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Original Articles

Morphometric Study of Scapula and Related Surgical Importance of Suprascapular Notch among West Coastal Population of South India

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Morphometric measurements of suprascapular notch give us a better understanding of predisposing factors of the compression of suprascapular nerve. The objectives were to correlate the variations in morphometric features of the scapula and suprascapularnotch. Across sectional study design was carried out with 150 dry adult human scapulae of unknown sex (70 right and 80 left). Morphometry of the scapula, maximum depth (MD) and superior transverse diameter (STD) of suprascapular notch were measured. Scapular index and infraspinous index were calculated. The indices show that the right scapula is shorter and broader than that of left scapula. There was no statistically significant difference between the anthropometric measurements of the suprascapular notch between right and left side ($p>0.05$).The present study has provided a database on the morphometric variables of the scapula and suprascapular notch in the South Indian population.

Keywords: Suprascapular notch; Suprascapular nerve; Scapula morphometry; Scapular Index, Infraspinous index

Introduction

The scapula is a triangular flat bone which has three borders, two processes and two surfaces that lies overlying the 2nd to 7th ribs on the posterolateral aspect of the thorax. The scapula has a spine which subdivides the posterior surface into a supraspinous fossa and infraspinous fossa. The concave anterior surface has a subscapular fossa [7]. The suprascapular notch is seen as a depression on the superior border of the scapula which is converted into a foramen by the superior transverse scapular ligament. The suprascapular nerve and vein crosses below the ligament while the suprascapular artery crosses above the ligament to reach the anterior surface [1, 5]. The morphology and morphometry of the scapula has clinical and anthropological importance and will help the surgeons in the field of prosthesis and shoulder girdle arthroplasty. The study of dimensions of the suprascapular notch can provide with a guide way for landmark for suprascapular nerve block and to correlate suprascapular nerve entrapment syndrome [10,11]. Variations in the morphology of suprascapular notch have been identified as one of the causes of suprascapular nerve neuropathy by suprascapular nerve entrapment [2,6,11,14,16]. Morphometric measurements of suprascapular notch give us a better understanding of predisposing factors which cause compression of the suprascapular nerve. Many researchers had attempted to classify suprascapular notch and the most popular classification is by Rengachary et al. [14].

The anthropometric data obtained from different geographical locations may vary due to racial, genetic and geographical factors across populations. Upon the back drop of paucity of data in west coastal population of South India, this study was proposed with an aim to generate reference data for both clinical and research purposes in this region. The study objectives were to correlate the variations in morphometric features of the scapula and suprascapular notch. We also focused to calculate scapular index and infraspinous index of human dry scapulae of South Indian population.

Material and Methods

Across sectional study was carried out with one hundred and fifty (150) dry adult human scapulae of unknown sex (70 right and 80 left). All ethical principles for human research were followed and ethical approval was obtained from the Institutional Ethics Committee of the medical college from where data were collected. The inclusion criteria were the human scapulae which are completely ossified and with no deformity. Scapulae with any deformities and pathologies with broken notches were excluded.

The measurements were taken with a digital Vernier caliper (Vernier Caliper with Fine Adjustment, Yuzuki Company, India), with precision of 0-600 mm/24 inch. The following variables were studied and documented. Maximum length and breadth of scapula, length and width of scapular spine, length of supraspinous line and infraspinous line, Maximum distance, length and breadth between/ of acromion and coracoid process, glenoid fossa and axial border were measured. The dry weight of the scapula was noted down with a paediatric weighing scale **(Fig. 1).**

For suprascapular notch dimensions and morphometric analysis the maximum depth of suprascapular notch (MD) and superior transverse diameter (STD) of suprascapular notch were measured. The indices namely scapular index, infraspinous index were calculated.

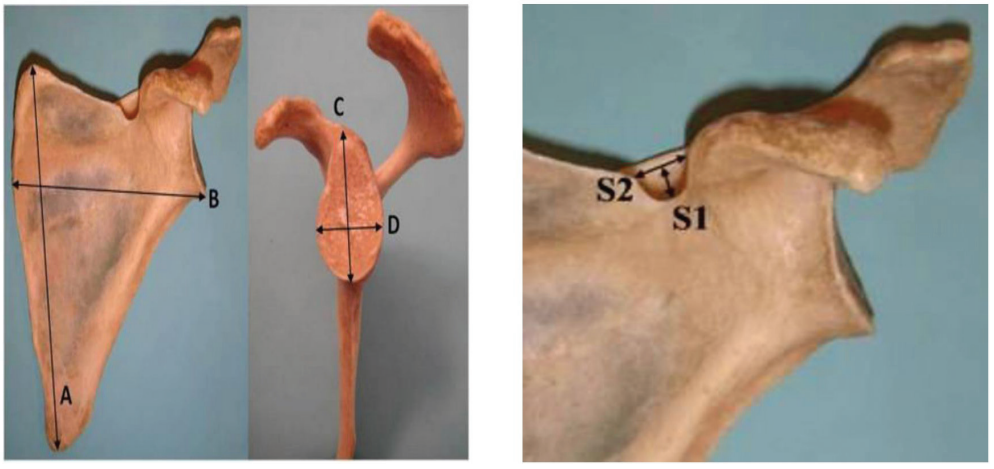

Fig. 1

The STD was measured as the maximum distance between most superior edges of suprascapular notch (SSN).The maximum depth was measured as 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 index was calculated toexpress scapular breadth as percentage of scapular height. Lengthier scapulas had increased scapular index and vice versa. Infraspinous Index was calculated by scapular breadth X100/ Infraspinous height. Infraspinous index expresses scapular breadth as percentage of infraspinous height, broader scapulas had increased infraspinous and vice versa indicates a narrower scapula. Details were photographed, recorded and analyzed statistically. The measurements above were taken for three repetitions and the average was recorded to avoid any possible measuring error. Rengachary *et al* (1979) [14] method of classification of suprascapular notch was used in the present study. It is 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–asymmetrical U-shaped notch; Type IV–a small, V-shaped notch; Type V –the medial part of the ligament being ossified; and Type VI – Ligament completely ossified and forming a foramen.

Statistical analysis was done by using the Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago Illinois, USA). The mean and standard deviation were noted down. Comparison of means for the right and left sides of scapula was done with Z test. Frequencies of the various shapes were obtained while chi-square was used to compare for both sides. Difference was noted down as statistically significant if the $p< 0.05$.

Results

Scapular index were calculated for scapulas of both right and left side. The mean of right scapular index was higher than left scapular index (**Table 1, Fig. 2**). Infraspinous index was found higher in right sides scapulas. The mean of right infraspinous index was 96.98mmand left was 96.38mm (**Fig. 3**).The scapular index and infraspinous index shows that the right scapula is shorter and broader than that of left scapula.

Table 1. Difference between Scapular Index and Infra Spinous Index (Right and Left)

Details of measurements	Right scapular Index(mm)	Left scapular Index(mm)	Right Infra Spinous Index(mm)	Left Infra Spinous Index(mm)
Samples	70	80	70	80
Mean	74.82	72.41	96.98	96.38
Std. deviation	6.052	5.893	9.54	10.05

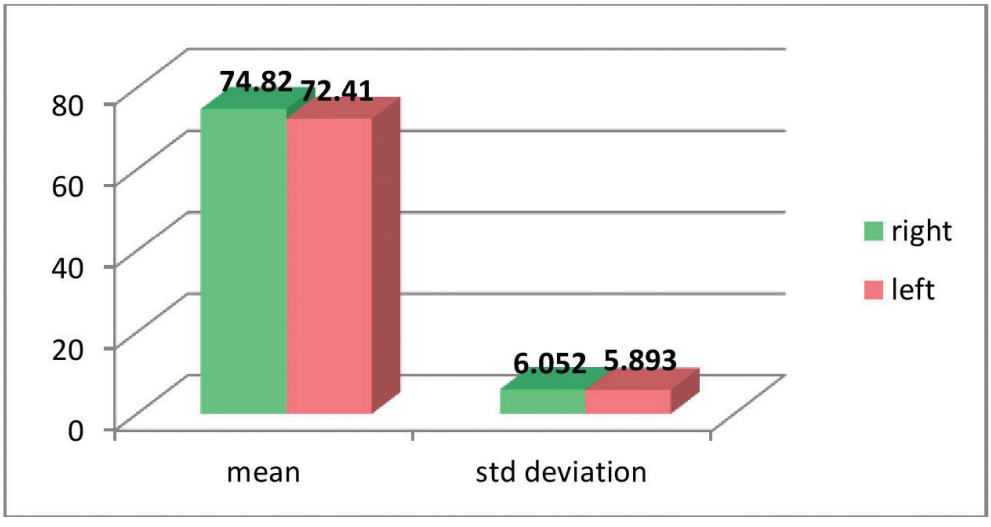

Fig. 2

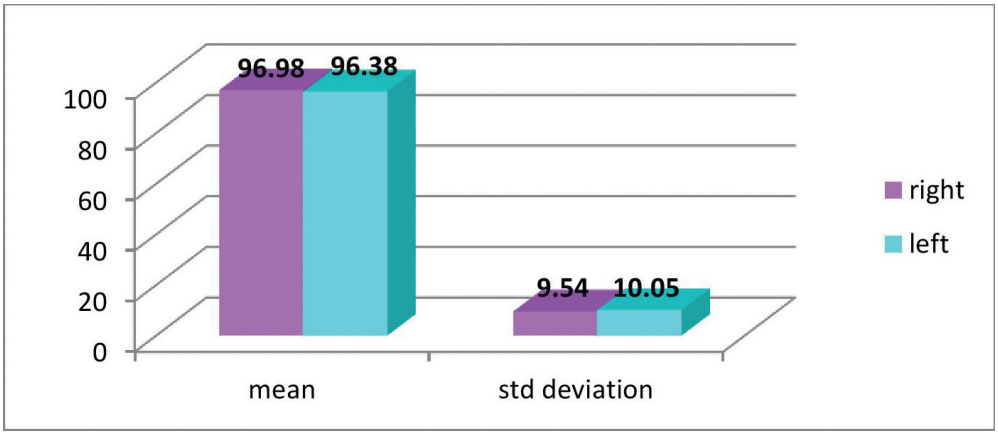

Fig. 3

In the scapulae with longer superior transverse diameter (STD), the morphological length and width of scapula, maximum length of the coracoid process, width of the glenoid cavity were higher than in the bones with longer maximal depth (MD) i.e; (STD>MD). In scapulae with (MD>STD)length of scapular spine, maximal width of scapular spine, length of acromion, length of the glenoid cavity were higher than in the scapulae with longer STD (**Table 2**).

Table 2. Measurements and indices of the scapulae and suprascapular notch

Measurements and indices of scapula(mm) Mean(mm)	**Scapulae with longer maximal depth(MD>STD):R-L**		**Scapulae with longer superior transverse diameter(STD>MD):R-L**			
	Standard deviation	**Min-Max(mm)**	**Mean (mm)**	**Standard deviation**	**Min-Max(mm)**	
1.MORPHOLOGICAL LENGTH	138.83	11.96	109-165	142.67	12.43	103-170
2.MORPHOLOGICAL WIDTH	100.11	7.75	80-114	103.33	6.51	81-116
3.PROJECTION LENGTH OF SCAPULAR SPINE	131.71	9.923	103-151	131.11	9.78	112-152
4.MAXIMAL WIDTH OF SCAPULAR SPINE	44.05	4.00	36-53	42.68	4.1	33-53
5.LENGTH OF ACROMION	49.79	6.86	33-60	48.96	7.19	32-84
6.MAXIMAL LENGTH OF THE CORACOID PROCESS	43.27	5.05	31-53	44.55	4.75	32-57
7.LENGTH OF THE GLENOID CAVITY	35.44	4.00	28-47	35.31	4.30	20-45
8.WIDTH OF GLENOID CAVITY	24.53	2.89	19-31	25.14	3.44	18-40
9.WIDTH-LENGTH INDEX(%)	62.4	4.5	59.4-71.5	63.8	4.6	59.3-72.6
10.GLENOID CAVITY INDEX(%)	73.4	6.2	58.3-84.1	74.1	6.8	59.6-85.3

There was no statistically significant difference between the anthropometric measurements of the group with higher MD and the group with higher STD of the suprascapular notch ($p>0.05$). The correlation between morphometric features of the

scapula and the dimensions of the suprascapular notch (depth) and superior transverse diameter (STD) is analyzed by pearson correlation indexes which are explained in **Table 3**. We found no statistically significant correlation between the depth and STD of the suprascapular notch and the major dimensions of the scapula and glenoid fossa.

In the present study, Type III SSN was the most frequent type of suprascapular notch (63%) followed by Type II observed in 34% and Type VI seen in 3%of the scapulas. Descriptive analysis of the dimensions of the suprascapular notch types according to Rengachary *et al* (1979) [14] classification have been mentioned in **Table 4**.

Table 3. Correlation indexes between the dimensions of the scapula and the dimensions of the scapular notch

Particulars	A	B	C	D	E
MD.SN Pearson's correlation	0.111	0.001	-0.07	0.043	-0.01
Sig.(2-tailed)	0.17	0.98	0.38	0.59	0.92
STD.SN Pearson's correlation	0.034	0.07	-0.07	0.001	0.12
Sig.(2-tailed)	0.67	0.37	0.35	0.99	0.11

*statistically significant ($p<0.05$) correlation indexes
Abbreviations: MD. SN – Maximum depth of suprascapular notch, STD.SN-Superior transverse diameter of scapular notch,A- Maximum length of scapula, B-Maximum breadth of scapula, C – Maximum length of glenoid fossa, D – Maximum breadth of glenoid fossa, E – Length of axial border

Table 4. Descriptive analysis of the dimensions of the suprascapular notch types according to Rengachary *et al* (1979) [13] classification

Type		Mean (cm)	Std. deviation	Minimum (cm)	Maximum (cm)	Median (cm)
III	DSN	0.74	0.23	0.21	1.62	0.71
	WSN	0.91	0.25	0.41	1.72	0.91
II	DSN	0.54	0.12	0.23	1.02	0.53
	WSN	1.23	0.37	0.52	3.12	1.21
VI	DSN	0.90	0.3	0.22	1.92	0.91
	WSN	0.64	0.23	0.42	1.12	0.62

Abbreviations: DSN – depth of the suprascapular notch, WSN – width of the suprascapular notch

Discussion

The present study correlates the variations in morphometric features of the scapula and suprascapular notch (SSN) of dry human scapulae of the Southern India. The variables of consideration included the superior transverse diameter (STD), the maximal depth (MD) and the shape of the SSN. The result showed that there is no significant difference in the values of STD and MD between the right and left SSN. Manikum *et al* (2015) reported that the right MD was significantly deeper in right than that of the left, while there is no significant difference in the STD [6]. Jezierski *et al* noted that the suprascapular notch was significantly wider and shallower on right side [4].

The STD in the present study was a little narrower (1.285 cm) compared to studies of Manikum *et al* (2015) of South Africa (1.39 cm) while the MD in the present study was deeper (0.997 cm) than the comparative study (0.68 cm) [6]. The size and dimensions of the SSN has been considered as a possible factor for suprascapular nerve entrapment as SSN is the frequent site for nerve compression [1, 2, 11]. However, compression of the suprascapular nerve may also occur at the base of the scapular spine [1].

Suprascapular nerve entrapment syndrome is characterized by pain on the posterolateral aspect of the shoulder, weakness of the arm, difficulty in external rotation and abduction movements resulting from paresis and atrophy of the infraspinatus and supraspinatus muscles [5]. Flower and Garson measured the mean scapular index of Europeans and Negroids. Scapular index of European population was 65.91mm and that of Negroid samples was 68.16 mm. Negroes had shorter scapula than that of Europeans. In present study there is an increased mean dimensions for right and left scapular index which itself is an indicator for shorter scapulae. This suggests that scapulae of South Indian population are shorter than European and Negroid populations [3, 8, 11]. This indicates that a geographical variation does exist between anthropometric measurements of bones among different populations in various countries.

In the present study, the mean of right infraspinous index was 96.98 mm and left was 96.38 mm. This shows that right scapula is slightly broader than the left scapula. Flower and Garson reported infraspinous index of Europeans were 87.79 mm and that of Negroid population as 93.88 mm. Scapulae of Negroes were shorter and broader than that of Europeans. Similarly, the present study results suggest that scapulae of South Indian population are broader and shorter than European and Negroid population. These differences may be due to the difference in general small built and stature of South Indian population when compared to other study population [3].

In the present study, classification of SSN was based on most popular and verified classification system. In the present study, Type III SSN was the most frequent type of suprascapular notch with 63% of cases. This is similar to the findings in various studies with a frequency of 45%, 52%, 66.9% in Europe, Asia and in Africa [5, 6, 8,12]. However, few authors reported type III as the third frequent type [15, 17]. Type VI SSN involves ossification of the superior transverse scapular ligament. In the present study, type VI SSN was found (3%).The shape of the SSN is important in the aetiopathogenesis of suprascapular nerve entrapment as it has been hypothesized that 'V' shaped narrower notch is more likely to cause nerve entrapment than 'U' type broader notch [11]. Narrow notch has been found in patients with the suprascapular neuropathy [1, 10]. Polguj et al. [9] reported the existence of a direct correlation between the scapular length and

the suprascapular notch depth (R=0.265) and an inverse correlation between the ratio length/width of the scapular body and the suprascapular notch depth (R=−0.327). But, present study reports no correlation between the above mentioned parameters.

The study of dimensions of suprascapular notch will help the anatomists, radiologists, neurosurgeons and orthopaedic surgeons for a better understanding, diagnosis and management of suprascapular nerve entrapment syndrome correlating with the specific type of suprascapular notch. 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 [13].

Conclusion

The morphometric variables of the scapula and suprascapular notch of the study samples had decreased dimensions when compared to recent data for the scapular dimensions of from other continents. The present study has provided a database on the morphometric variables of the scapula and suprascapular notch in the South Indian population. Morphometric variables are the most important factor affecting the procedural outcomes and management of suprascapular nerve entrapment syndrome. However, this warrants further investigation with larger multi centric study involving different ethnic groups from the country.

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