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Applied anatomy of the suprascapular nerve: a cadaveric study

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SUMMARY

The suprascapular nerve plays a very important role in the shoulder. Characterization of anatomy is essential to assist surgeons in shoulder surgery. Objectives: This study is to determine further the anatomical characteristics of the SSN regarding origin, pathway, branching and correlations of SSN with some neighboring structures. Thirty specimens taken from 15 fresh cadavers (9 males and 6 females) were dissected and data were recorded. The presences of the motor branches, sensitive branches, some neighboring structures and the correlation between them and the SSN were described. The distances from the SSN at the suprascapular notch and spinoglenoid notch to some neighboring structures were measured. The SSN arises from the upper trunk of the brachial plexus. The nerve has two motor branches for supraspinatus and infraspinatus muscles and two sensory branches, the superior articular branch for acromioclavicular joint and coracohumeral ligament about 73.3%, the inferior articular branch for the posterior joint capsule about 100%. The average distance from the nerve at the suprascapular notch to the acromion lateral border is 61.4 mm, to the tip of coracoid is 49.5 mm, and to the superior rim of the glenoid is 31.7 mm. The average distance from the nerve at the spinoglenoid notch to the posterior rim of the glenoid is 19.9 mm. This circles the safe distances for shoulder surgeries. This study determines the anatomical characteristics of the SSN and defines the safe zone on the shoulder. It allows surgeons to avoid causing the nerve injury and to approach it easily.

Key words: Suprascapular nerve – Superior transverse scapular ligament – Anterior coracoscapular ligament – Spinoglenoid ligament – Suprascapular neuropathy

Abbreviations:
Suprascapular nerve (SSN)
Superior transverse scapular ligament (STSL)
Anterior coracoscapular ligament (ACSL)
Spinoglenoid ligament (SGL)

INTRODUCTION

The suprascapular nerve (SSN) innervates the supraspinatus and infraspinatus muscles, which are components of the rotator cuff. It is also responsible for a large part of the sensitive innervation of the shoulder joints. In literature, a condition of unilateral shoulder paralysis was due to the compression of the SSN (Schilf, 1952), and then the clinical entity of suprascapular neuropathy was described by some authors. SSN entrapment is said to be an unusual condition causing pain and functional loss in the shoulder (Kostretzis et al., 2017). Twenty-one studies with 275 patients (276 shoulders) in which patients had decompression of SSN were reviewed, the results were satisfied (Momaya et al., 2018). In order to support

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Fig 1. Incision.

surgeons, many anatomy studies were performed. It is agreed that the SSN has two motor branches that innervate the supraspinatus and infraspinatus muscle. Yet different results about sensory branches were given. Generally, SSN has two sensory branches. The first is a superior articular branch , called “nervus suprascapularis ramus articularis”, which innervates the coracoclavicular ligaments, the coracohumeral ligament, the subacromial bursa, and posterior parts of the shoulder. The second is an inferior articular branch that goes to posterior joint capsule (Aszmann et al., 1996; Vorster et al., 2008). Differences, though, were found in the ratio of sensory branches. As for the first branch, changes were found from 9.8% (Horiguchi, 1980), 14.7% (Ajmani, 1994), 87.1% (Vorster et al., 2008) to 100% (Ebraheim et al., 2011). For the second branch, few detailed descriptions were found in some authors’ studies (Horiguchi, 1980; Ajmani, 1994). Yet, to the contrary, some authors discerned it in high ratio 74.2-100% (Vorster et al., 2008; Ebraheim et al., 2011). The correlation of the SSN with some neighboring structures is also different as stated by some authors. The SSN often recognized goes under superior transverse scapular ligament, but the pathway of corresponding vessels was seen differently. In a study in which 103 cadavers were dissected, the arrangement of SSN and corresponding vessels at the suprascapular notch was classified into 3 types. As classified for type I in that study, the SSN goes under the superior transverse scapular ligament (STSL) and vessels go over the STSL, and was 59.4% (Yang et al., 2012). In another study of 106 formalin-fixed cadaveric shoulders, the arrangement of SSN and corresponding vessels was classified differently into 4 types, in which type I was the SSN and suprascapular vein go under the STSL and the suprascapular artery goes over the STSL, appearing in 61.3% (Polgujet al., 2015). Therefore, differences found in those descriptions by the authors on anatomy of SSN should be perceived. The present study herein is aimed at determining and clarifying further the anatomical characteristics of the SSN from origin, pathway, branching and to the correlations of the SSN with some neighboring structures. This may be helpful for surgeons who perform shoulder surgery, either decompression of SSN or related operation at this region.

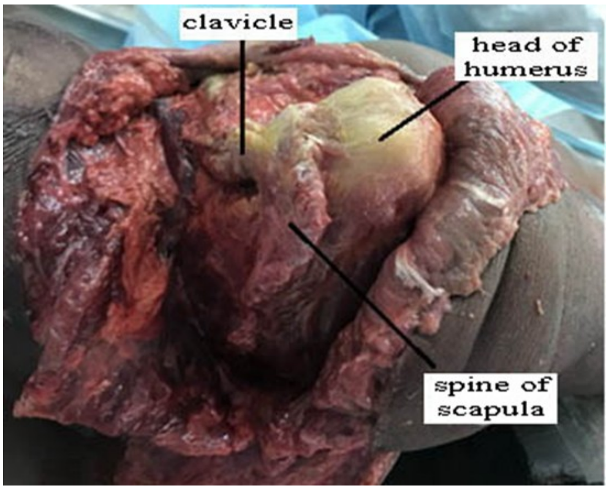

Fig 2. Deltoid and trapezius muscles were dissected.

MATERIALS AND METHODS

The research project was approved by the Bioethics Commission of the University of Medicine and Pharmacy at Ho Chi Minh city, Viet Nam. Number of Bioethics Commission Approval: 210/ĐHYD-HĐ on 28th June 2017.

Thirty specimens, 15 right and 15 left shoulders, taken from 15 fresh cadavers (9 males and 6 females) at different ages were dissected and data were recorded. The dissections were performed on fresh frozen cadavers at the Department of Anatomy of the University of Medicine and Pharmacy at Ho Chi Minh City. The exclusion criteria comprised any signs of lesion or tumors causing deformation of anatomy landmarks at shoulder or congenital malformations. Dissection tools set were used and cadavers were dissected under magnifying glass. A Vernier caliper was used to measure distances.

After incision, the deltoid and trapezius muscle were dissected and the origin of SSN was exposed at the brachial plexus (Figs. 1, 2). Then it was dissected along the course of SSN (Fig. 3). Now the

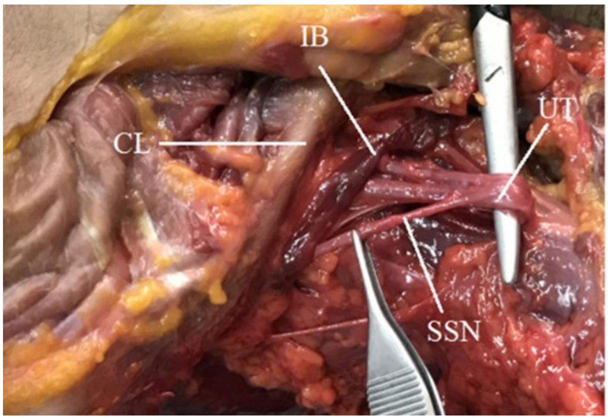

Fig 3. The suprascapular nerve (SSN). CL: clavicle. IB: inferior belly of omohyoid muscle. UT: upper trunk of brachial plexus.

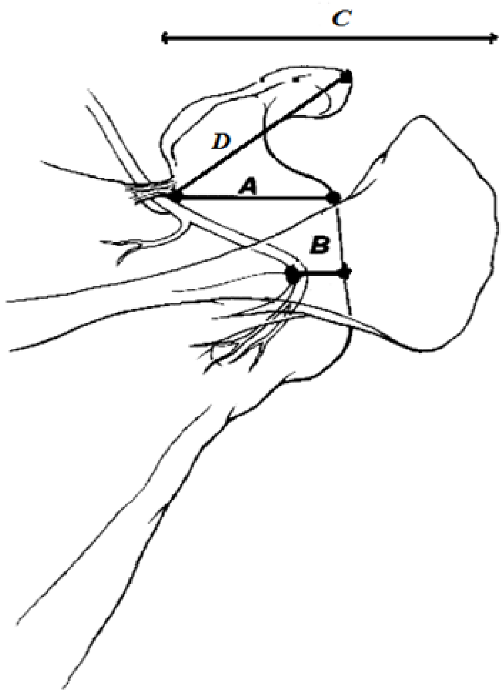

Fig 4. The distances from the SSN at suprascapular notch and spinoglenoid notch to the anatomical marks. **A**: distance from the nerve at the suprascapular notch to the superior rim of the glenoid, **B**: distance from the nerve at the spinoglenoid notch to the posterior rim of glenoid, **C**: distance from the nerve at the suprascapular notch to the acromion lateral border, **D**: distance from the nerve at the suprascapular notch to the tip of coracoid.

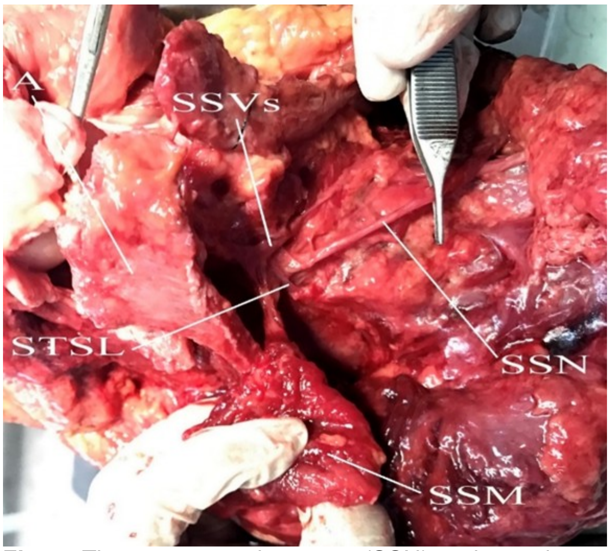

Fig 5. The suprascapular nerve (SSN) under and vessels (SSVs) over the superior transverse scapular ligament (STSL). A: acromion, SSM: suprascapular muscle.

presences of branches of SSN were recorded. Some neighboring structures such as the superior transverse scapular ligament (STSL), anterior coracoscapular ligament (ACSL), suprascapular vessels, spinoglenoid ligament (SGL) and the correlation between them and the SSN were also recorded. Finally, distances from the SSN at the suprascapular notch and those from the spinoglenoid notch to the acromion lateral border (C), the tip of coracoid (D), the superior rim of the glenoid (A), the posterior rim of the glenoid (B) were measured (Fig. 4).

RESULTS

The study sample consists of 30 specimens (15 left and 15 right) from 9 male cadavers and 6 female cadavers with an average age of 64.9.

Origin, pathway, branching of the SSN

It is found, in any of the 30 samples dissected, that the SSN originates from the upper trunk of the brachial plexus. It runs behind the clavicle at the posterior triangle of the neck and parallel to the inferior belly of the omohyoid muscle, deep to the trapezius muscle. After that, SSN runs to the superior border of the scapular, passes through the suprascapular notch to the suprascapular fossa. It gives a branch ended in the supraspinatus muscle at the supraspinatus fossa and a branch ended in the infraspinatus muscle at the infraspinatus fossa. In 22/30 specimens (73.3%), a branch was found leaving from the main stem at the level of the suprascapular notch to reach the coracohumeral ligament, the acromioclavicular joint, and the subacromial bursa. And in 30/30 specimens (100%), a branch was seen separating from the main stem at the level of spinoglenoid notch going to the posterior capsule of the shoulder joint.

The correlation of the SSN with some neighboring structures

The anterior coracoscapular ligament. None of this ligament was found in any specimen (0%). The superior transverse scapular ligament. At the suprascapular notch along the course of the SSN, the presence of the STSL was observed in all specimens (100%). None of the complete ossification of the STSL and none of the STSL which had more than one bundle in any specimen were found.

The correlation of the position of the SSN with the suprascapular vessels and the STSL. The SSN always runs inferior to the STSL at suprascapular notch. The suprascapular vessels run superior to the STSL (Fig. 5) in 24 specimens (type I) (80%), superior and inferior to the STSL (Fig. 6) in 4 specimens (type II) (13.3%), inferior to the STSL in 2 specimens (type III) (6.7%) (Fig. 7).

At the spinoglenoid notch, the presence of the SGL was observed in every of the 30 specimens (100%).

Distances from the SSN at the suprascapular notch and the spinoglenoid notch to the anatomical marks: the average distance measured from the nerve at the suprascapular notch to the superior rim of the glenoid is 31.7 mm (26.9-39.5) and from the nerve at the spinoglenoid notch to the posterior

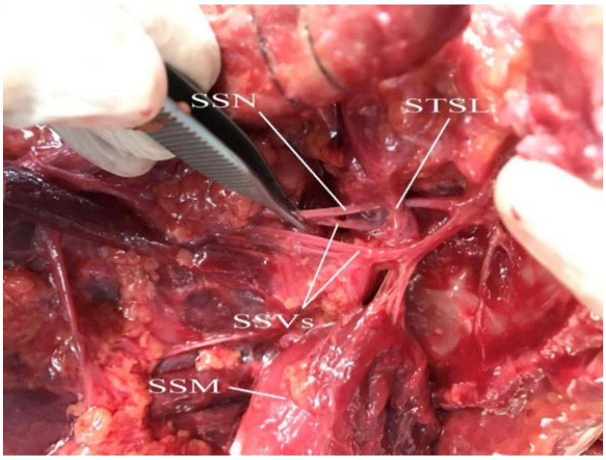

Fig 6. The suprascapular nerve (SSN) under and vessels (SSVs) under and over the superior transverse scapular ligament (STSL). SSM: suprascapular muscle.

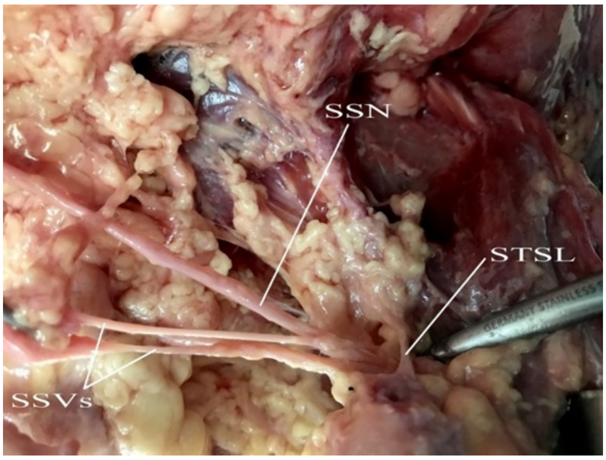

Fig 7. The suprascapular nerve (SSN) and vessels (SSVs) under the superior transverse scapular ligament (STSL).

rim of glenoid is 19.9 mm (18.4-22.8). The average distance from the nerve at the suprascapular notch to the acromion lateral border is 61.4 mm (54.7-69.5). The average distance from the nerve at the suprascapular notch to the tip of coracoid is 49.5 mm (45.9-52.7).

DISCUSSION

Origin, pathway, branching of the SSN

In this study, all the SSN were found to have branches to the supraspinatus muscle at the supraspinatus fossa and to the infraspinatus muscle at the infraspinatus fossa. It is thought that they are two motor branches that innervate the supraspinatus muscle and infraspinatus muscle. Besides that, there was not any branch going to other muscles. This matches with most descriptions in the literature, so there is nothing to discuss more about that. In literature, an amount of the SSN was said to have two branches, which are sensory branches. In this study, when SSN was dissected along its course, branches that split from SSN were found not going to the muscle but to other structures such as the ligament, bursa, articular capsule, skin or other structures that shall be recognized as sensory branches. In such view, two sensory branches were found in this study. For the first branch, some authors described it leading to the skin (Horiguchi, 1980; Ajmani, 1994) but in this study, it was observed with the same course to the ligaments and the joints, not to the skin (Fig. 8). In other studies, it was described as an articular branch with the same course. That was observed in 87.1% of a South African population and in 100% of a US population (Vorster et al., 2008; Ebraheim et al., 2011). In these two research works, none of the sensory branch to the skin was described, this is of the same findings with our study's. In consensus with Vorster et al. (2008) and Ebraheimet al. (2011), this branch is taken "superior articular branch" as it was proposed (Aszmannet al., 2002). The different presence rates of this branch indicate that this one thought to go to the skin should be very rare. About the second sensory branch, it appears 100% in this study (Fig. 9). It was found by other authors in 74.2% specimens (Vorster et al., 2008) and in

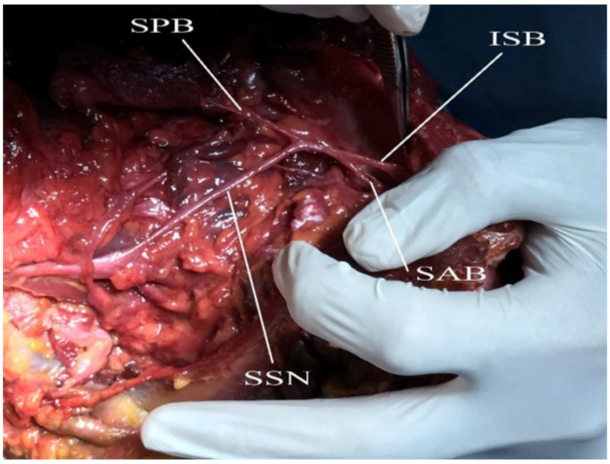

Fig 8. Superior articular branch (SAB). SSN: suprascapular nerve, SPB: branch to the supraspinatus muscle, ISB: branch to infraspinatus muscle.

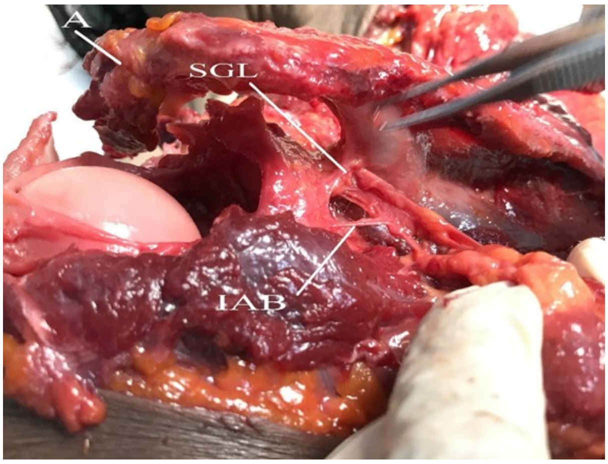

Fig 9. Inferior articular branch (IAB). A: acromion, SGL: spinoglenoid ligament.

100% specimens (Ebraheim et al., 2011): these are in a high rate. Based on its course and as it was proposed (Aszmannet al., 2002), it is taken as “inferior articular branch”. Thus, as found in this study and in other authors, it indicates that the second sensory branch is common.

The correlation of the SSN with some neighboring structures

The anterior coracoscapular ligament. This ligament was not found in any specimens of this study. The ACSL is a fibrous band extending on the anterior side of the suprascapular notch. It was first described and found in 60% of the US population (Avery et al., 2002). In Turkish population, it was found in 18.8% (Bayramoglu et al., 2002) and 32% (Gurseset al., 2015). A prevalence of 51.2% was found in Polish population (Polguj et al., 2015), and in another study it was present in 52/100 scapulae (52%), and in all cases the SSN travelled superior to it (Podgórski et al., 2015). This ligament was recorded as documented in 28% of Thai population (Piyawinijwong, 2012). The difference of the presence rate of ACSL in researches may be due to differences in the population and the sample size. It is clear that in study findings in Thai population, a country in Southeast Asia neighboring Vietnam, the prevalence is much lower despite the larger sample size when comparing with those given by European and American authors. This ligament is probably rare in Southeast Asia, or it may be too thin to be recognized in this study.

The superior transverse scapular ligament. In this study, the occurrence of the STSL was found in all specimens. However, the complete ossification of the STSL was not seen in any specimens. This result may be explained by the fact that the size of the sample in this study is not large enough and the occurrence of this variation in the Vietnamese population is rare. The frequency of completely ossified STSL varies widely in many places (Edelson, 1995; Polguj et al., 2014; Labetowicz et al., 2017; Kim et al., 2018). In some populations, it is very rare, for example in the Alaska Eskimos, 0.3% (Hrdlička, 1942) but in some other places it can occur more frequently, as found in Brazil, 30.8% (Silva et al., 2007). The explanation for this diversity is not yet available. In addition, the present investigation did not document any instance where the STSL had more than one bundle. As this variation occurs, the space for the nerve to pass through the suprascapular notch may decrease, which should bear the risk of nerve compression. In a study, one case of bifid type and one case of trifid type of STSL were reported (Ticker, 1998) and in another study only one case of trifid type was shown (Polguj et al. 2012). It means that this variation of STSL on the shoulders is rare, occurring at very small rates, which explains why it is not found in many studies in the world, even in this study.

The correlation of the position of the SSN with the suprascapular vessels and the STSL. The SSN always runs inferior to the STSL at the suprascapular notch in all specimens of this study. This matches with most descriptions in the literature. About the arrangement of the suprascapular vessel and SSN, what was found is similar to that by Yang et al. (2012). Type I is all suprascapular vessels running over the STSL, type II is the vessels running over and under the STSL simultaneously (that means artery and vein, one runs over and the other runs under the STSL) and type III is all vessels running under the STSL. According to Yang et al. (2012), type I was found in 59.4%, type II in 29.7%, and type III in 10.9%. In the present study, type I was seen in 80% of the specimens, type II found in 13.3% of the specimens and type III observed in 6.7% of the specimens. It occurred that in most specimens in the suprascapular vessels above the STSL and the SSN below the ligaments were recognized as they pass through the suprascapular notch. The arrangement of the suprascapular vessel in this study are similar to those given by some other authors (Avery et al. 2002; Duparc et al., 2010; Yang et al., 2012), and this is consistent with the description commonly found in the literature. Yet the outcome from another study was given with a different classification. In that study, type I was for suprascapular artery going over STSL but SSN and suprascapular vein running under STSL. It was seen in 61.3%. In the contrary, type II was for all vessels going over STSL, being at a low rate 17%. Besides, an added type (type IV) was proposed, it formed from other variants of vessels (9.4%) (Polgujet al., 2015). In this present study none of this type was seen.

The spinoglenoid ligament. The occurrence of the SGL was found in every of the 30 specimens. An author showed that this rate was 14% (Ticker et al., 1998) and some authors documented the presence of the SGL with a very low rate (Demaio et al., 1991; Bektas et al., 2003), as opposed to the results of this present study (100%) and others (80% to 100 %) (Cummins et al., 1998; Plancher et al., 2005; Duparc et al., 2010). In agreement with many authors, it is believed that the presence of the SGL is very common and the difference in the results of these studies is directly related to the preparation of the specimens being studied. Tissue that was not preserved with the fresh-frozen technique tends to become friable, making meticulous cadaveric dissection difficult. In the relationship between the SSN, the suprascapular vessels and the SGL, the results of this study and those of other authors showed that the nerve and the blood vessels are below the SGL in all cases of this ligament presence.

The distances from the SSN at suprascapular notch and spinoglenoid notch to the anatomical marks – The safe zone. In the present study, the average distance from the nerve at the suprascapular notch to the superior rim of the glenoid (distance A, Fig. 4) is 31.7 mm (26.9-39.5) and from the nerve at the spinoglenoid notch to the posterior rim of glenoid (distance B, Fig. 4) is 19.9 mm (18.4-22.8). From these results, a safe zone was identified to avoid SSN injury. It is in the range within 26 mm from the glenoid rim at the level of the superior rim of the glenoid and in the range within 18 mm from the posterior rim of the glenoid at the level of the base of the scapular spine. The measurements and the safe zone of this study are different from those given by some authors (Bigliani et al., 1990; Shishido et al., 2001; Gumina et al., 2011). This difference may be due to the sample sizes and ethnic races studied. In general, when compared to the mentioned above studies, sample size of this study was the smallest, while the minimum of distance A and the minimum of distance B (Fig.4) were larger than the other authors' minimum distances, so a larger safe zone was given. In the limited capacity of this study, a safe zone can be described for the Vietnamese based on the study outcome in which the real safe zone may be smaller. The average distance from the nerve at the suprascapular notch to the acromion lateral border (distance C, Fig. 4) is 61.4 mm (54.7-69.5) helps to determine a safe distance of less than 54 mm measured from the acromion lateral border. The results of this study are quite similar to some other authors (Terra et al., 2010; Tom et al., 2014). From these results, it is assumed that the position of SSN at the suprascapular notch is approximately 61 mm from the acromion lateral border. The average distance from the nerve at the suprascapular notch to the tip of coracoid (distance D, Fig. 4) is 49.5 mm (45.9-52.7). Thus, it is thought that a distance of less than 45 mm measured from the tip of the coracoid can be safe. This measurement has not been reported in the literature of other authors.

CONCLUSION

Results of this study prove that SSN has 2 motor branches for the supraspinatus muscle and infraspinatus muscle; it also has 2 sensory branches, which are the superior articular branch (73.3%) and the inferior articular branch (100%). No anterior coracoscapular ligament was found at the suprascapular notch in the 30 specimens. Nor any cases of complete ossification, bifid, or trifid types of the superior transverse scapular ligament. The average distance from SSN at suprascapular notch to acromion lateral border is 61.4 mm, to the superior rim of glenoid is 31.7 mm. The average distance from SSN at spinoglenoid notch to posterior rim of glenoid is 19.9 mm. A new parameter in this study is average distance from the nerve at the suprascapular notch to the tip of coracoid, it is 49.5 mm. These parameters can be consulted during surgery in shoulder area to avoid iatrogenic complications.

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