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Morphological assessment of superior transverse scapular ligament in cadavers from Bihar Region

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Abstract
The study of suprascapular nerve (SSN) in dry scapulae will not give an idea of exact space available for suprascapular nerve in SSN as the main characters of suprascapular nerve and STSL who play major role in SNES are missing. In cadaveric dissection the effect of variations in morphology of STSL on suprascapular nerve and its relation to the suprascapular opening cross sectional area will be helpful. Hence the present study was planned to evaluate the superior transverse scapular ligament and its clinical correlation.
The present study was planned in Department of Anpatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India from jan 2017 to july 2017. Total 15 cadavers used for dissection purpose were used for current study. Approval of the institutional ethical committee was taken prior to conduct of this study.
Cadaveric study of STSL providing idea of variations of morphology of STSL shall be of help to surgeons and arthroscopist to plan their approach in treatment of SNES. Radiologist, neurosurgeons and orthopedic surgeons should bear this anatomical variation in mind, since its existence alters the surgical technique or arthroscopic decompression of the suprascapular nerve. But further detail study should be done on large number of scapulae from different region and population along with cadaveric, radiologic and clinical cases study.

Keywords: superior transverse scapular ligament, STSL, cadavers, etc

Introduction
The superior transverse ligament (transverse or suprascapular ligament) converts the scapular notch into a foramen or opening. It is a thin and flat fascicle, narrower at the middle than at the extremities, attached by one end to the base of the coracoid process and by the other to the medial end of the scapular notch. The suprascapular nerve runs through the foramen; the transverse scapular vessels cross over the ligament. The ligament can become ossified and impinge the underlying suprascapular nerve. This may cause paralysis of both supraspinatus and infraspinatus muscles.
The suprascapular nerve is a nerve that arises from the brachial plexus. It is responsible for the innervation of some of the muscles that attach on the scapula, namely the supraspinatus and infraspinatus muscles. The suprascapular nerve arises from the upper trunk of the brachial plexus which is formed by the union of the ventral rami of the fifth and sixth cervical nerves. After branching from the upper trunk, the nerve passes across the posterior triangle of the neck parallel to the inferior belly of the omohyoid muscle and deep to the trapezius muscle. It then runs along the superior border of the scapula, passes through the suprascapular notch inferior to the superior transverse scapular ligament and enters the supraspinous fossa [1]. It then passes beneath the supraspinatus, and curves around the lateral border of the spine of the scapula through spinogleniod notch to the infraspinous fossa.
The suprascapular artery is a branch of the thyrocervical trunk on the neck. At first, it passes downward and laterally across the scalenus anterior and phrenic nerve, being covered by the sternocleidomastoid muscle; it then crosses the subclavian artery and the brachial plexus, running behind and parallel with the clavicle and subclavius muscle and beneath the inferior belly of the omohyoid to the superior border of the scapula. It passes over the superior transverse scapular ligament (unlike the suprascapular nerve, which passes below the ligament) [2-3].
The artery then enters the supraspinous fossa of the scapula. It travels close to the bone, running between the scapula and the supraspinatus muscle, to which it supplies branches. It then descends behind the neck of the scapula, through the great scapular notch and under cover of the inferior transverse ligament, to reach the infraspinatous fossa, where it supplies infraspinatus [4] and anastomoses with the scapular circumflex artery and the descending branch (aka dorsal scapular artery) of the transverse cervical artery.
Besides distributing branches to the sternocleidomastoid (which, however, mainly is supplied by the occipital artery and the superior thyroid artery), subclavius (which mainly is supplied by the thoracoacromial artery), and neighboring muscles, it gives off a suprasternal branch, which crosses over the sternal end of the clavicle to the skin of the upper part of the chest; and an acromial branch, which pierces the trapezius and supplies the skin over the acromion, anastomosing with the thoracoacromial artery. Just as with supplying the subclavius muscle, it anastomoses with the thoracoacromial artery in supplying skin areas.
As the artery passes over the superior transverse scapular ligament, it sends a branch into the subscapular fossa, where it ramifies beneath the subscapularis, and anastomoses with the subscapular artery and with the dorsal scapular artery. It also sends articular branches to the acromioclavicular joint and the shoulder joint, and a nutrient artery to the clavicle.

The scapula is a flat, triangular bone of shoulder girdle situated posterolateral aspect of chest wall1. The suprascapular notch is present onsuperior border of the scapula, just medial to the base of coracoid process. It is converted into a foramen by superior transverse scapular ligaments (STSL) [5]. Suprascapular foramen transmits suprascapular nerve, while suprascapular vessels pass above the ligament. The suprascapular nerve supply motor branches to the Supraspinatus, Infraspinatus and sensory branches to the rotator cuff muscles, and the ligaments of shoulder and acromioclavicular joint [6]. Suprascapular notch shows many variations, such as ossification of STSL [7]. This region is the most common site of suprascapular nerve injury, and ossification of STSL is the one of the most important predisposing factor of this neuropathy [8].

The superior transverse scapular ligament (STSL) is present above the suprascapular notch (SSN). It joins the two superior corners of this notch and converts it into suprascapular foramen through which passes the suprascapular nerve (SN), while the suprascapular artery and vein usually pass above the ligament [9]. An anatomy textbook describes ossification of STSL [10]. Many researchers have reported variations of STSL. This ligament may be calcified, partially or completely ossified, trifurcation and anomalous bands of it [11]. According to Harris *et al*. the ossification of the STSL was considered anomalous (Harris R *et al.* 2001). The variations of size and shape of suprascapular notch and STSL have been known to predispose to SN entrapment neuropathy [12-13]. The presence of an ossified STSL may produce difficulty during decompression of the suprascapular notch if the condition is not known [11]. Many researchers reported variable incidence of complete ossification of STSL which varies in different population. In Indian population there is very little data is available. Considering the paucity of data on incidence of ossification of STSL we studied this topic.

The study of suprascapular nerve (SSN) in dry scapulae will not give an idea of exact space available for suprascapular nerve in SSN as the main characters of suprascapular nerve and STSL who play major role in SNES are missing. In cadaveric dissection the effect of variations in morphology of STSL on suprascapular nerve and its relation to the suprascapular opening cross sectional area will be helpful. Hence the present study was planned to evaluate the superior transverse scapular ligament and its clinical correlation.

Methodology

The present study was planned in Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India Jan 2017 to July 2017. Total 15 cadavers used for dissection purpose were used for current study. Approval of the institutional ethical committee was taken prior to conduct of this study.

Exclusion criteria: Cadavers with any operative procedure in suprascapular notch region or topographical derangement of shoulders were excluded.

Cadavers with any operative procedure in suprascapular notch region or topographical derangement of shoulders were excluded. The suprascapular region was dissected. The trapezius was reflected, followed by reflection of muscles namely the deltoid followed by subscapularis muscle and supraspinatus muscle. The suprascapular ligament was carefully dissected and its relation to the suprascapular vessels and nerve were delineated. The morphology of STSL, its relation to suprascapular nerve and vessels and presence of any abnormal masses in this area were recorded. The cross sectional area of the suprascapular opening was calculated using the mathematical formula of calculating the area of an ellipse as described in an article by Mitchel [14].

Results & Discussion

Multiple studies have been carried out with particular reference to suprascapular notch, partial or complete ossification of superior transverse scapular ligament to avoid this risk during operative procedures and to study the pathology of suprascapular nerve compression.

De Mulder *et al*. [15] & Warner *et al*. [16] explained in their study that during open surgical procedures, the distance between margin of the glenoid cavity and suprascapular notch is very critical and it needs dissection of the posterior shoulder joint. A safe zone is explained by them to avoid damage to the suprascapular nerve during the surgeries around this area [17]. These distances are 1.4 cm from posterior border of glenoid just at the base of spine of scapula & 2.3 cm from glenoid just at the upper rim of glenoid. Therefore, the surgeons aware about this safe zone during surgical procedures at shoulder joint, to avoid damage of the nerve.

Polguj M [18]. Found bifid superior transverse scapular ligament in 3.1% population, while Ticker JB *et al*. [5] found trifid superior transverse scapular ligament in only 3% population. There are five types of superior transverse scapular ligament as explained by Bayramoglu *et al*. [19]. The first is fan shaped, which is the most common type, the second type has an additional anterior coracoscapular ligament. The third type has two parts i.e. anterior & posterior and in fourth type the ligament is calcified, which is least common type. Wang HJ [20] explained a scapula with double suprascapular foramen in Chinese population. The motor supply of supra & infraspinatus muscles comes from suprascapular nerve, but this nerve does not supply the adjoining skin. So, any irritations in the nerve fibers causes deep pain, which is not well localized. When the patient comes to a clinician with his complains, the muscles atropy get started [21].

For early & correct diagnosis, every clinician must have detail anatomical knowledge about the course of suprascapular nerve & all possible sites of its compression. It is mainly compressed at two sites: (a) At the suprascapular notch & (b) At the base of scapular spine.

Thompson *et al*. [23] explained that its compression against superior transverse scapular ligament occurs mainly during horizontal adduction & abduction of shoulder joint. This compression may be more when superior transeverse scapular ligament becomes ossified. The suprascapular nerve entrapment syndrome presents with initial symptoms of burning sensations, numbness & weakness in the hand, which later on present only weakness of abduction and external rotation of shoulder joint as explained by Black KP & Lombardo JA. The X-ray, CT scan, electromyographic studies (EMG), nerve conduction velocity test (NCV), MRI & arthroghaphy are some recent investigation techniques which helps in correct diagnosis of nerve entrapment.

Table 1: Measurements of STSL on right & left side

	STSL on right side (mm)		STSL on left side (mm)	
	Range	**Mean**	**Range**	**Mean**
Superior length	6 – 41	23.5	11 – 36	23.5
Inferior Length	8 – 19	13.5	8 – 21	14.5
Thickness at lateral end	1 – 2	1.5	1 - 2.5	1.75
Thickness at medial end	1 – 1.9	1.45	1 – 2.9	1.95
Width at lateral end	2 - 8.5	5.25	2 – 7.5	4.75
Width at medial end	4 – 35.5	19.75	3.5 – 32.5	18.0

Table 2: Relations of suprascapular vessels and nerve to STSL

%	Polguj *et al.* 4 %	Podgorski 41	Present study
Type I	72.1	96	28
Type II	27.9	0	55
Type III	0	4	17

Superior transverse scapular ligament connects two regions of the same bone and does not cross any joint, and no mechanical function has yet been attributed to it. Nevertheless, variations in its thickness and length, and its tendency to ossify, suggest that the ligament responds to changes in mechanical load. The frequency with which the SSL ossifies, relates to the fibro cartilaginous character of the ligament [24]. The anatomical knowledge of suprascapular foramen is of extreme importance for clinicians; it can be a risk factor during surgical explorations involving a suprascapular nerve decompression [25].

The coexistence of the suprascapular notch and the suprascapular foramen is another anatomical variation in the suprascapular region [26]. The presence of an ossified STSL may also pose a challenge during decompression of the suprascapular notch if the condition is not fully appreciated [27]. The ossification of the STSL may also alter the attachment of the omohyoid muscle, which has its attachment close to it. The lateral border of the scapula has a projection and it may have distorted the attachment of the omohyoid muscle, thereby altering its action [28]. The documented variations of the superior transverse scapular ligament include calcification, partial or complete ossification and multiple bands.

Conclusion

Cadaveric study of STSL providing idea of variations of morphology of STSL shall be of help to surgeons and arthroscopist to plan their approach in treatment of SNES. Radiologist, neurosurgeons and orthopedic surgeons should bear this anatomical variation in mind, since its existence alters the surgical technique or arthroscopic decompression of the suprascapular nerve. But further detail study should be done on large number of scapulae from different region and population along with cadaveric, radiologic and clinical cases study.

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