch is covered for opening by the Superior Transverse Scapular Ligament (STSL) (Figures 2-3).

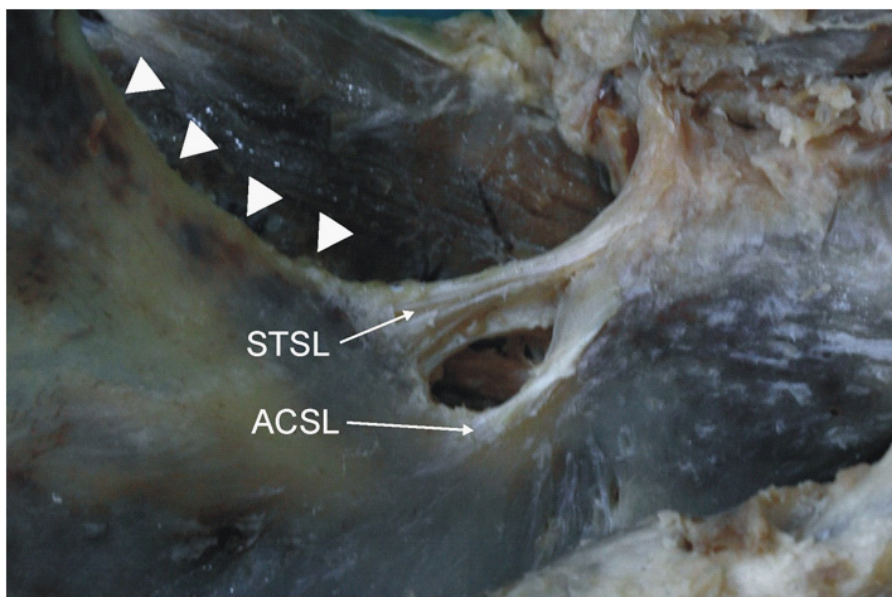


Figure 2: The cadaveric specimen of the Structures at suprascapular region: ACSL - Anterior Coracoscapular Ligament, STSL - Superior Transverse Scapular Ligament, arrowheads - superior border of the scapula.

Usually, below the ligament, the suprascapular nerve and vein run through the formed foramen, whereas the suprascapular artery passes above the ligament (Figure 3).

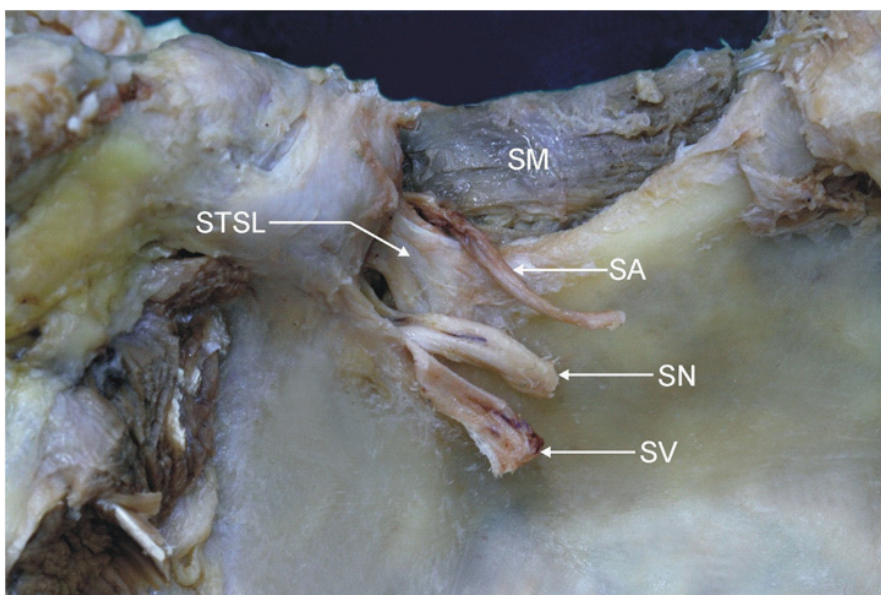


Figure 3: The cadaveric specimen of the Structures at suprascapular region: SA - suprascapular artery, SN - suprascapular nerve, SV - suprascapular vein, SM - supraspinatus muscle, STSL - superior transverse scapular ligament.

In 18.8-60% of cases a singular fibrous band, called Anterior Coracoscaphular Ligament (**ACSL**), extends on the anterior side of the suprascapular notch, below the level of the superior transverse scapular ligament (Figure 2) [12-15]. The suprascapular notch is characterized by great variety of forms, what has resulted in introduction of a several classifications [16-18]. Also other structures at suprascapular notch region were characterized by varied morphological form: superior transverse scapular ligament [13,19], anterior coracoscaphular ligament [14,15] and suprascapular triad (nerve, vein, artery) topography [20, 21].

Morphology of the suprascapular notch region is important from clinical point of view because it is the most common place of the suprascapular nerve compression and injury [22,23]. The problem of suprascapular nerve entrapment formation is complex and depends also on factors such as the morphological variations of the structures in this region. Especially, the shape and size of the suprascapular notch is the most important factor in the aetiopathology of suprascapular nerve injury [16,24]. A narrow SSN and V-shaped notch may predispose a patient to this neuropathy [16, 25]. Also, band-shape bifid or completely ossified STSL is potentially more likely to be associated with nerve entrapment [19,26,27]. According to quantitative analysis of the space available for the path of the suprascapular nerve in specific locations when the suprascapular vessels and nerve lie beneath the superior transverse scapular ligament, were found to have the smallest mean area of the suprascapular opening compared to the others [21]. It may promote of suprascapular nerve entrapment syndrome. Therefore, knowledge of themorphology of the suprascapular region, especially SSN shape and STSL variations, is particularly important in various techniques associated with ultrasonographic investisgation around suprascapular notch region.

SUPRASCAPULAR NERVE NEUROPATHY

The suprascapular nerve is a mixed motor and sensory nerve receiving contributions mainly from the C5 and C6 nerve roots. It transfers from anterior to posterior scapular region by suprascapular notch below superior transverse scapular ligament (Figure 3). In the supraspinal fossa, the nerve commonly gives off 2 motor branches to the supraspinatus muscle and also sensory branches to the posterior glenohumeral capsule, acromioclavicular joint, and coracohumeral ligament. In 15% of patients, the suprascapular nerve receives cutaneous sensory fibers from the upper lateral arm [28,29,30]. Suprascapular nerve transfer from supraspinatus fossa to infraspinatus fossa by spinoglenoidal notch below inferior transverse scapular ligament in the infraspinal fossa, the nerve commonly gives off 2 motor branches to the supraspinatus muscle [31].

Suprascapular nerve neuropathy was first described by Andre Thomas in 1936 [32]. The symptom of this neuropathy is deep, diffused, poorly localized pain that becomes worse during overhead activities or at night when the patient tries to sleep on the affected side. It is typically located in the posterior and lateral aspect of the shoulder and radiates to the arm [5,6,22].

The aetiology of the suprascapular nerve neuropathy depends on several factors. According to our previously morphological studies, band-shaped superior transverse scapular ligament, and type III suprascapular triad arrangement (the suprascapular vessels and nerve lie beneath the superior transverse scapular ligament) may promote this neuropathy [15,19,21]. The aim of the research was to perform comparative ultrasonographic study.

The suprascapular neuropathy is not often in general population, however in some group of sportsmen (especially for volleyball players and baseball pitchers) injury of the suprascapular nerve occur more frequently than in others. In 1994, Holzgraefe et al. [33] described the frequency of suprascapular nerve neuropathy in international level high-performance volleyball players was 33%. It most often affects individuals under the age of 38. Due to the higher frequency of this pathology observed in middle-aged patients, it is also important from a demographic point of view. In the majority of cases the syndrome is associated with late diagnosis. It has been estimated that 0.4-2% of the superior extremity girdle pain is caused by this neuropathy [23]. Therefore, this pathology must be taken into consideration while differentiating entities manifesting themselves with similar symptoms. However, in most cases the diagnosis is made late, after a few or several dozen months. In this stage the supra- and infraspinous muscles are usually atrophied to some extent, what may result in a decrease in the patient's occupational activity or permanent disability [6,22]. Therefore such knowledge has high economic and societal impact.

ULTRASONOGRAPHIC INVESTIGATION AT SUPRASCAPULAR NOTCH REGION

The first description of value of US imaging in identification of the shapes of SSN was by Moriggl [34]. In 1997, based on the group of 97 volunteers he confirmed usefulness of this method. However, according to Moriggl that interpretation was difficult for partially ossified superior transverse scapular ligament and even impossible with it completely ossification. Also Marhofer et al. [35] confirmed limitation in visualization of suprascapular nerve when it is in close proximity to bony structures.

In 2010 Peng et al. [36] suggested that in procedure of visualization of suprascapular nerve more usefulness is the coronal plane over the suprascapular fossa with a slight anterior tilt, on the floor of the scapular spine between the spinoglenoid notch and the scapular notch. In their opinion the concave shape of the floor may be misinterpreted as the suprascapular notch. According to their observations the fascia of the supraspinatus muscle sometimes may be considered as the superior transverse scapular ligament. Some previously studies also confirmed such interpretation. According to Harmon and Hearty [37] the final US probe position should be more in the coronal plane than in the transverse plane, because the structures in the suprascapular fossa are all obscured by the scapular spine in the transverse plane. From methodological point of view the spine of the scapula, the coracoid process, and the acromion were used as landmarks in recognizing the position of the USG to visualize suprascapular notch region [9,36]. Rothe et al.

[38] suggested that localization of the omohyoid muscle in a longitudinal section facilitates the visualization of the SSN.

Ultrasonographic investigation may recognized not only presence but also shape of the suprascapular notches [9,39] (Figures 4-6). According to Polguy et al. [39] ultrasonographic examination of the SSN is characterized by high specificity for deep-shape of the SSN (Figure 4), and high sensitivity in recognizing wide-shape of the SSN (Figures 5-6). Suprascapular nerve was well visualized in the bottom of the suprascapular notch below the superior transverse scapular ligament (Figure 6). Also suprascapular artery and vein were well recognized using Color Doppler (Figure 7). According to toYücesoy et al. [9] artery-vein suprascapular complex passing through the SSNwas visualized in 86 shoulders of 43 subjects (86%). Also the STSL demonstrated in 96 shoulders (96%) of 48 out of 50 volunteers as an echogenic band on SSN [9]. It is well visualized as hyperechogenic band (Figures 4, 6).



Figure 4: Ultrasonographic investigation of the suprascapular notch region, arrows - suprascapular notch, STSL - superior transverse scapular ligament.

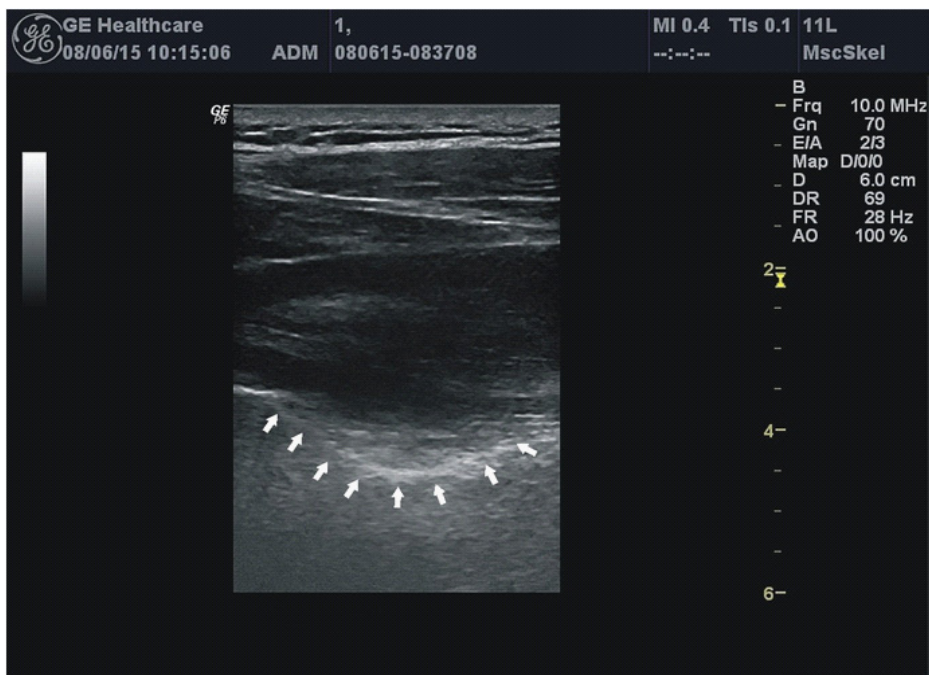


Figure 5: Ultrasonographic investigation of the suprascapular notch region, arrows - suprascapular notch.

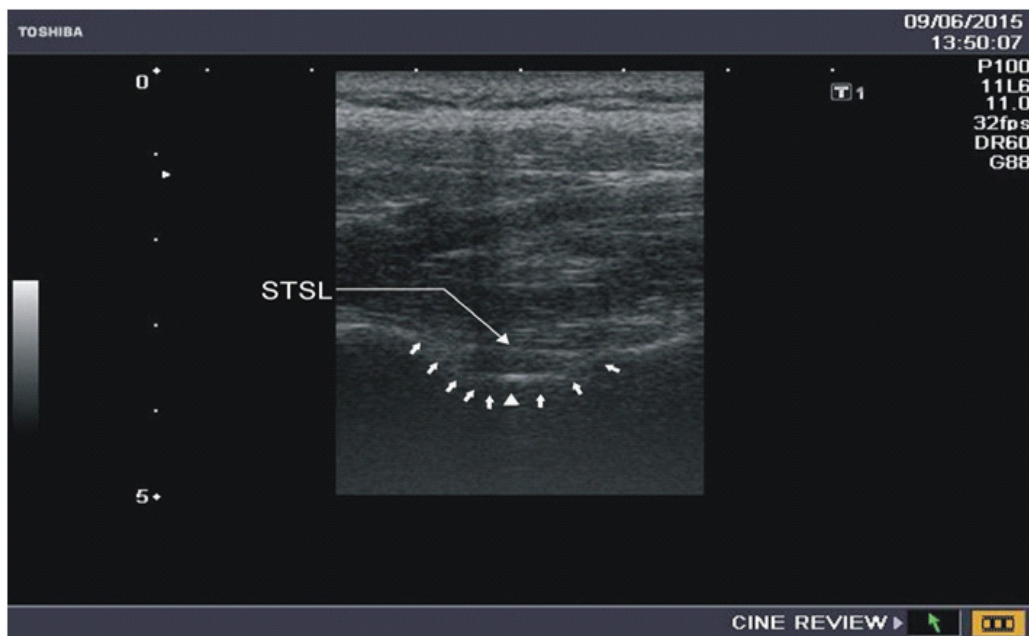


Figure 6: Ultrasonographic investigation of the suprascapular notch region, arrowhead - suprascapular nerve, STSL - superior transverse scapular ligament.

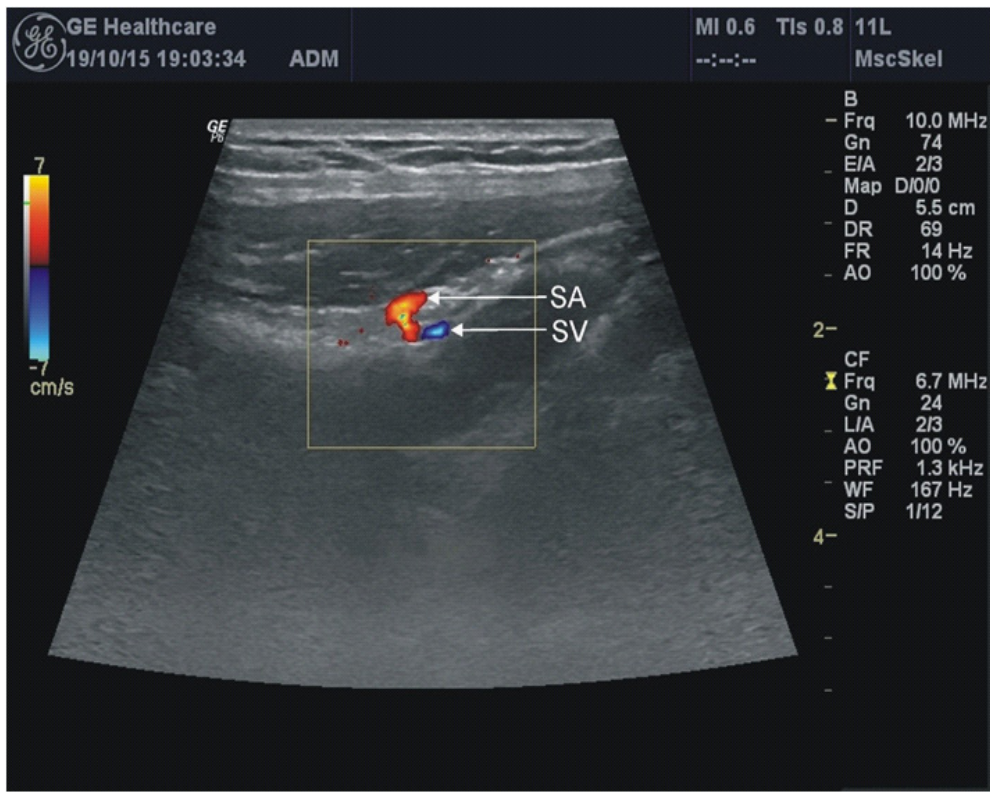


Figure 7: Ultrasonographic investigation of the suprascapular notch region (Color Doppler), SA - Suprascapular Artery, SV - suprascapular vein.

SUPRASCAPULAR NERVE BLOCKADE (SSNB)

The use of Ultrasound (US) to perform peripheral nerve blocks is a relatively new technique that is rapidly gaining popularity over the more traditional techniques. It has many obvious advantages in regional anesthesia and pain conditions, and it has been found equal or superior to Neurostimulation (NS) technique in peripheral nerve blocks [40,41].

First reports of described suprascapular nerve block were from 1941 by Wertheim and Rovenstein [42] and from 1949 by Milowsky and Rovenstine [43]. This procedure has been widely used by anesthesiologists since then in various situations such as adhesive capsulitis and for pain control after shoulder arthroscopy. Harmon and Hearty [37] described it as a technique, which can be easily learned and can be applied by emergency physicians with the support of ultrasound.

Blind suprascapular nerve blockade is one of the possible treatment options in acute and chronic pain management of suprascapular nerve entrapment syndromes, but some possible complications such as pneumothorax, periosteal pain or injury of the close neighboring vascular structures are the limitations of the procedure [44,45]. Visualization of the related anatomic part and the needle with guidance of US may improve the success and lower the complication

rates [46-48]. Karatas and Meray [49] have reported that nerve blocks close to the nerve with Electromyography (**EMG**) guidance is more effective than blind injection in the suprascapular fossa. Thus, techniques that target the nerve more selectively are potentially advantageous.

In 2014, Rothe et al. [47] reported a methodological study of a new approach to selectively block the SSN in a more proximal position compared with the classic approach. They used also additional ultrasonographic landmarks to identify the suprascapular notch: the trapezius muscle in transverse section, the inferior belly of the omohyoid muscle in longitudinal section, and the upper part of the serratus anterior muscle under the omohyoid muscle.

Harmon and Hearty [37] suggest that the ideal ultrasound transducer should have high resolution capabilities between 10 and 15 MHz. However, in several previous studies more commonly used ultrasound transducer resolution capabilities between 7 and 12 MHz [9,11,39,41,46,50,51].

According to the results of Yücesoy et al. study [9] the skin-notch base interval is another important parameter for nerve blockade. We predict that during the US-guided blockade, needle puncture of about 40-45 mm in length should not be exceeded so as to decrease the risk of pneumothorax and to prevent periosteal pain caused by the needle at the notch base [9]. Sonographic visualization of various SSN morphologies is possible and may be useful in several procedures around this region [39].

According to Gorthi et al. [46] ultrasound-guided suprascapular nerve block is a safe, effective, and accurate method in achieving immediate and long-term pain relief in patients with chronic, nonspecific perisoulder pain, with normal range of motion, normal imaging studies, and no identified shoulder pathology.

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