An Osteological Study Of Morphometric Variations Of Suprascapular Notch In South Gujarat Region

Hamzah M Hafezji*, Deepa S Gupta**

*Tutor, **Professor And Head, Department Of Anatomy, Surat Municipal Institute Of Medical Education And Research (SMIMER), Surat-395010, Gujarat, India

Abstract: Background: The suprascapular notch is a depression in the lateral part of superior border of scapula. The suprascapular ligament bridges the notch. The suprascapular nerve passes below the ligament and corresponding artery above the ligament. Variation in size and shape of suprascapular notch is identified as one of the causes of suprascapular nerve entrapment. Aim Of Study: To study morphological variations of suprascapular notch in dry scapulae of South Gujarat (Indian) population and compare data with studies in other ethnic populations. Materials And Methods: Total 200 dry human scapulae were obtained from Anatomy departments of three medical colleges of south Gujarat. Three dimensions were defined and measured for each suprascapular notch (SSN) using classical osteometry: maximal depth (MD), superior transverse diameter (STD) and middle transverse diameter (MTD). Based on Michał Polguj's classification SSN was classified into five types. The results of the present study were compared with previous studies in different populations. Results: The proportion of Type III SSN is highest (46.5 %) followed by Type V (26 %), Type I (16 %), Type IV (6 %) and Type II (5.5 %). For Type III SSN, proportion of subtype III c is highest (36.5 %), followed by subtype III b (6 %) and subtype III a (4 %). For Type I SSN, proportion of subtype I c is highest (8.5 %), followed by subtype I a (4 %) and Subtype I b (3.5 %).Conclusion: The suprascapular nerve entrapment syndrome, in most cases is due to morphological variations of suprascapular notch particularly complete ossification of suprascapular ligament. So the knowledge of such variations is essential for clinicians, to make a proper diagnosis of shoulder pain and to plan the most suitable surgical intervention. [Hafezji H Natl J Integr Res Med, 2021; 12(1):30-35]

Key Words: Entrapment neuropathy, Suprascapular foramen, Suprascapular ligament, Suprascapular notch, Suprascapular nerve.

Author for correspondence: Dr. Hamzah M Hafezji, B/302, Silver Palace, Opp. Dairy World, Haripura, Surat-395003.Gujarat. India E-Mail: dr.hamzah_786@yahoo.com Mobile: 09909666500.

Introduction: The suprascapular notch (SSN) is a depression in superior border of the scapula, medial to the coracoid process, which is bridged by the suprascapular ligament. The suprascapular nerve (SN) passes below the ligament[1] and innervates the supraspinatus and infraspinatus muscles and ligaments of the shoulder and acromioclavicular joints.

The suprascapular notch serves as an important landmark for the suprascapular nerve during various shoulder operations. It is also the main site for compression of the suprascapular entrapment neuropathy because of limited space due to bony and ligamentous constraints.

The morphological variations of SSN are considered to be a risk factor for suprascapular entrapment neuropathy, particularly the complete ossification of suprascapular ligament which forms a bony foramen[2]. The Suprascapular Nerve Entrapment Syndrome was first described by Kopell and Thompson[3].

It is characterized by dull pain in the posterolateral region of shoulder, atrophy of the supraspinatus and infraspinatus muscles and weakness of external rotation and abduction of arm[2,4,5].

It is most frequently found in baseball players, weight lifters, fencers, hunters and individuals occupied with overhead work requiring extreme abduction and external rotation of shoulder[4,5,6].

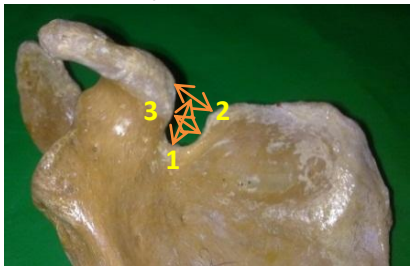
This exerts traction on the suprascapular nerve leading to its compression against the superior transverse scapular ligament.

The frequency of SN neuropathy in international level high-performance volleyball players was as high as 33%[2].Most studies conducted to describe variations of SSN were qualitative and based on visual observations. The present study classified SSN based on osteometry.

Material and Methods:A total of 200 dry human scapulae of unknown age and sex were obtained from the anatomy departments of SMIMER and GMC, Surat and GMERS,Valsad after obtaining permission from the heads of the concerned departments. Scapulae broken particularly in the study area were excluded.

The type of supra scapular notch was determined by classical osteometry using sliding digital vernier calliper (with accuracy upto 0.01 mm). Three dimensions were defined and measured for each SSN: (1)The maximal depth (MD): the maximum value of the longitudinal measurements taken in the vertical plane from an imaginary line between the superior corners of the notch to the deepest point of the suprascapular notch. (2) The superior transverse diameter (STD): the maximum value of the horizontal measurements taken in the horizontal plane between the corners of the SSN on the superior border of the scapula. (3) The middle transverse diameter (MTD): the value of the horizontal measurements taken in the horizontal plane between the opposite walls of the SSN in half dimension of MD perpendicular to it. These dimensions are shown in Figure-1.The photographs representative of various types of notches were taken using a digital camera and they were documented.

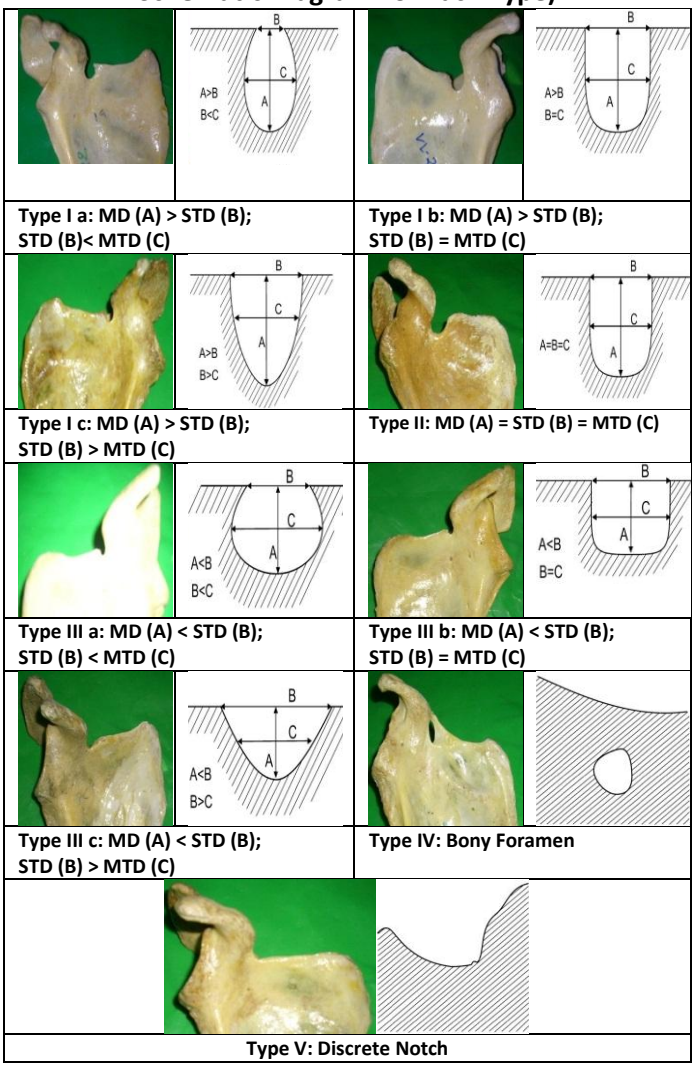
Figure-1: Dimensions of SSN (Where 1→MD, 2→ STD and 3→ MTD)



Using above parameters, the SSNs were classified into five types (based on classification of Michał Polguj et al [7]). Type I: MD >STD; Type II: MD = STD; Type III: STD > MD; Type IV: A bony suprascapular foramen and Type V: A discrete suprascapular notch. Types I and III were further classified into three subtypes: subtype a: STD < MTD; subtype b: STD = MTD and subtype c: STD > MTD [Figure-2].

Statistical Analysis: Continuous variables were expressed by mean and standard deviation. Categorical variable were expressed in percentage. To find out the mean difference between two independent groups,independent't' test was usedand to determine the relation between two independent continuous variable, Pearson`s correlation technique was used.To find out the mean difference for more than two continuous variables ANOVA test has been used. To know the relation between different groups multiple comparison test (Post hoc test - Turky's test) is applied. Level of significance is considered 95 %. All statistical analysis is done by SPSS 20and Open EPI software.

Figure-2: Types Of SSN Based On Michal Polguj's Classification (Shown By A Photograph And A Schematic Diagram For Each Type)



Type I a: MD (A) > STD (B); STD (B)< MTD (C)

Type I b: MD (A) > STD (B); STD (B) = MTD (C)

Type I c: MD (A) > STD (B); STD (B) > MTD (C)

Type II: MD (A) = STD (B) = MTD (C)

Type III a: MD (A) < STD (B); STD (B) < MTD (C)

Type III b: MD (A) < STD (B); STD (B) = MTD (C)

Type III c: MD (A) < STD (B); STD (B) > MTD (C)

Type IV: Bony Foramen

Type V: Discrete Notch

Result: The proportion of different types of SSNs on both sides is mentioned in Table-1 and shown as bar diagram in Graph-1. The proportion of Type III SSN is highest (46.5 %). For each dimension of SSN mean, range and standard deviation were calculated. Mean value is found

highest for MD and MTD in Type II SSN and for STD in Type III SSN. The variation is lowest in Type II SSN for MD, STD and MTD.The results are mentioned inTable-2.

The difference in the mean value between all three types is statistically significant (for MD: p between Types I and III (p value - 0.0001).When results are compared between two sides, mean value found to be higher on right side for all three parameters in Types I, II and III SSN.

Variation found to be lower on left side for all three parameters in Types I and III SSN while value - 0.006; for STD and MTD: p value - 0.0001).When mean value of STD is compared for two types (by applying Post Hoc test for multiple comparisons) significant difference is found between Types I and III (p value - 0.0001). Similarly for MTD significant difference is found between Types I and II (p value - 0.0001) and also lower on right side in Type II SSN [Table-3].The difference in the mean value of various parameters between right and left sides was calculated using independent't' test for all three types of SSN. No significant difference found for any parameter in any type[Table-4].

Table1: Classification Of SSN Based On Geometric Measurements.

Type Of SSN	Right Side	Left Side	Total	%Age
Type - I	13	19	32	16
I a	02	06	08	04
I b	02	05	07	3.5
I c	09	08	17	8.5
Type - II	02	09	11	5.5
Type - III	47	46	93	46.5
III a	05	03	08	04
III b	06	06	12	06
III c	36	37	73	36.5
Type - IV	09	03	12	06
Type - V	30	22	52	26
Total	101	99	200	

Graph-1: Graph Showing Distribution Of SSN On Two Sides.

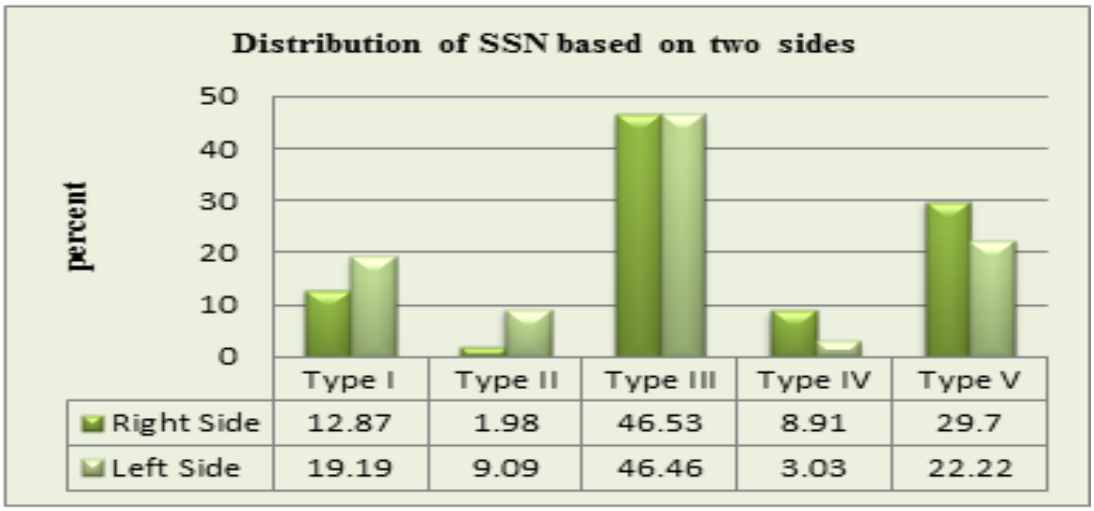


Table 2: Measurements Of Suprascapular Notch.

Parameter	Measurement	Type I SSN (mm)	Type II SSN (mm)	Type III SSN (mm)
MD	Mean	7.84	8.68	6.71
	Std. Deviation	2.45	1.65	2.38
	Range	3.1 - 11.0	6.04 – 10.9	2.4 - 11.7

STD	Mean	5.74	8.68	9.18
	Std. Deviation	2.17	1.65	3.08
	Range	2.4 – 9.3	6.04 – 10.9	3.7 – 18.8
MTD	Mean	5.61	8.70	7.56
	Std. Deviation	1.86	1.64	2.39
	Range	2.4 – 8.6	6.04 – 10.9	3.10 – 15.4

Table 3: Measurements of Suprascapular Notch: Comparison on two sides.

Type of SSN	MD of SSN (mm) [Mean ± SD]		STD of SSN (mm) [Mean ± SD]		MTD of SSN (mm) [Mean ± SD]	
	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side
Type I	8.12 ± 2.62	7.66 ± 2.39	6.26 ± 2.44	5.39 ± 1.96	5.87 ± 2.03	5.43± 1.78
Type II	9.80 ± 0.71	8.44 ± 1.73	9.80 ± 0.71	8.44 ± 1.73	9.80 ± 0.71	8.46±1.72
Type III	7.04 ± 2.42	6.38 ± 2.34	9.63 ± 3.33	8.73 ± 2.77	7.82 ± 2.53	7.32±2.26

Table4: Calculations Of Difference In The Mean Value Of Various Parameters Between Right And Left Sides.

Type of SSN	Parameters	'p' Value	Mean Difference Between Two Sides	Lower Limit	Upper Limit
Type I	MD	0.611	0.46	-1.366	2.286
	STD	0.273	0.87	-0.721	2.461
	MTD	0.521	0.44	-0.944	1.824
Type II	MD	0.319	1.36	-1.555	4.274
	STD	0.319	1.36	-1.555	4.274
	MTD	0.319	1.34	-1.558	4.238
Type III	MD	0.185	0.66	-0.321	1.641
	STD	0.160	0.90	-0.363	2.163
	MTD	0.345	0.50	-0.548	1.548

For Type IV SSN (bony foramen), length and width of bony foramen measured and mean value calculated for both sides [Table-5].

Table 5: Mean Dimensions Of Bony Foramen.

Side	Mean Length (In mm)	Mean Width (In mm)
Right	8.76	3.69
Left	8.43	3.35

Discussion: Variations in the morphology of SSN have been identified as one of the causes of suprascapular nerve entrapment. Several classifications of variation of SSN have been reported.

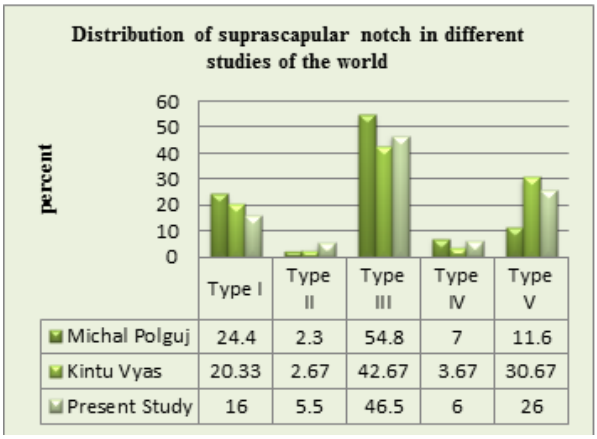
Michal Polguj and Colleagues[7]have conducted a study in Polish population. They used classical osteometry and Digital photographic documentation using MultiScanBase v.14.02 software. They measured MD, STD and MTD and classified scapula into five types and three subtypes under each of Type I and Type III. This classification is simple and based on specific geometric measurements. It provides a more detailed description of SSN and includes almost all different types of notches. So the present study follows the classification given by Michal Polguj.A comparative analysis of studies based on Michal Polguj's classification is given in Table-6 and shown as bar diagram in Graph-2.

Table 6: Distribution Of SSN In Different Studies Of The World Based On Polguj's Classification.

Type of SSN	Michal Polguj et al [7] (%)	Vyas Kintu et al [8] (%)	Present study (%)
Type I	24.4	20.33	16
I a	15.1	6	4
I b	3.5	5	3.5
I c	5.8	9.33	8.5
Type II	2.3	2.67	5.5
Type III	54.8	42.67	46.5
III a	8.2	2.33	4
III b	2.3	2.67	6
III c	44.2	37.67	36.5
Type IV	7	3.67	6
Type V	11.6	30.67	26

Thus in all studies there is preponderance of Type III SSN. When relative proportion of other types compared, present study correlates with study of Vyas et al[8].Present study reported relatively high incidence of Type II SSN (5.5 %) compared to2.3 % by Michal Polguj et al[7]and 2.67 % by VyasKintu et al[8]. Incidence of Type I SSN (16 %) is low compared to 24.4 % by Michal Polguj et al[7] and 20.33 % by VyasKintu et al[8]. Incidence of Type V (26 %) is quiet high compared to Michal Polguj et al[7] (11.6 %) and lower than VyasKintu et al[8](30.67 %).

Graph-2: Graph Showing Distribution Of SSN In Different Studies.(Based On Polguj's Classification)



	Type I	Type II	Type III	Type IV	Type V
Michal Polguj	24.4	2.3	54.8	7	11.6
Kintu Vyas	20.33	2.67	42.67	3.67	30.67
Present Study	16	5.5	46.5	6	26

Hrdicka A et al[9,10](Native Americans) described five types of SSN based on visual observations: Type I absent notch; Type II shallow notch; Type III medium notch; Type IV deep notch and Type V complete foramen. Olivier G et al[11](French population) classified SSN based on visual observations. Type I very small notch; Type II shallow notch; Type III deep notch with corners of the SSN on the superior border of the scapula were distant; Type IV deep notch with corners of the SSN on the superior border of the scapula were close and Type V bony foramen.

Rengachary et al[12,13] classified the SSN into six types. Type I was without a discrete notch, identical to our type V; Type II V-shaped notch; Type III U-shaped notch; Type IV had a very small and V-shaped notch; Type V had a U-shaped notch and partial ossification and Type VI had a bony foramen with a completely ossified the STSL, identical to our type IV notch.

Ticker et al[14] classified the SSNs into U-shaped and V-shaped. He separately classified ossification of the suprascapular ligament into three groups: no ossification, partial ossification and complete ossification (bony foramen). Bayramoglu et al[15] modified the classification of Rengachary et al.

Natsis et al[16] distinguished five different types of SSN: Type I without a discrete notch (8.3%); Type II a notch that was found to be the longest in its transverse diameter (41.85%); Type III a notch that was the longest in its vertical diameter (41.85%); Type IV a bony foramen (7.3%) and Type V a notch and a bony foramen (0.7%). Duparc et al[17] (2010) mentioned that U-shaped SSN (63.3%) and V-shaped SSN (36.7%). Wang H et al[18] (2011) also classified SSN into five types according to Natsis and found that the most prevalent group was type II (58.11%) followed by type III (28.23%).In India, GargSoni et al[19](2012) conducted the study on 100 scapulae and classified the SSN into five types as per classification of Natsis and found that the most prevalent group were type II (72%) followed by type III (20%), type I (5%) and type IV (3%). Type V was not found by Hua-junwang et al[18] and GargSoni et al[19]. Dunkelgrun et al[20] compared Rengachary's and Ticker's classifications, and suggested that Ticker's classification was more reliable and easy to use.All abovementioned studies classify SSNs qualitatively and not based on specific geometrical parameters.

Conclusion: The suprascapular nerve entrapment syndrome, in most cases is because of morphological variations of suprascapular notch particularly complete ossification of suprascapular ligament. Therefore the knowledgeof such variations is essential for clinicians, to understand location and source of entrapment and also to plan the most suitable surgical intervention. The quantitative assessment of SSN done in present study provides a precise and well-sorted data about SSN variations and also supplements the existing reports of its kind. This in turn helps clinicians in thorough understanding of the pathophysiology of suprascapular neuropathies.Since the present study was performed with a limited number of scapulae, more radiological, clinical and cadaveric studies need to be done for helping the clinician in the diagnosis and treatment of suprascapular neuropathies.

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