Original Research Article

The suprascapular notch dimensions & its correlation with scapular morphometry of human dry scapula in clinical relevance for nerve entrapment syndrome

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Abstract

Introduction: Morphological variations of the suprascapular notch are very important clinically for possible predisposing factors for compression of the suprascapular nerve in this region**.** Hence its correlation with basic anthropometric measurements of human scapula is important clinically. **Materials and methods:** 100 dry intact scapulae (48 right & 52 left) were examined for the study were taken from department of anatomy, Sapthagiri institute of medical science & research centre, Bangalore. Various parameters of suprascapular notch & of scapula were taken. **Results:** In the present study, suprascapular notch mean depth was lesser than mean superior transverse diameter of suprascapular notch, most frequent notch was type 3 & least was type 5. All the Parameters of scapula were in inverse correlation with that of scapular notch measurements except for corocoid thickness & glenoid index. There was a statistical significant correlation between depth of suprascapular notch with scapular width & between superior transverse diameter of notch with scapular width, acromion width & also with glenoid & scapular index. **Conclusion:** The present study aimed to establish a correlation between the shape of the Suprascapular notch and other parameters of scapulae. Knowing this anatomical variations in detail along the course of the suprascapular nerve is important for a better understanding of the location and the source of the entrapment syndrome & for making a proper diagnosis and planning the suitable surgical intervention during arthroscopic shoulder operations.

Keywords: Suprascapular notch, Suprascapular nerve, Superior transverse scapular ligament, Suprascapular foramen.

Introduction

The suprascapular notch is situated in the lateral part of the superior border of the scapula just adjacent to the base of the coracoid process. This notch is converted into a foramen by the superior transverse scapular ligament and serves as a passage for the suprascapular nerve[1]. Rengachary et al[2,3]studies classified the suprascapular notch into six types, based on its shape. Type I is 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 is a wide, blunt, v-shaped notch, type III is a symmetrical u-shaped notch with parallel margins, type IV is a small v-shaped notch, type V is similar to type III with the medial part of the ligament ossified and type VI is with the ligament completely ossified and forming a foramen. Natsis et al[4]studies proposed a classification which was based on a study which was done on 423 scapulae as Type I is without a discrete notch, type II is a notch with the longest transverse diameter, type III is a notch with the longest vertical diameter, type IV is a bony foramen and type V is a notch and a foramen.

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Ticker et al[5] studies classified suprascapular notch on basis of morphological appearance as U and V. Iqbal et al[6]studies reported three types of suprascapular notches, based on their shapes, 'U', 'V', 'J' on gross examination, following the observations cited by Hrdick A et al[7], Bayramoglu A et al[8], Nastis et al , distinguished V notch on the basis of vertical and transverse diameter measurements and Polguj M et al[9] studies used geometrical parameters for assessment of V shape suprascapular notch. Morphological variations of the suprascapular notch are very important clinically for possible predisposing factors, for compression of the suprascapular nerve in this region. In the whole population, approximately 1–2 % all shoulder pain is caused by the suprascapular nerve entrapment syndrome[9]. Suprascapular nerve entrapment was first described by studies of Kopell and Thompson et al[10]. The result of suprascapular nerve entrapment is weakness of the arm difficulty in external rotation and abduction and then atrophy of the infraspinatus and supraspinatus muscles. Incidence of suprascapular neuropathy is 7 –10%. Most of the reported incidence is in overhead athlets like volleyball players accounting 12–33% of athletic population[11]. The suprascapular notch is an important landmark of the suprascapular nerve during arthroscopic shoulder operations[12,13]. Knowing the anatomical variations in detail, along the course of the suprascapular nerve, is important for a better understanding of the location and the source of the entrapment syndrome. We aimed to verify the reliability of the existing data concerning the anatomy of the notch, by analyzing a considerable number of dried scapulae and comparing our results with literature. We assessed potential correlations between the dimensions of the notch and the major dimensions of the scapula. We also

evaluated variations of the dimensions and of the area among the different types of the suprascapular notch.

Materials and Methods

100 dry, unpaired adult human cadaveric scapulae taken from Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore were evaluated. The age and gender of the bones was not known. Adult intact scapulae with clear features were included into study while broken or defective scapulae were excluded. Out of total 100 dry human scapula, 48 were of right side and 72 of the left side, A sliding digital Vernier caliper and measuring scale were used for taking linear measurements.

Statistical analysis

The statistical significant difference between the morphometry of notch & its types with other parameters of scapula was assessed. A p level of < 0.05 was accepted as statistically significant. Each measurement was expressed in terms of Mean, Standard deviation, Minimum and Maximum, calculated by Microsoft office Excel worksheet. The data was analyzed using SPSS version 17.0.corelation

The following measurements of the scapula were taken: Type of suprascapular notch, Supra-scapular notch Superior transverse diameter (STD) measured by the maximum value of the horizontal measurements taken in the horizontal plane between the corners of the suprascapular notch on the superior border of the scapulae, Supra-scapular notch mean depth (MD)measured by 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 ,Scapular length measured by distance from the superior angle to the inferior angle of scapula, Scapular width: measured by the maximum transverse diameter between the medial border of the scapula, where the spine meets the body of the scapula, and the anterior lip of the glenoid, Glenoid length measured by maximum distance measured from the inferior point on the glenoid margin to the most prominent point of the supraglenoid tubercle. Glenoid breadth measured by maximum breadth of the articular margin of the glenoid cavity perpendicular to the glenoid cavity height, Acromion length measured by the maximum distance between tip and midpoint of posterior border of acromion process, Acromion breadth measured by the maximum distance between the lateral and medial borders at the midpoint of the acromion process. Length of the coracoid process measured form the base to the tip of the coracoid process, Coracoid thickness measured by maximum thickness of corocoid process, Projection length of scapular spine measured from the medial edge of the scapula to the lateral edge of the acromion process, Width-length index of scapula measured by width of scapula / length of scapula × 100%., Glenoid cavity index measured by width of glenoid cavity / length of glenoid cavity × 100%, Suprascapular notch area measured by ratio of superior transverse diameter divided by maximum depth of notch.

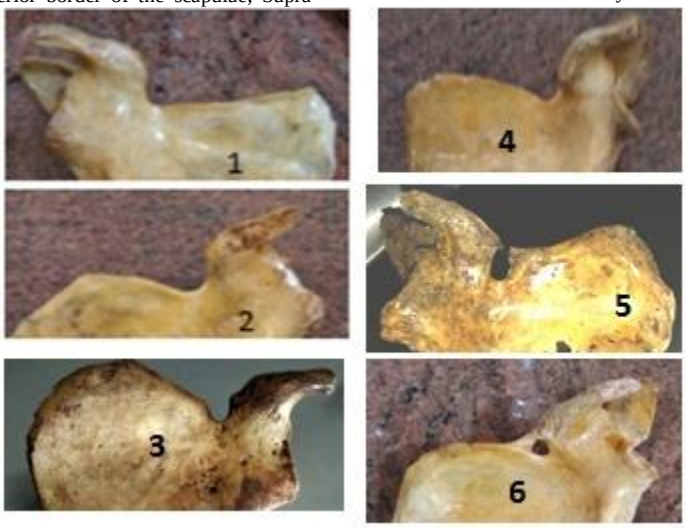

Fig. 1: showing types of suprascapular notch based on Rengachary et al classification[2,3]

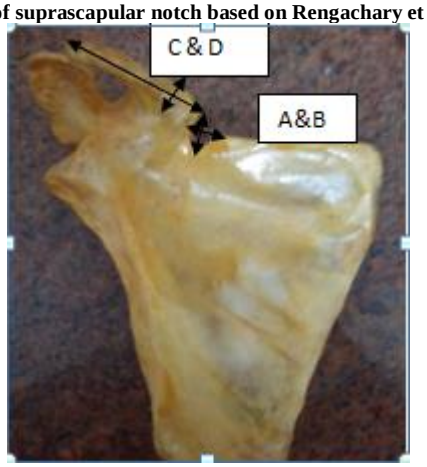

Fig. 2: showing, A & B: superior transverse diameter & depth of suprascapular notch, C &D: length & thickness of corocoid process

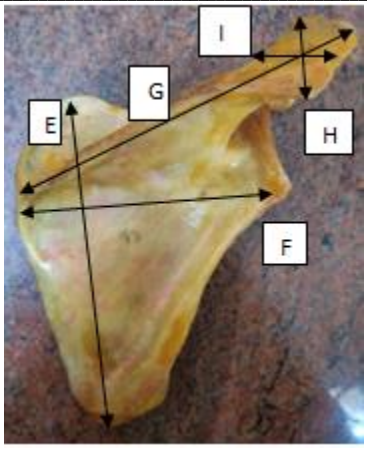

Fig. 3:showing parameters of scapula, E:length of scapula, F: bredth of scapula, G: projection length of spine, H: length of acromion, I:width of acromion

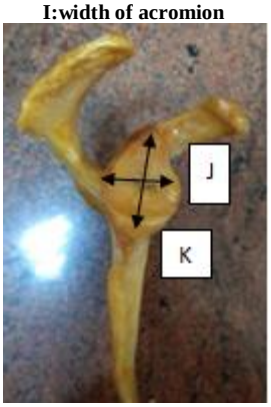

Fig. 4 : showing J: suoerior-inferior diameter of glenoid cavity, K: anetrior –posterior diameter of glenoid cavity

Result

In the present study, suprascapular notch mean depth was 0.85±0.57cm & superior transverse diameter was 1.75±1.25cm, suprascapular notch type 3 were more common, second most common being type1, least is type 5. Suprascapular depth & transverse diameter was more in type 5, next highest in type 2 & least in type 4, the Mean depth was lesser than mean superior transverse diameter of suprascapular notch. Type 1, followed by type 4 & 3, has maximum surface area of notch, whear as type 5, 2 have the least surface area, where depth of notch had inverse correlation with ratio of scapular notch. In 5 scapula superior transverse diameter was equal to maximum depth. In 81 scapula all the parameters of scapula were more when superior transverse diameter was more than mean depth of notch & in 4 scapula superior transverse diameter was less than mean depth of notch, except for corocoid thickness & glenoid index. All the Parameters of scapula have inverse correlation with that of scapular notch measurements. There is a statistical significant correlation between depth of suprascapular notch with scapular width, & statistical significant correlation between superior transverse diameter of suprascapular notch & scapular width, superior transverse diameter of suprascapular notch & acromion width , superior transverse diameter of suprascapular notch & glenoid index scapular index.

Analyzing the relationship between dimensions and types of the suprascapular notch (in the graph 1), we found a statistically significant difference ($p< 0.0001$) in depth between Type II and Type III,IV, between Type II and Type III , Type III and Type IV, between Type I and Type II . We also found (in graph 2) a significant difference ($p< 0.0001$) in superior transverse diameter of notch (width) between Type II and Type III, IV between Type III and Type IV, Between Type I and Type II, III, IV. The analysis of the width (STD)/depth ratio (in graph 3) showed a statistically significant difference between all notch types except between Type III and Type V and between Type V and Type VI. The highest ratio was associated to Type I (2.79 cm; IC 95%: 2.29-3.29 cm). This is followed respectively in descending order, by Types III, IV, II and V. The lowest ratio belonged to Type VI (0.00 cm)

Table 1: showing Comparison of suprascapular notch (SSN) with other parameters of scapular when of maximum depth (MD) & maximum superior transverse diameter (STD) were more & both were equal

	Measurements of scapula	MD>STD	MD<STD	MD=STD
1	Scapular length	13.4±1.42	13.5±0.96	14.56±0.32
2	Scapular width	8.17±1.18	8.66±0.79	8.8±1.09
3	Glenoid length	3.51±0.57	3.57±0.31	3.74±0.21
4	Glenoid width	2±0.35	2.21±0.20	2.3±0.1
5	Acromial length	3.55±0.56	3.85±0.63	4.52±0.38
6	Acromial width	1.9±0.23	2.23±0.38	2.52±0.10
7	Projection length of scapula	11.6±1.71	12.2±0.76	12.12±0.16
8	Coracoids thickness	1.6±0.34	1.15±0.20	1.16±0.05
9	Corocoid length	3.62±0.53	3.68±0.37	3.84±0.05

10	Width length index	60.85±2.69	63.4±8.69	60.6±8.96
11	Glenoid index	63.5±2.19	62.11±5.16	61.6±3.69
12	STD/MD ratio	0.67+0.20	2.46+1.29	1+0
13	SSN depth	1.2±0.70	0.84±0.54	0.66±0.05
14	SSN STD	0.72±0.25	1.85±1.2	0.66±0.05

Table 2: showing relation of types of suprascapular notch(SSN) with its mean depth (MD) & with superior transverse diameter(STD) measurements., superior transverse diameter & depth of SSN ratio & most frequent (percentage) of type of notch

Notch type	SSN MD	SSN STD	SST/MD ratio	Percentage of scapula
	Mean±SD	Mean±SD	Mean±SD	
Type 1	1.0 ±0.3	2.65±1.23	2.78±1.31	22%
Type 2	1.0±0.59	1.87±1.26	1.90±0.93	16%
Type 3	0.74±0.58	1.31±1.02	2.23±1.60	34%
Type 4	0.55±0.36	1.06±0.45	2.48±1.08	16%
Type 5	1.45±0.63	2.7±1.27	1.83±0.07	4%
Type 6	0	0	0	8%

Table 3 : showing descriptive Notch Type

Notch Type		Mean	Median	Std. Deviation	Minimum	Maximum
Type I						
	MD	1.0182	1.1000	.37751	.40	1.50
	STD	2.6545	2.6000	1.23316	1.10	5.50
Type II		1.0000	.7000	.59330	.50	2.30
	MD	1.8750	1.5500	1.26148	.60	4.10
	STD					
Type III						
	MD	0.7471	.4000	.58891	.20	2.20
	STD		.9000	1.02232	.50	3.80
		1.3176				
Type IV		0.5500	.4000	.36515	.20	1.20
		1.0625	.9000	.45000	.60	2.10
	MD					
	STD					
Type V						
	MD	1.4500	1.4500	.63509	.90	2.00
	STD	2.7000	2.7000	1.27017	1.60	3.80
Type VI		.0000	.0000	.00000	.00	.00
		.0000	.0000	.00000	.00	.00
	MD					
	STD					

Table 4: showing descriptive analysis of type of suprascapular notch(SSN) & its other parameters. MD: mean depth. STD- superior transverse diameter of suprascapular notch

	Scapila Length	**Scapula Width**	**Glenoid Length**	**Glenoid Width**	**Acromion Length**	**Acromion width**	**Glenoid Index**
MD of SSN	0.061	0.227*	0.047	-0.042	-0.007	0.174	-0.078
Pearson's Correlation Sig.(2-tailed)	0.548	0.023	0.642	0.676	0.943	0.084	0.439
STD of SSN	-0.035	0.267*	0.214*	-0.038	-0.005	0.237*	-0.250*
Pearson's Correlation Sig.(2-tailed)	0.729	0.007	0.033	0.705	0.958	0.017	0.012

Discussion

In the present study, scapula with superior transverse diameter was more than mean depth (STD>MD) were greater in percentage when compared to other authors & lesser in percentage when MD>STD. when transverse diameter & depth were equal (STD=MD) our study was less in percentage when compared to Polguji M et al[9] studies, but more when compared to Muralidhar reddy S et al[16] studies when these parameters were equal.

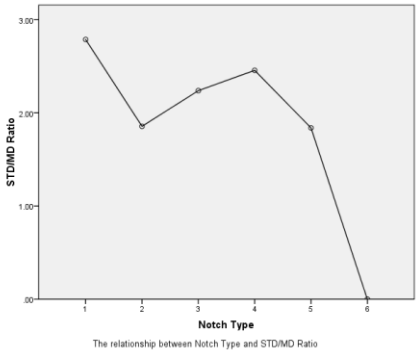

Fig. 5: showing relationship between notch types & ration of suprascapular superior transverse diameter (width) & mean depth of suprascapular notch

Table 5: Comparison of percentage of suprascapular notch when SST>MD, MD>STD, STD=MD with other authors in different populations. (MD: mean depth, STD: superior transverse diameter)

Authors(region)	STD>MD	MD>STD	STD=MD
Rengachary et al (America) [2,3]	31%	48%	-
Natsis et al (greek) [4]	41.85%	41.85%	-
Ticker et al (America) [5]	33%	31%	-
Urguden M et al (Turkish) [14]	24%	40%	-
Polguj M et al (Poland) [9]	57.7%	24.4%	2.3%
Muralidhar reddy S et al (India)[15]	56.73%	14.42%	5.76%
Muralidhar reddy S et al (India) [16]	24.4%	57.7%	2.3%
Present study Iindia)	81%	4%	5%

Table 6: showing comparison of suprascapular notch mean & SD of depth & mean, of superior transverse diameter with other authors

Study	**Suprascapular notch maximum depth (Mean±SD)**	**Suprascapular notch superior transverse diameter (Mean±SD)**
Peter EricsonL et al[17]	0.547±0.20	0.907±0.27
Swapna R Chavan et al[18]	0.595±0.31	--
Wang HJ et al[19]	1.29±0.41	0.71±0.27
Albino paolo et al[20]	0.96±0.36	0.57±0.23
Present study	0.78±0.57	1.61±1.25

Maximum depth of notch was greater than Peterson Ericson Let al & Swapna R Chavan et al studies and lesser than Wang HJ et al & Albino Paolo et al studies, the superior transverse diameter of present study was greater than other studies.

Table 7: Showing the comparison of types of suprascapular notch (SSN) & its depth & superior transverse diameter with other authors

Notch type Rangachari et al classification[2,3]	Muralidhar Reddy S et al[15]		Present study	
	SSN depth	SSN superior transverse diameter	SSN depth	SSN superior transverse diameter
Type 1	-	-	1.0 ±0.3	2.65±1.23
Type 2	6.5 ± 1.57	8.58±1.82	1.0±0.59	1.87±1.26
Type 3	7.11±2.41	10.63±3.06	0.74±0.58	1.31±1.02
Type 4	2.06±0.33	2.64±0.68	0.55±0.36	1.06±0.45
Type 5	9.09±2.69	5.65±0.9	1.45±0.63	2.7±1.27
Type 6	-	-	0	0

In the present study superior transverse diameter was more than mean depth of suprascapular notch in all types which was similar with Muralidhar Reddy S et al studies in type 2,3,4 but less with type 5, & all the measurements were less compared to Muralidhar Reddy S et al studies.

Table 8: showing comparison of percentage of types of suprascapular notch with other authors based on Rengachari et al classification

Types of suprascapular notch(Rengachary et al[2,3] classification	Albino Paolo[20]	Rengachary et al[2,3]	SinketSR et al[21]	Usha Kannan et al 22	Natsis et al[4]	Muralidhar Reddy S et al[15]	Present study
1	12.4%	6%	22%	20%	8%	21.15%	22%

2	19.8%	24	21%	10%	31%	8.65%	16%
3	22.8%	40%	29%	52%	48%	59.61%	34%
4	31.1%	13%	5%	4%	3%	2.88%	16%
5	10.2%	11%	18%	4%	6%	5.76%	4%
6	3.6%	6%	4%	10%	4%	1.92%	8%
Total no	500	211	135	400	423	104	100

In present study, based on Rengachar etal classification[2,3]suprascapular notch type 3 is more frequent similar to Rengachary et al, Sinkeet SR et al[21], Usha kannan et al[22], Natsis etal[4], Muralidhar Reddy S et al[15] ,except Albino Paolo et al[20] studies where type 4 was common. Type 5 was least common in the present study coincide with Usha Kannan et al[22] studies, but in other studies type 6 was the least common.

Table 9: showing comparison of frequency of types of suprascapular notch with other authors based on Natsis et al[4] studies classification

Type of notch(Natsis Classification)	Natsis (greek)[4]	Wang HJ (Chinese) [19]	Muralidhar Reddy S (India) [15]	Present study(India)
1	8.3	28	21.25	20
2	41.85	58.16	56.73	32
3	41.85	28.23	14.42	36
4	7.3	3	1.92	8
5	0.7	-	-	4

Based on Natsis et al[4] studies classification type 3 was more common in present study whereas type 2 in common in other studies.

Table 10: Comparative distribution U and V type of suprascapular notches with other authors

Study	U- type	V-type
Ticker et al[5]	77 %	23%
Bayramoglu A et al [8]	62.5%	25%
Duparc F et al[23]	63.3%	36.7%
Muralidhar reddy S et al[15]	69.23%	26.92%
Present study	50%	36%

Based on U or V type of notch, U type was more frequent than V type which was similar to other studies, U type was lesser & V type was more in values when compared to other authors

Dunkelgrun M et al[24], studies stated that the U-shaped notch had a large area than the V-shaped notch, leading to an assumption that the V-shaped notch was more likely to be connected with the nerve entrapment.

Table 11: Comparative distribution of suprascapular foramen in different regions & authors

Population	Author	SSN foramen
French	Olivier G et al [25]	5 – 6.5%
Italian	Vallois HV et al [26]	6.1%
Greek	Natsis et al [4]	7.3%
Turkish	Urguden M et al [14] Bayramoglu A et al[8]	6 – 12.5%
America	Edelson JG et al [27] Tubbs RS et al [28] Rengachary et al [2,3]	3.7% 3.7% 4%
Alaskan Eskimos	Hrdicka A et al [29]	0.3%
Native America	Hrdicka A et al [29]	2.1 – 2.9%
India	Muralidhar reddy S et al [15]	1.93%
India	Present study	8%

In the present study suprascapular foramen type 6 was more in percentage when compared to other studies, less in percentage when compared with Urguden M et al[14] & Bayramoglu et al[8] studies. Although the differences might be influenced by the different samples analyzed and methods of evaluation and classification, we agree with the assumption that the occurrence of a complete ossification of the STSL could have basically a genetic influence . In the present study there is a statestical significant correlation between depth of suprascapular notch with scapular width & statestical significant correlation between superior transverse diameter of suprascapular notch & scapular width, superior transverse diameter of suprascapular notch & acromion width , superior transverse diameter of suprascapular notch & glenoid index ,scapular index. Talking into consideration the correlation between the SSN and basic anthropometric measurements of the scapulae, in the Muralidhar Reddy S et al[16] studies, a low positive correlation is observed between mean depth of the notch and length of the scapula and between superior transverse diameter(STD) of the notch and Mean Width (MW) of the scapula. A similar study was carried out by Polguji M et al[9] who reported that there is a positive correlation (R = 0.265179) between projection length of scapular spine, maximal width of scapular spine, maximal length of acromion, maximal width of the coracoid process, and length and width of the glenoid cavity, morphological length of the scapula and mean depth (MD) of the notch, but they described there was no correlation between morphological width of the scapula and the STD of the notch., the MD of the SSN negatively correlated with the scapular morphological length, morphological width, width/length (WLI) glenoid cavity index (GCI). It could be assumed that in long scapula, maximum depth of the notch may be more and in when the width of the scapula is more, the width of the notch may be more. In the present study it was observed that there was inverse correlation between suprascapular notch & with other parameter of scapula like when depth of suprascapular notch was more, other parameters of scapula were less & when depth of notch less, other parameters of scapula were high except for corocoid thickness & glenoid index had positive correlation with the notch. There is a statestical significant correlation between depth of suprascapular notch with scapular width & statestical significant correlation between superior transverse diameter of suprascapular notch & scapular width, superior transverse diameter of suprascapular notch & acromion width , superior transverse diameter of suprascapular notch & glenoid index, scapular index. When compared to Polguji M et al[9] studies, our study coincides with parameters of length ,width of scapula, width length index, glenoid cavity index when mean depth of scapula was less compared to superior transverse diameter of suprascapular notch . In our

opinion, the different statistical method used to determine the correlation as well as the size of the sample considered may have led to a discrepancy in the results of the two works. In the present study, when superior transverse diameter & depth of notch was compared, type 1 had maximum area followed by type 1,4, least by type 5. When SSN depth is more STD/MD ratio is less & depth of SSN is more STD/MD is less have inverse correlation. In analyzing the trends reported by albino polo et al[20] study, found that Type III, V and VI , Dunkelgrun M et al[24] stated that type III , Rengachary et al[2,3]. studies, Type IV have the lowest width/ depth ratio (indicative of the area occupied by the suprascapular notch). These type of notch are more likely to suffer from the suprascapular nerve entrapment syndrome; our study agrees with Polgji M et al[9] studies where type 5 suffers from nerve entrapment syndrome. In the present study when compared to other authors, scapula with superior transverse diameter was more than mean depth (STD>MD) were greater in percentage when compared to other authors & lesser in percentage when MD>STD. Maximum depth of notch was greater than the superior transverse diameter. The superior transverse diameter was more than mean depth of suprascapular notch in all types of notches. Based on Rangachary et al[2,3] studies classification, suprascapular notch type 3 is more frequent similar to others. Based on Natsis et al[4] studies classification type 3 was more common present study whereas type 2 in common in other studies. Based on U or V type of notch, U type was more frequent than V type which was similar to other studies. The suprascapular foramen type 6 was more in percentage when compared to other studies. There was inverse correlation between suprascapular notch & with other parameter of scapula. suprascapular notch type 5 with less area more likely suffers from suprascapular nerve entrapment syndrome. We believe that the different aims and methods of the studies may explain the difference in the results. Comparison of studies with other authors from different regions, revealed variations in the osteometric values of the scapula, the basis of which could be attributed to racial and ethnic differences. This information is very important because it is possible to measure the morphological length and width of the scapula in living people and to anticipate the depth of the SSN without using X-ray.

Conclusion

The precise measurements of various parameters suprascapular notch and other parameters of the scapula in the south region, India have been summarized and presented in this paper. The present study aimed to establish a correlation between the shape of the SSN and basic anthropometric measurements of the scapulae. Also it allowed a very precise description of anthropometric measurements in the scapulae in two groups with different SSN diameters (first with higher MD and second with higher STD) and also 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. The determination of the notch type, particularly in rotator cuff tears, is helpful in avoiding iatrogenic nerve lesions. Since the suprascapular nerve entrapment syndrome might be caused by complete ossification of superior transverse scapular ligament with formation of suprascapular foraman and other morphometric variations of suprascapular notch, the knowledge on such variations is essential for clinicians, for making a proper diagnosis and for planning the most suitable surgical interventions and help in designing implants for the shoulder joint in south India region.

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