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Anatomical assessment on various types of Suprascapular notch in cadavers in ANM medical college Gaya Bihar

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Abstract
The supra scapular notch is situated in the lateral part of the superior border of the scapula, adjacent to the base of the coracoid process. The notch is converted into a foramen by the transverse scapular ligament and it serves as a passage for the suprascapular nerve. Suprascapular nerve entrapment is an acquired neuropathy which is secondary to the compression of the nerve, in the bony suprascapular notch. The suprascapular notch is an important landmark of the suprascapular nerve during arthroscopic shoulder operations. The present study was planned as the literature revealed that only very little data was available on the morphology of the suprascapular notch, particularly in the north Indian population & compare it with incidence among various races of world to know its clinical significance.
The present study was planned in Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India from Jan 2016 July 2016. Total 50 human dried scapulae received in the department were evaluated in the present study. Each scapula is observed carefully for different shapes of suprascapular notches on superior border of scapula. Approval of the institutional ethical committee was taken prior to conduct of this study.
A study on the morphology of the suprascapular notch is useful, as the notch is the common site of nerve compression. The type of notch may be the cause of a nerve entrapment. One of the site of compression of suprascapular nerve is the suprascapular notch. Since the suprascapular notch is the common site of nerve entrapment, the knowledge about morphometric variation of suprascapular notch is essential for clinician in making a proper diagnosis and for planning the most suitable surgical intervention.

Keywords: scapula, Suprascapular notch, Suprascapular nerve entrapment, superior transverse scapular ligament, etc

Introduction
The suprascapular notch (or scapular notch) is a notch in the superior border of the scapula, just medial to the base of the coracoid process. This notch is converted into a foramen by the superior transverse scapular ligament, and serves for the passage of the suprascapular nerve (but not its corresponding artery); sometimes the ligament is ossified. The suprascapular artery travels superiorly to the superior transverse ligament [1]. According to Rengachary *et al*. 1979, there are six basic types of scapular notch [2]:
Type I (8%): Notch is absent. The superior border forms a wide depression from the medial angle to the coracoid process.
Type II (31%): Notch is a blunted V-shape occupying the middle third of the superior border.
Type III (48%): Notch is U-shaped with nearly parallel margins.
Type IV (3%): Notch is V-shaped and very small. A shallow groove is frequently formed for the suprascapular nerve adjacent to the notch.
Type V (6%): Notch is minimal and U-shaped with a partially ossified ligament.
Type VI (4%): Notch is a foramen as the ligament is completely ossified.
Suprascapular neuropathy is a less common cause of shoulder pain in athletes but is seen particularly in those who participate in overhead activities. Athletes who participate regularly in overhead sports are more susceptible to developing suprascapular neuropathy. Sports such as baseball, volleyball, and tennis demand skills that place substantial load on the athlete's shoulder when the upper limb is in an overhead or abducted and externally rotated position [3].
The suprascapular nerve (SSN) is a mixed nerve that provides the motor innervation of the supraspinatus and infraspinatus muscles and the sensory and proprioceptive innervation of the posterior aspect of the glenohumeral joint, as well as the acromioclavicular joint, subacromial bursa, and scapula [4]. This nerve carries afferents from approximately 70% of the shoulder joint. The nerve arises from the upper trunk of the brachial plexus and is composed predominantly of C5-C6 level fibers. Some authors suggest that the nerve may also receive contributions from the fourth cervical nerve root in as many as 25% of people. Although the suprascapular nerve is a mixed nerve, it typically carries no cutaneous afferent fibers. The SSN is thought to carry cutaneous afferent fibers in only 15-25% of the general population.
In its initial course, the SSN courses posterior and parallel to the inferior belly of the omohyoid muscle and anterior to the trapezius muscle in the posterior triangle of the neck. The nerve then passes dorsally through the suprascapular notch, where it is retained by the transverse scapular ligament, into the suprascapular fossa, where 2 motor branches to the

supraspinatus muscle originate. Just proximal to the suprascapular notch, the SSN gives off the superior articular branch, which travels with its fellow nerve through the notch before proceeding laterally to innervate the acromioclavicular joint and its associated bursa and the coracoclavicular and coracohumeral ligaments.

Cadaveric studies reveal that the suprascapular notch may be either U -shaped or V -shaped, and some physicians believe that this anatomic variation may be related to an individual's predisposition to SSN entrapment at this level. After supplying the supraspinatus, the nerve subsequently travels inferolaterally to wrap around the spine of the scapula at the spinoglenoid notch.

In roughly 15-80% of cadavers studied, the spinoglenoid (inferior transverse scapular) ligament traverses this notch, creating a tunnel through which the nerve travels. Interestingly, the spinoglenoid ligament is reportedly more common in males than in females; this observation may provide an anatomic basis for any possible sex-related predominance in the prevalence of volleyball shoulder. The inferior articular branch, which contains afferents from the posterior glenohumeral joint capsule, joins the suprascapular nerve at the level of the spine of the scapula. After exiting the fibro-osseous tunnel at the spinoglenoid notch the nerve turns inferomedially before arborizing into 3 or 4 terminal branches that supply the infraspinatus muscle.

Suprascapular nerve entrapment or injury can occur at the suprascapular notch or the spinoglenoid notch. The resulting clinical presentation depends on the location of the suprascapular neuropathy. Selective involvement of the suprascapular nerve at the spinoglenoid notch level results in the isolated atrophy and weakness of the infraspinatus muscle that has been described as an infraspinatus syndrome. The available literature suggests that the most common site of entrapment among volleyball athletes is the spinoglenoid notch [5].

Several mechanisms have been proposed for suprascapular neuropathy. These mechanisms include repeat traction and microtrauma, direct compression of the nerve by surrounding normal anatomy or compression by pathologic space occupying lesions, and ischemia of the nerve from repetitive trauma. However, general agreement is that the suprascapular nerve may be vulnerable to injury due to compressive forces or repetitive distraction.

One mechanism is a traction injury that overhead athletes can be susceptible to, given the great amount of motion at the shoulder. The importance of the scapula in the throwing motion and other overhead sport-specific skills is now well appreciated. As the scapula protracts and retracts with functional use of the upper limb, some traction of the suprascapular nerve can be expected to occur at one or both notches through which it traverses. This concept forms the basis of the "sling effect," which proposes that, in certain functional positions of the upper limb, the suprascapular nerve is exposed to damaging sheer stress in the suprascapular notch. Similar reasoning leads to the prediction that the nerve is vulnerable to traction injury as it bends around the spine of the scapula at the spinoglenoid notch.

Some authors have proposed that individuals in whom the suprascapular nerve angles sharply around the spinoglenoid notch may be particularly prone to this mechanism of injury. The so-called "SICK scapula" (defined by Burkhart *et al* as scapular protraction, inferior border prominence, coracoid tightness, and scapular dyskinesis) that occurs in adaptive response to chronic shoulder overuse and functional instability may also theoretically contribute to the increased tension on the suprascapular nerve via the sling effect [6].

Demirhan *et al* reported that the spinoglenoid ligament, when present, inserts into the posterior glenohumeral capsule [7]. They also observed that the ligament becomes taut when the ipsilateral upper limb is adducted across the body or internally rotated; this motion results in traction of the suprascapular nerve at the spinoglenoid notch. Other possible mechanisms in which the suprascapular nerve may be compromised include Sandow and Ilic's proposal that the suprascapular nerve nerve is vulnerable to direct compression by the medial border of the spinatus tendons at the spinoglenoid notch when the upper limb is abducted and externally rotated [8]. This mechanism would appear to be a further manifestation of posterior (or internal) impingement.

Ferretti, who has written extensively about volleyball shoulder, hypothesized that the mechanism of selective injury to the terminal portion of the suprascapular nerve in volleyball players is traction on the nerve due to repetitive, sudden, eccentric activation of the infraspinatus during the deceleration phase of the floater serve [5].

Another mechanism of injured is due direct compression on the nerve by a space-occupying lesion. Several studies have reported that the suprascapular nerve may be compressed in the vicinity of the spinoglenoid notch by ganglion cysts arising from the glenohumeral joint [9-11]. These ganglion cysts, like Baker cysts that occur in the popliteal fossa after meniscal degeneration or injury, are likely to be the consequence of an injury to the posterior glenoid labrum with resultant leakage of synovial fluid.

Finally, some investigators have also proposed that suprascapular neuropathy can result from ischemia caused by migration of posttraumatic microemboli from the suprascapular artery (which generally follows a course parallel to the companion nerve) to the vasa nervorum.

The supra scapular notch is situated in the lateral part of the superior border of the scapula, adjacent to the base of the coracoid process. The notch is converted into a foramen by the transverse scapular ligament and it serves as a passage for the suprascapular nerve. Suprascapular nerve entrapment is an acquired neuropathy which is secondary to the compression of the nerve, in the bony suprascapular notch. The suprascapular notch is an important landmark of the suprascapular nerve during arthroscopic shoulder operations. The present study was planned as the literature revealed that only very little data was available on the morphology of the suprascapular notch, particularly in the north Indian population & compare it with incidence among various races of world to know its clinical significance.

Methodology

The present study was planned in Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India from Jan 2016 to july 2016. Total 50 human dried scapulae received in the department were evaluated in the present study. Each scapula is observed carefully for different shapes of suprascapular notches on superior border of scapula. Approval of the institutional ethical committee was taken prior to conduct of this study.

Description of various types of SSN is as follows:

Type I: Notch presents as slight indentation at the superior border of scapula.

Type II: "V"- shaped notch having STL more than MD.
Type III: "U"- shaped notch having MD more than STL.
Type IV: "J"- shaped notch with a groove at its one end.
Type V: U shaped notch presenting a partial ossification at its medial end.
Superior Transverse Length (STL): It is the horizontal distance between two upper ends of SSN Maximum Depth (MD): Vertical distance between deepest point of SSN and midpoint of line joining the two upper ends of SSN.
Middle Transverse Length (MTL): It is the horizontal distance between midpoints of two borders of SSN.

Results & Discussion

The most common relation at the suprascapular notch is that the artery travels superior to the suprascapular ligament while the nerve travels below it [12]. Common reasons for suprascapular nerve entrapment include ossification of suprascapular ligament direct trauma, fracture of the scapula, ganglion cysts, lipomas, tumours, occupational overuse, and stretch injuries. This is due to narrowing of anatomical space of the suprascapular notch [13]. Different authors has classified suprascapular notch on basis of morphological appearance as U and V. J on gross examination. Some authors has distinguished V notch on the basis of vertical and transverse diameter measurements [14-15].

Several descriptions of the suprascapular notch variations have been studied in different populations - Hrdicka [20], Olivier [21], Rengachary *et al*. [16-17] Ticker *et al*., [19] Bayramoglu *et al*. [22] Natsis *et al*. [18] Sinkeet [23], Wang [24] and Polguj [25]. A difference in the classification of the notches had been mentioned by earlier authors. Rengachary *et al*. [16-17] classified the suprascapular notch into six types, based on its shape. Type I – the entire superior border of the scapula shows a wide depression from the medial superior angle to the base of the coracoid process, type II – a wide, blunt, v-shaped notch, type III – a symmetrical, u-shaped notch with parallel margins, type IV – a small, v-shaped notch, type V – similar to type III with the medial part of the ligament ossified and type VI – with the ligament completely ossified and forming a foramen.

Table 1: Dimensions of various types of suprascapular notch

Type of SSN	Superior transverse length in mm (STL) Mean ± SD	Middle Transverse length in mm (MTL) Mean ± SD	Maximum Depth in mm (MD) Mean ± SD
Type I	-	-	-
Type II	11.5 ± 2.8	8.7 ± 2.2	8.1 ± 1.6
Type III	9.3 ± 2.9	7.9 ± 2.8	11.1 ± 1.9
Type IV	8.9 ± 2.5	6.5 ± 2.4	6.4 ± 2.1
Type V	3.9 ± 1.1	5.4 ± 1.3	8.5 ± 0.9
Type VI	-	-	-

Table 2: Shapes of suprascapular notch with its incidences

Sr. No.	Shapes	Number	Percentage
1.	"Deep U" Shape	16	32
2.	"Shallow U" Shape	14	28
3.	"J" Shape	12	24
4.	"V" Shape	6	12
5.	Indented	2	4
	Total	50	100%

Table 3: Comparison of different shapes of suprascapular notch studied by different authors

Sr. No	Shape of SSN	Rengachary *et al*. [16-17]	Natsis *et al*. [18]	Sinkeet *et al*. [23]	Albino *et al*. [13]	Current study
1.	Deep U Shape	48	40	29	23	32
2.	Shallow U Shape	31	24	21	20	28
3.	J Shape	-	-	-	-	24
4.	V Shape	3	13	5	31	12
5.	Indented	-	-	-	-	4

Dunkelgrun *et al* found in his study that V shaped notches have lesser area than U shaped notches [26], so this is a causative factor for suprascapular nerve entrapment syndrome. Cummins *et al* also found that V shaped suprascapular notch was commonly associated with suprascapular nerve entrapment syndrome [27], but no direct correlation found between them clinically. Natsis *et al*. studied on 423 scapulae & also divided the notches into five different types depending upon vertical & horizontal diameters [28].

In the present study, Deep U shape is most common & Indented is least common type of shape of suprascapular notch. Iqbal *et al* found only three different types of notch i.e. U, V & J in their study on Pakistani population in 2010 [129]. In their study, J shaped was most common type. Albino *et al* studied on 500 dried scapulae of Italian population in 2013 about relationship between suprascapular notch and postero superior limit of the safe zone for the suprascapular nerve [30].

They also classified the suprascapular notch according to Rengachary's method into six different types, in which Type IV was most common & Type VI was least common. Vashudha TK *et al*. studied on 115 Indian dried scapulae about different shapes of suprascapular notch & degree of ossification of suprascapular ligament [31]. They found eight different shapes of suprascapular notch i.e. symmetrical U shaped, shallow U shaped, J shape, wide notch, indented, hockey stick, deep U shape & grooved. Among them symmetrical U shape was most common & groove was least common. In the present study, Deep U shape is most common & Indented is least common among different shapes of suprascapular notch. Udayasree L *et al* also studied on 42 Indian dried scapulae about different shapes of suprascapular notch & degree of ossification of suprascapular ligament [32].

De Mulder *et al*. [33] and Warner *et al*. [34] described that the distance between the SSN and the margin of the glenoid cavity is critical during open surgical procedures requiring dissection of the posterior shoulder joint. A safe zone has been described to avoid injuries during surgical procedures, based on the critical distance within which they can be done safely [4]. It has been reported that 2.3 cm from the glenoid rim at the level of the superior rim of the glenoid and 1.4 cm from the posterior rim of the glenoid at the level of the base of the scapular spine are safe [35].

The knowledge of morphometric variations of suprascapular notch and ossification of suprascapular ligament is very important for clinicians. This knowledge is very important

in sports medicine as well as for orthopaedic surgeons in management of cases of shoulder pain. Radiologists can easily diagnosed such cases by using imaging modalities like MRI, CT and Ultrasound. Further histopathological studies on suprascapular nerve are needed to get more information on this matter.

The study was performed with a limited number of dried cadaveric scapulae. Further research is needed to confirm the correlation between notch type and suprascapular nerve entrapment utilizing other sources such as radiographic images as well as a larger sample size.

Conclusion

A study on the morphology of the suprascapular notch is useful, as the notch is the common site of nerve compression. The type of notch may be the cause of a nerve entrapment. One of the site of compression of suprascapular nerve is the suprascapular notch. Since the suprascapular notch is the common site of nerve entrapment, the knowledge about morphometric variation of suprascapular notch is essential for clinician in making a proper diagnosis and for planning the most suitable surgical intervention.

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