www.ajbrui.org

Afr. J. Biomed. Res. Vol. 25 (January, 2022); 53 - 57

Research Article

Morphometric Study of the Suprascapular Notch in Nigerian Dry Scapulae

***Ukoha U.[1], Okeke C.M.[1], , Ukoha C.C.[2], Ekezie J.[3] and Mbah J.C.[1]**

[1]*Department of Anatomy, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria*
[2]*Department of Microbiology, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria*
[3]*Department of Anatomy, Federal University of Technology, Owerri, Imo State, Nigeria*

ABSTRACT

Suprascapular notch (SSN) of the scapular is a depression on the lateral part of its superior border, which is bridged by the superior transverse scapular ligament as it transmits the suprascapular nerve to the supraspinous fossa. Variations in morphology of the SSN have been associated with suprascapular nerve entrapment. The aim of this study was to characterize the morphological variations of suprascapular notch in Nigerian dry scapulae. A total of 193 human dry scapulae (96 Right and 97 Left) were studied. The variables of study included the shape of the SSN, superior transverse diameter (STD), inferior transverse diameter (ITD) and maximum depth (MD) of the SSN. The metric variables were measured with a Vernier Calliper. The SSN was classified based on Renganchary *et al* classification. The values of the STD, ITD, and MD were 1.285 ± 0.536, 0.724 ± 0.316 and 0.997 ± 0.441 respectively. These values showed no statistical difference between the right and the left sides. The prevalence of the types of SSN (in decreasing order) were type III (71%), type II (22%), type I & V (3% each) type IV (1%) and type VI (0%). The findings of the present study showed that type III was the most prevalent type while type VI (formed by complete ossification of the suprascapular ligament) was not found in the study.

Keywords: *suprascapular notch, suprascapular nerve, scapular, morphometry, Nigeria*

*Author for correspondence: *Email: okeke.chijioke@yahoo.com; Tel: +2348030465528*

Received: October 2020; Accepted: July 2021

INTRODUCTION

The scapula (also called the shoulder blade) is a triangular flat bone that lies on the posterolateral aspect of the thorax, overlying the 2nd to 7th ribs (Moore *et al*, 2014). The scapula, the clavicle and the manubrium of the sternum, constitute the pectoral/shoulder girdle. The scapula has three borders (Superior, lateral and medial borders), three angles (Lateral, superior and inferior angles), two processes (coracoid and acromion process) and two surfaces (Anterior and posterior surfaces). Its convex posterior surface is unevenly divided by the spine of the scapula into a small supraspinous fossa and a much larger infraspinous fossa while the concave costal surface (anterior surface) has a large subscapular fossa. The triangular body (blade) of the scapula is thin and translucent superior and inferior to the scapular spine (Moore *et al*, 2014). The suprascapular notch is seen as a depression in the lateral part of the superior border of the scapula, just medial to the base of the coracoids process. It is converted into a foramen by the superior transverse scapular ligament. The suprascapular nerve and vein pass under the ligament while the suprascapular artery passes above it (Aghera *et al*, 2017; Kannan *et al*, 2014). A good knowledge of the morphormetric variation of the scapulae is important in clinical investigation as it helps to understand shoulder and back pains (Büyükmumcu *et al*, 2013) as well as the arrangement of the neurovascular structures thereon. Jezierski *et al* (2017) noted in their study that suprascapular notch containing both suprascapular nerve and vein was significantly wider and shallower. The suprascapular notch is frequently bridged by bone rather than a ligament, converting it into foramen in some animals but its incidence is much less in humans (Jezierski *et al*, 2017).

The suprascapular nerve is formed by fibres from C5, C6 and occasionally from C4 (Tubbs *et al*, 2013). It supplies the supraspinatus and infraspinatus, and sensory branches to rotator cuff muscles and ligamentous structures of the shoulder and acromioclavicular joints (Jacob *et al*, 2012). Accordingly, this notch is an important landmark for suprascapular nerve block during arthroscopic shoulder operations (Rakshitha *et al*, 2018; Polguj *et al*, 2012).

Variations in the morphology of suprascapular notch have been identified as one of the causes of suprascapular nerve entrapment (Manikum *et al*, 2015; Polguj *et al*, 2013); narrow suprascapular notches have been frequently observed in patients with suprascapular nerve entrapment syndrome (Bage *et al*, 2017; Vaidya *et al*, 2018; Rengachary *et al* 1979). Suprascapular nerve neuropathy is a frequent symptomatic presentation in some individuals who have been involved in violent overhead activities, using a particular upper limb. Thus, morphometric variations of the suprascapular notch are very important clinically for understanding possible predisposing factors for compression of the suprascapular nerve in this region.

Many researchers had attempted classification of the supraclavicular notch. Perhaps the most popular classification is that produced by Rengachary *et al* (1979) who classified this notch into six types, based on its shape viz (Figure 1).

Good understanding of the anatomical variations of the suprascapular notch is necessary both for investigation and intervention in pathologies around the shoulder regions. Furthermore, it is known that anthropometric data obtained from biological features in one location may not be a standard reference for other locations, given the fact of varying nature of racial, ethnic, genetic and geographical factors across populations. Upon the backdrop of paucity of data in our area, this study tries to determine the morphometric features of the suprascapular notch and its variation in human dry scapulae of Southern part of Nigeria with an aim to generate reference data for both clinical and research purposes in the region.

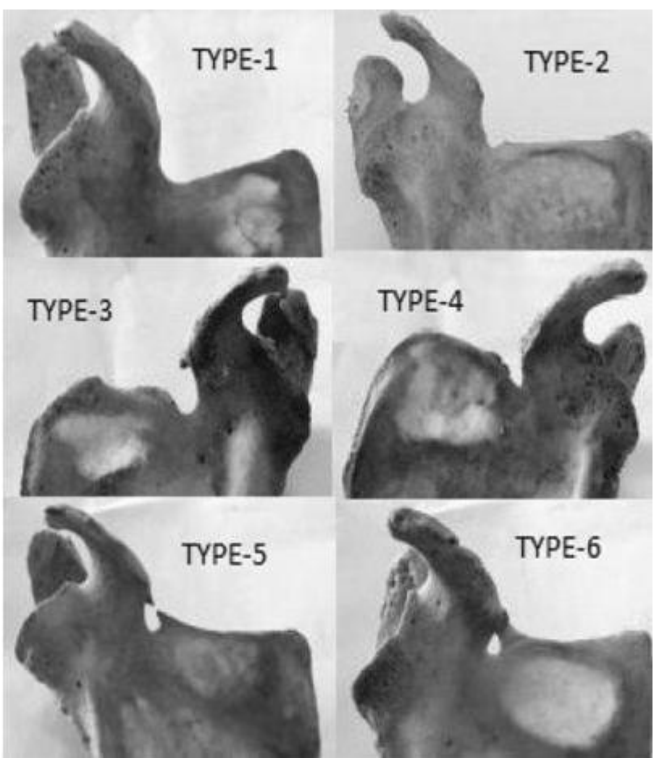

Figure 1
Pictoral representation of types of suprascapular notch'
Type I –the entire superior border of the scapula shows a wide depression from the medial superior angle to the base of coracoid process; Type II –a wide and blunt V-shaped notch; Type III –a symmetrical U-shaped notch; Type IV –a small, V-shaped notch;
Type V –similar to type III with the medial part of the ligament ossified and ; Type VI – Ligament completely ossified and forming a foramen.
Adapted from Aghera *et al*, 2017

MATERIALS AND METHODS

Study area and sample: The study was a cadaveric study that tried to determine the morphometry of the suprascapular notch. One hundred and ninety-three (193) dry adult human scapulae (96 right and 97 left) were studied. The sex was unknown. The scapulae were obtained from the osteology collections held in the museum of various Departments of Anatomy of the following Universities in Nigeria: Nnamdi Azikiwe University Awka, (81 scapulae), University of Benin, (17 Scapulae), University of Nigeria, (64 Scapulae), Delta State University Abraka, (24 scapulae), and Anambra State University, Uli, (7 scapulae). These universities are located in the Southern part of Nigeria.

Ethical approval: Ethical approval for this research was obtained from the Ethical Committee of Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Awka, Nigeria. The ethical approval was used to obtain permission from the Departments of Anatomy of other various Institutions to in order to use their osteology collections.

Inclusion criteria: The Scapular bones must be of Nigeria origin and were non- pathological.

Exclusion criteria: This included pathological scapular bones and scapulae with broken notches.

Variables of study: The following variables were studied and recorded: sidedness of the scapular, shape of the suprascapular notch; superior transverse diameter (STD), inferior transverse diameter (ITD) and the maximum depth (MD) of the suprascapular notch (figure 2). The metric variables were measured in centimeter (cm). The STD was measured as the maximum distance between superior-most edges of suprascapular notch (SSN). The ITD was measured as the maximum distance between the edges of the curved arch at the base of the suprascapular notch (SSN). The MD of suprascapular notch was measured as the maximum vertical distance between deepest points at the base of suprascapular notch to an imaginary line between superior edges of notch. The measurements above were taken three times and the average was recorded. This is to reduce measurement error. The measurements was taken with a digital Vernier caliper (Metric & Sae Digital Display ISO9001: 2000, Jumlee Company, China), with precision of 0.01mm.

Method of classification: Rengachary *et al* (1979) method of classification of suprascapular notch was used as follows: Type I – the entire superior border of the scapula shows a wide depression from the medial superior angle to the base of coracoid process; Type II – a wide and blunt V-shaped notch ; Type III – a symmetrical U-shaped notch; Type IV – a small, V-shaped notch; Type V – similar to type III with the medial part of the ligament ossified; and Type VI – Ligament completely ossified and forming a foramen

Statistical analysis: Statistical analysis was done by using the Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago Illinois, USA). The mean and standard deviation of the values were obtained. Comparison of means for the right and left sides was done with student's t-test. Frequencies of the various shapes were obtained while chi-square was used to compare for both sides. Difference is deemed statistically significant if the $P < 0.05$.

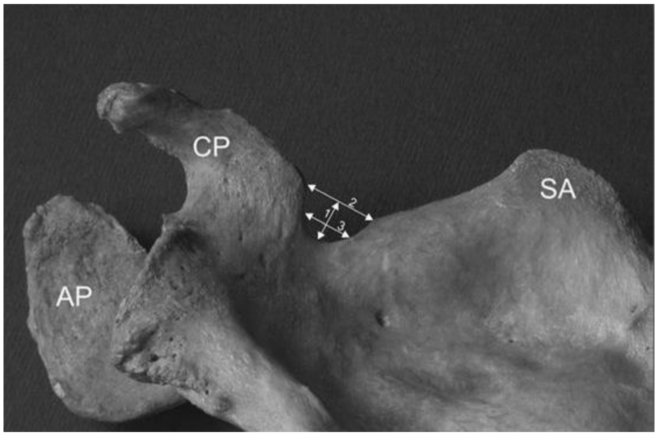

Figure 2:
Landmarks for measurements of suprascapular notch
1=Maximum depth 2=superior transverse diameter 3= inferior transverse diameter (Adapted from Polguj *et al* 2011)

RESULTS

Table1 shows the mean and standard deviations of the metric variables. The superior transverse diameter (STD) had the highest value, followed by the maximum depth (MD) while the inferior transverse diameter (ITD) had the least value. This applied to the right and left scapulae separately and when both are combined. The values of STD and ITD were slightly higher in the right than in the left scapular, while the value of the MD was higher on the left side as compared to the right side. However, these differences were not significant (P > 0.05).

Table 2 shows the distribution of various types of suprascapular notch of the scapular in the study. There was significant difference in the frequencies of various types of suprascapular notch. However, the same pattern of frequency was observed in both the right and left scapular. Type III was the most frequent. Type II was the next most frequent, which is followed by type I and V. Type IV was the least frequent while type VI was not observed in the present study.

Table 1
Descriptive statistics of the metric variables on the right and left suprascapular notches

Variable	Mean (cm) ± SD			t-value	p-value
	Combined	Right side	Left side		
STD	1.285 ±0.536	1.308 ±0.541	1.262 ±0.534	0.590	0.556
ITD	0.724 ±0.316	0.737 ±0.303	0.712 ±0.330	0.548	0.584
MD	0.997 ±0.441	0.976 ±0.402	0.018 ±0.479	-0.662	0.509

Table 2:
Frequency distribution of various types of suprascapular notch of the scapula

Variable	Mean (cm) ± SD			χ^2	Sig.
	Combined	Right side	Left side		
Type I	6 (3%)	4 (3%)	2 (2%)		
Type II	43 (22%)	22 (23%)	21(22%)		
Type III	136 (71%)	66 (69%)	70 (72%)	336.0	0.000
Type IV	2 (1%)	1 (1%)	1 (1%)		
Type V	6 (3%)	3(3%)	3 (3%)		
Type VI	0	0	0		
Total	193 (100%)	96 (100%)	97 (100%)		

DISCUSSION

The present study aimed at characterizing the morphometric variables of the suprascapular notch (SSN) of dry human scapulae of the Southern Nigeria. The variables of interest included the superior transverse diameter (STD), the inferior transverse diameter (ITD), the maximal depth (MD) and the shape of the SSN which was used in classifying the SSN into various types based on Rengachary *et al* classification. The result showed that there is no significant difference in the values of STD, ITD and MD between the right and left SSN. Manikum *et al* (2015) reported that the right MD was significantly deeper than that of the left, while there is no significant difference in the STD. This suggests that the shapes of the SSN can be affected by laterality, and so does the nerve entrapment syndrome.

The STD in the present study was a little narrower (1.285cm) than that of Manikum *et al* (2015) in South Africa (1.39cm) while the MD in the present study was deeper (0.997cm) than that in Manikum *et al* (2015) (0.68cm). The size and dimensions of the SSN has been considered a possible factor for suprascapular nerve entrapment (Aghera *et al*, 2017). This is because the SSN is the most likely site for nerve compression all the through the course of the suprascapular nerve (Polguj *et al* 2013, Manikum *et al* 2015, Aghera *et al*, 2017). SSN is therefore regarded as the most important point in the course of the suprascapular nerve (Bage *et al*, 2017). However, compression of the suprascapular nerve may also occur at the base of the scapular spine, though this is less common (Aghera *et al*, 2017).

Compression of the suprascapular nerve would lead to suprascapular nerve entrapment syndrome. This disorder is characterized by pain on the posterolateral aspect of the shoulder, weakness of the arm, difficulty in external rotation and abduction, resulting from paresis and atrophy of the infraspinatus and supraspinatus muscles (Kannan *et al*, 2014). Apart from nerve compression at the SSN, there are other causes of suprascapular nerve neuropathy which may include direct trauma, rotator cuff tear, ganglion cysts causing compression and sports injury due to repeated traction (Aghera *et al*, 2017). Suprascapular nerve is also majorly involved in Parsonage Turner syndrome which features include severe shoulder pain followed by numbness and weakness (Rakshitha *et al* 2018).

Table 3:
Comparison of types of suprascapular notch across several locations

Authors	Year	Population	Type I (%)	Type II (%)	Type III (%)	Type IV (%)	Type V (%)	Type VI (%)
Albino *et al*	2013	Italy	12.4	19.8	22.8	31.1	10.2	3.6
Sinkeet *et al*	2010	Kenya	22	21	29	5	18	4
Iqbal *et al*	2010	Pakistan	18	20	13	-	-	-
Kannan *et al*	2014	South India	20	10	52	4	4	10
Manikum *et al*	2015	South India	5	65	5	18	7	-
Hassanein *et al*	2015	Egypt	8.24	7.89	60.53	31.58	-	2.35
Vedha *et al*	2017	South India	21.2	5.6	37.2	5.2	5.2	9.2
Reddy *et al*	2017	South India	6.6	41.5	44.3	-	4.7	2.8
Present study		Nigeria	3	22	71	1	3	0

Entrapment of suprascapular nerve at the suprascapular notch was first described by Kopell *et al* (cited by Kannan *et al*, 2014) in 1959. The suprascapular nerve entrapment syndrome is frequently seen in sports persons who repeatedly stress the shoulder with overhead upper limb movements that involves excessive abduction and external rotation. Examples of these sports include volleyball, baseball, weight lifting, tennis players, fencers, hunters using bows, dancers and figure skaters (Kannan *et al*, 2014). The literature suggests that suprascapular nerve entrapment occurs in 1-2 % of all patients with shoulder pain (Manikum *et al* 2015). The frequency is even higher in athletes. For instance, it was reported to be 33% in international high performance volleyball players (Polguj *et al* 2011). Males are said to be affected more than females in a ratio of about 4:1; probably because males are more involved in these high-performance sports (Polguj *et al* 2013; Bage *et al*, 2017). More so, it occurs mainly in persons under the age of 35 years (Polguj *et al* 2013).

In the present study, Type III SSN was the most frequent type of suprascapular notch (71%). This is similar to the findings of Dushyant *et al*, (2014) (45%), Usha *et al*, (2014) (52%), and Polguj *et al*, (2014) (66.9%). However, Sutaria (2013) and Vandana *et al* (2013) reported type III as the third frequent type. Indeed type III SSN is the most common type as suggested by numerous works in Europe Asia (Manikum *et al* 2015) and in Africa (Table 3). The shape of the SSN is important in the aetiopathogenesis of suprascapular nerve entrapment as it has been hypothesized that 'V' shaped notch is more likely to cause nerve entrapment than 'U' type (Polguj *et al* 2013). Narrow notch has been has been found in patient with this suprascapular neuropathy (Aghera *et al*, 2017).

Type VI SSN involves ossification of the superior transverse scapular ligament. It is regarded as one of the predisposing factors for the nerve entrapment since the notch is reduced in size (Polguj *et al*, 2012). In the present study, type VI SSN was not found. This may perhaps reflect reduced incidence of suprascapular nerve entrapment syndrome in the study population. However, in the literature, the incidence of complete ossification of the superior transverse scapular ligament was stated to be between 3 to 12.5% (Polguj *et al*, 2012). This is any way highly variable as a study in Brazilian population recorded prevalence as high as 30.76% (Gray 2013). Surgical removal of the ossified ligament is a treatment option in the management of suprascapular nerve entrapment syndrome in patients with complete ossification of the superior transverse scapular ligament (Rakshitha *et al*, 2018). Furthermore, presence of an ossified superior transverse scapular ligament may pose a problem during decompression of the suprascapular notch if the condition is not fully appreciated (Aghera *et al*, 2017).

In the present study, classification of SSN was based on Rengachary *et al* classification of SSN. This is because it is the most popular and verified classification system in the literature. Several newer classification systems have emerged over the years. Ticker *et al* (1998) simply classified the SSN into two types: U and V shaped SSN. Iqbal *et al* (2010) classified the SSN into three types: U, V and J shaped SSN. Natsis *et al* (2007) developed a classification based on the vertical and transverse dimensions of the notch. Type I- without a discrete notch, Type II- a notch that was longest in its transverse diameter, Type III- a notch that was longest in its vertical diameter, Type IV- a bony foramen and Type V- a notch and a bony foramen. Polgul *et al* (2011) developed a classification system for SSN in an attempt to be more specific in classifying the SSN. They incorporated three measurements which include the superior transverse diameter (STD), the middle transverse diameter (MDT) and the maximum depth (MD). In type I, MD was greater than STD. This type was divided into three subtypes: IA, IB and IC. Subtype IA presented longer MTD than STD, while IC presented shorter MTD than STD and IB presented equal diameters (STD=MTD). Type II presented equal MD, STD and MTD. Type III presented longer STD than MD. As with type I, this type was also divided into three subtypes: IIIA, IIIB and IIIC. In IIIA, MTD was longer than STD. In IIIC, it was the opposite (STD>MTD) and in IIIB these diameters were equal (STD=MTD). In type IV, a bony bridge joins the corners of the SSN. Type V presents a discrete notch. These newer classifications would need to be validated and reproduced by other researches (Manikum *et al* 2015) before they can be used as standards.

In conclusion, the present study has provided a database on the morphometric variables of the suprascapular notch in the Southern part of Nigeria. There was no laterality on the dimensions of the SSN. Type III was the most prevalent type of SSN in the present study while the suprascapular foramen (Type VI) which forms by the ossification of the suprascapular ligament was not observed in the present study. This study will therefore be useful to Anatomists, Radiologists, Neurosurgeons, Orthopaedic surgeons and related disciplines for a better understanding, diagnosis and management of suprascapular nerve entrapment syndrome.

Acknowledgement
We express our heartfelt gratitude to all the Heads of Department of Anatomy of the various Institutions who gave us access to use the scapular in their respective Departments for this morphometric study.

REFERENCES

Aghera B.R., Ahmed S., Javia M., Agarwal G.C. (2017). Morphological and morphometric study of supra scapular notch and incidence of ossified superior transverse scapular ligament in human dry scapulae and its clinical implication. Int J Anat Res. 5(3.2):4212-4215.

Bage N.N., Sriambika K., Murugan M., Nim V.K. (2017). Morphometric study of suprascapular notch as a factor of suprascapular nerve entrapment and dimensions of safe zone to prevent suprascapular nerve injury. Int J Anat Res. Vol 5(2.3):4015-4019.

Büyükmumcu M., Seker M., Ozbek O., Akin D., Koc O., Aydin A.D., Salbacak A. (2013). Complete Ossification of the Superior Transverse Scapular Ligament in an Turkish Male Adult Int. J. Morphol 31(2):590-593.

Dushyant A., Brijendra S., Geetika A.A. (2014). Human scapulae; Suprascapular notch, morphometry and variations. Indian Journal of Clinical Anatomy &Physiology. 1(1):1-7.

Gray D.J. (2013). Variations in human scapulae. American Journal of Physical Anthropology. 29(1):57–72.

Iqbal K., Iqbal R., Khan S.G. (2010). Anatomical variations in shape of suprascapular notch of scapula. J Morphol Science. 27:1-2.

Jacob P.J., Arun K.B. (2012). Suprascapular Nerve Entrapment Syndrome. Kerala Journal of Orthopaedics. 25 (1): 21- 24.

Jezierski H., Podgórski M., Stefanczyk L., Kachlik D., Polguj M. (2017). The Influence of Suprascapular Notch Shape on the Visualization of Structures in the Suprascapular Notch Region: Studies Based on a New Four-Stage Ultrasonographic Protocol, BioMed Res Inter. 1-7 Available online at https://doi.org/10.1155/2017/5323628 (assessed 25th September 2020)

Kannan U., Kannan N.S., Anbalagan J., Rao S. (2014). Morphometric Study of Suprascapular Notch in Indian Dry Scapulae with Specific Reference to the Incidence of Completely Ossified Superior Transverse Scapular Ligament. Clin Diagn Res. 8(3): 7–10.

Manikum C., Rennie C., Naidu E.C.S., Azu O.O. (2015) A morphological study of the suprascapular notch in a sample of scapulae at the University of KwaZulu Natal. Int. J. Morphol., 33(4):1365-1370.

Moore K.L., Dalley A.F., Agur A.M.R. (2014). Moore Clinically oriented Anatomy. 7th Edition 675 - 676. Lippincott Williams and Wilkins; United States of America.

Natsis K., Totlis T., Tsikaras P., Appell H.J., Skandalakis P., Koebke J. (2007). Proposal for Classification of the suprascapular notch: a study on 423 dried scapulas. Clinical Anatomy. 20:135-139.

Polguj M., Jdrzejewski K.S., Podgórski M., Topo M. (2011). Correlation between morphometry of the suprascapular notch and anthropometric measurements of the scapula. Folia Morphol. 70(2):109–15

Polguj M., Podgórski M., Jędrzejewski J., Topol M. (2012). The double suprascapular foramen: unique anatomical variation and the new hypothesis of its formation. Skeletal Radiol 41:1631–1636.

Polguj M., Sibiński M., Grzegorzewski A., Grzelak P., Majos A., **Topol M. (2013).** Variation in morphology of suprascapular notch as a factor of suprascapular nerve entrapment Int Orthop. 37(11): 2185–2192.

Polguj M., Sibiński M., Grzegorzewski A., Grzelak P., Ludomir S., Topol M. (2014). Suprascapular Notch Asymmetry: A Study on 311 Patients. BioMed Research International. Volume 2014. Available online at https://doi.org/10.1155/2014/196896 (assessed 26th September, 2020).

Rakshitha C., Komala N. (2018). Suprascapular notch in human scapula: A morphometric study. Int J Anat Res. 6(1):4840-4843.

Rakshitha C., Komala N. (2018). Suprascapular notch in human scapula: a morphometric study. Int J Anat Res 6(1.1): 4840-4843.

Rengachary S.S., Burr D., Lucas S., Hassanein K.M., Mohn M.P., Matzke H. (1979). Suprascapular entrapment neuropathy: a clinical, anatomical and comparative study. Part 2. Clinical study of Neurosurgery, 5: 447-451.

Sutaria L., Nayak T., Patel S., Jadav H., Pensi C. (2013). Morphology and morphometric analysis of suprascapular notch. Inter J Biomed and Advance Res, 4(1):35-39.

Ticker J.B., Djurasovic M., Strauch R.J., April E.W., Pollock R.G., Flatow E.L., Bigliani L.U. (1998). The incidence of ganglion cysts and other variations in anatomy along the course of the suprascapular nerve. Journal of Shoulder Elbow Surgery, 7: 472-478.

Tubbs R.S., Nechtman C., D'antoni A.V., Shoja M.M., Mortazavi M.M., Loukas M., Rozzelle C.J., Spinner R.J. (2013). Ossification of the suprascapular ligament: A risk factor for suprascapular nerve compression? Int J Shoulder Surg. 7: 19–22.

Usha K., Kannan N.S., Anbalagan J., Rao S. (2014) Morphometric Study of Suprascapular Notch in Indian Dry Scapulae with Specific Reference to the Incidence of Completely Ossified Superior Transverse Scapular Ligament. Journal of Clinical and Diagnostic Research, 8(3): 7-10.

Vaidya V.K., Srivastava G., Munsif T., Tewari V., Sharma P.K. (2018). The morphological and morphometric study of suprascapular notch and its variations. Era's journal of medical research. 5(1).

Vandana R., Sudha P. (2013). Morphometric study of Suprascapular Notch. National Journal of Clinical Anatomy, 2(3):140–144.