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Original Research Article

Morphological variations of the suprascapular notch and its clinical correlation with suprascapular nerve entrapment syndrome

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ABSTRACT

Background: The suprascapular notch present medial to the coracoid process serves as a passage for the suprascapular nerve which supplies the rotator cuff muscles and ligaments in the acromio-clavicular and shoulder joints. The suprascapular nerve is commonly compressed at the suprascapular notch, which can result in severe shoulder pain, weakness of the arm, restricted range of movement, and eventually, atrophy of the muscles supplied by the nerve. The syndrome of suprascapular nerve entrapment is a significant differential diagnosis of shoulder pain. Unfortunately, it is often neglected while diagnosing shoulder pain or discomfort.

Purpose: Our study's main objective is to examine how often different morphological variations occur in the suprascapular notch and their potential role in causing suprascapular nerve entrapment syndrome.

Materials and Methods: We grossly examined 70 scapula to identify the presence, absence and type of suprascapular notch. We documented the observed variations of the suprascapular notch by capturing photographs and organizing the findings in a table.

Result: According to our findings, Type 3 (U-shaped notch) was the most frequently observed morphological variation of the suprascapular notch, while Type 1 (absence of suprascapular notch) was the least commonly found. Our findings provide fresh perspectives when compared to prior research.

Conclusion: Having knowledge of the morphological variations of the suprascapular notch plays a vital role in accurately diagnosing suprascapular nerve entrapment syndrome using non-invasive diagnostic imaging and planning the most suitable surgical interventions.

1. Introduction

The suprascapular notch is present medial to the base of the coracoid process in the superior border of the scapula, medial to the base of the coracoid process.[1] The notch is transformed into a foramen by the superior transverse scapular ligament which serves as a pathway for the supra scapular nerve (SSN). The SSN provides both sensory and motor nerve impulses to the rotator cuff muscles, as well as the ligaments in the acromio-clavicular and shoulder joints.

Kopell and Thompson were the first to describe the entrapment of the suprascapular nerve.[2] Compression of the SSN frequently occurs at the Suprascapular notch, leading to pain in the postero-lateral part of the shoulder, arm weakness, limited ability to externally rotate and abduct the arm, and ultimately, atrophy of the infraspinatus and supraspinatus muscles.[3]

The syndrome of nerve entrapment is typically associated with traumatic injuries to bones in the shoulder such as the clavicle, scapula, or proximal humerus. It

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can also occur in cases of shoulder joint dislocation or acromio-clavicular joint dislocation. The condition is most commonly found in athletes, particularly volleyball players, who regularly put their shoulders under strain with repeated overhead movements.

The syndrome of SSN entrapment is a significant factor that should be taken into consideration when diagnosing shoulder pain. Unfortunately, it is often neglected in the differential diagnosis for shoulder pain or discomfort.[4]

The primary aim of our study is to investigate the frequency of various morphological variations in the suprascapular notch, as well as the likelihood of these variations contributing to the development of SSN entrapment syndrome.

2. Aims

1. To describe morphological variations of the suprascapular nerve.
2. Clinical correlation between the anatomical differences of suprascapular nerve and suprascapular nerve entrapment syndrome.

3. Materials and Methods

For this study, we utilized 70 dry adult human scapulae of unidentified gender and origin. These specimens were obtained from the department of Anatomy at Employees State Insurance Medical College and Post Graduate Institute of Medical Science and Research in Rajajinagar, Bangalore, India.

Scapulae which were intact and unbroken were included in the study, whereas damaged and broken ones were excluded.

We conducted gross examinations of each scapula to identify the presence or absence of the suprascapular notch, as well as its specific type. We recorded our findings in a table and captured photographs to document the various types of suprascapular notches observed.

Fig. 1: A subset of the specimens collected during the research study

4. Results

We analyzed six distinct types of suprascapular notch. In our study of 70 scapulae, we found that 4 (5.91%) had no suprascapular notch (Type 1), 11 (15.91%) had a blunted V-shape (Type 2), 23 (32.25%) had a U-shape (Type 3), 9 (12.85%) were minimally V-shaped (Type 4), 17 (24.28%) had a V-shape with partial ossification (Type 5), and 6 (8.59%) had a foramen at the site of the suprascapular notch (Type 6). Our results indicate that the most common morphological variation of the suprascapular notch was Type 3, followed by Type 5, Type 2, Type 4, Type 6, and finally Type 1. Our findings offer new insights in comparison to previous research.

Our results regarding the morphological variations of the suprascapular notch are shown in Table 1.

Table 1: Our results of the morphological variations of the suprascapular notch using Rengachary classification

Type	No. of scapulae	Percentage
Type 1	4	5.91%
Type 2	11	15.91%
Type 3	23	32.25%
Type 4	9	12.85%
Type 5	17	24.28%
Type 6	6	8.59%
Total	70	

5. Discussion

The scapula is a slender, triangular bone that serves as the pivot point and foundation for all movements of the humerus. It is located in the posterior-lateral part of the chest wall, and it overlaps the second to seventh ribs. The suprascapular notch is a depression in the superior border of the scapula, which is situated just medial to the base of the coracoid process. The superior transverse scapular ligament converts this notch into a foramen. In some instances, this ligament may become ossified, resulting in a bony foramen.[5]

The suprascapular notch functions as a conduit for the suprascapular vessels and nerve.[6] The suprascapular nerve, which is a mixed peripheral nerve containing both motor and sensory elements, is a branch of the upper trunk (C5,6) of the brachial plexus. It enters the suprascapular notch inferior to the superior transverse scapular ligament and travels deep to the omohyoid and trapezius muscles.[7]

The Supraspinatus and Infraspinatus muscles receive their motor innervation from the SSN, while the acromioclavicular joint and glenohumeral joint receive sensory innervation from it.[8]

The SSN entrapment syndrome is significantly influenced by the type of suprascapular notch.[9] Different authors have categorized the anatomical types of this notch by considering various parameters such as its vertical length, shape, and transverse diameter. In our research, we utilized the Regachary classification.

Rengachary and colleagues in 1979 identified six categories of scapular notch.[10–12]

Type 1: Absent notch. Superior border of the notch forms a wide depression between the medial angle and coracoid process.

Type 2: Blunt V shaped notch in the middle third of the superior border.

Type 3: U-shaped notch with its margins nearly parallel

Type 4: Very small V shaped notch. Frequently there is a shallow groove that is formed for the suprascapular nerve adjacent to the notch.

Type 5: V shaped minimal notch and has a partially ossified ligament.

Type 6: The completely ossified ligament converts the notch into a foramen.

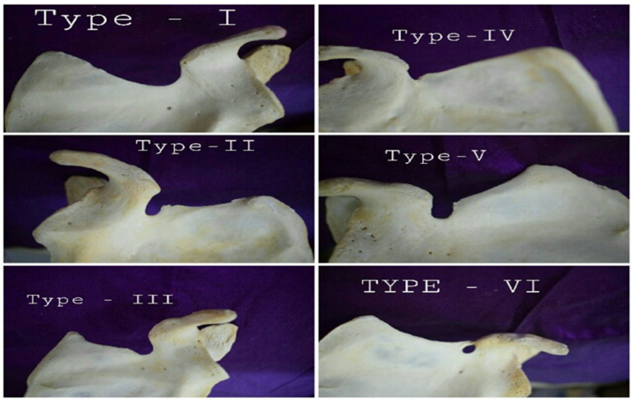

Fig. 2: The 6 types of suprascapular notch according to Rengachary classification identified in the specimens collected for the study. Type 1: Absent notch, Type 2: Blunt V shaped notch, Type 3: U-shaped notch, Type 4: Very small V shaped notch, Type 5: V shaped minimal notch, Type 6: Completely ossified ligament converting notch into a foramen.

In contrast to the Rengachary investigation, where type 4 was found to be the least common, our study found that type 1 was the least frequent. However, our findings of a higher occurrence of type 3 suprascapular notch were in agreement with Rengachary's study. Other studies conducted by Iqbal (2010)[13] and Paolo Albino (2013)[14] reported that type 5 and type 3 suprascapular notches, respectively, were most commonly observed.

Other studies with information regarding prevalence of suprascapular notch have been listed in Table 2.

Research on chicken and mouse models has been used to gain insights into the early formation and patterning of the scapula during embryonic, fetal, and early postnatal stages.

Unlike other appendicular bones that develop from a single tissue layer, the scapula is formed from contributions by the dermomyotome, somatopleure, and neural crest, making this a unique feature of its development.

The proximal spine and blade of the scapula originate from the dermomyotome, while the acromion, glenoid fossa, and coracoid arise from the somatopleure.[21]

During the fourth week of development, limb buds start to protrude as outpouchings from the ventrolateral body wall. The bones and connective tissues of the limbs arise from the mesenchymal core, which is derived from the parietal layer of the lateral plate mesoderm.

By the 6th week of development, the initial hyaline cartilage models, prior to the bones of the extremities, are formed by these chondrocytes.The scapula forms by endochondral ossification 2nd gestational month in humans, this cartilaginous scapula is invaded by blood vessels and osteoblasts allowing for the appearance of a single primary ossification center in the scapular neck region, which then facilitates bone formation.

By the sixth week of development, chondrocytes generate the initial hyaline cartilage models for the extremities' bones. The scapula develops through endochondral ossification during the second gestational month in humans. This cartilaginous structure is penetrated by osteoblasts and blood vessels, resulting in the appearance of a primary ossification center in the scapular neck area and the eventual bone formation.

Deviation from the aforementioned developmental process can result in the presence, absence, or variation in the types of Suprascapular notches.[21]

5.1. Clinical significance

The size and shape of the notch are critical factors in the development of nerve entrapment. Suprascapular nerve entrapment is an acquired neuropathy resulting from nerve compression in the suprascapular notch.

Although relatively uncommon, suprascapular nerve entrapment is a significant cause of shoulder pain and disability.

Morphological factors that may contribute to this condition include a narrow or deep suprascapular notch, a V-shaped notch, a band-shaped, bifurcated or completely ossified superior transverse scapular ligament, and unusual arrangements of the suprascapular vessels and nerves at the suprascapular notch. The international literature indicates that suprascapular nerve entrapment affects 1-2% of all patients with shoulder pain and may be misdiagnosed.[22]

Athletes who frequently perform overhead movements and experience repetitive strain have an increased risk of suprascapular nerve entrapment. In clinical practice, it is essential to have knowledge about the morphological variations of the suprascapular notch while conducting radiological imaging, such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and ultrasonography. Additionally, knowledge of the morphological variations is crucial during procedures such as arthroscopic shoulder

Table 2: Showing the prevalence of types of suprascapular notch according to different studies

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Rakshitha. C, Komala. N [15]	18.96%	34.48%	31.03%	6.90%	6.90%	3.45%
Michał Polguj [16]	24.18 %	1.95 %	3a) 2.92%, 3b) 0.97 % 3c) 52.27 %,	4.72 %	12.99 %	-
Rengachary, S. S., Burr, D. [10–12]	8%	31%	48%	3%	6%	4%
Kannan U et al [17]	20%	10%	52%	4%	4%	10%
Sangam MR et al [18]	21.15%	8.65%	59.61%	2.88%	5.76%	1.92%
D. Toneva, S. Nikolova [19]	15.7%	25.5%	44.1%	11.8%	2.9%	-
Sinkeet et al., [20]	22%	21%	29%	5%	18%	4%
Muralidhar	21.15%	8.65%	59.61%	2.88%	5.76%	1.93%
Paolo Albino et al., [14]	12.4%	19.8%	22.8%	31.1%	10.2%	3.6%
Hubert Jeziersk [20]	11.1%	6.0%	64.2%	18.7%	-	-
Present Study	5.71%	15.71%	32.85%	12.85%	24.2%	8.5%

operations or suprascapular nerve blockades.[23]

6. Conclusion

Understanding the variations in the morphology of the suprascapular notch is crucial for clinicians, as it is a frequently occurring site of nerve entrapment. Knowledge about the morphometric variations of suprascapular notch, as well as whether the superior transverse scapular ligament is completely or partially ossified, is important in making an accurate diagnosis using non-invasive diagnostic imaging and in planning appropriate surgical interventions. In our study, we found that the most common type of suprascapular notch was U-shaped notch (type 3) and least common was no suprascapular notch (type 1).

7. Limitations of the Study

Sample size was small and more number of scapulae could have been used for the study.

8. Abbreviations

SSN - Suprascapular nerve; CT - Computed Tomography, MRI - Magnetic Resonance Imaging.

9. Source of Funding

None.

10. Conflict of Interest

None.

11. Authors' Contributions

1. Dr. Guna Sekhar Moorthy Kollipara- Concept and design, Acquisition of data, analysis of data, interpretation of data, drafting the manuscript, revised critically for important intellectual content and has given final approval of the manuscript version to be published.
2. Dr Shruthi Sridhar- Acquisition of data, analysis of data, interpretation of data and drafting the manuscript.
3. Dr Vijayalakshmi Mannan K- Concept and design, acquisition of data, analysis of data.
4. Dr Padmalatha K- Conception and design of the work, Drafting of manuscript.
5. Dr Anushree Mohan Burade- Acquisition of data, interpretation and analysis of data.
6. Dr Shiva Sandesh Hossali Math- Acquisition of data and analysis of data.
7. Dr Niranjan Kumar- Concept and design, acquisition of data.

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