

Study of Morphometric Analysis of Scapula and Scapular Indices in Tamil Nadu Population.[Original Article]

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Abstract: The scapula is a large , flat triangular bone which lies on the posterolateral aspect of the chest. From the evolutionary point of view, scapula has undergone modifications especially in its shape. Scapular index has been used to note such modifications. This study was done on 100 dry unpaired adult human scapulae of unknown sex in the Coimbatore Medical College and Government Medical College and ESIC Hospital, Coimbatore. In the present study scapular measurements like length , breadth, infraspinous length and projection length of the scapular spine were taken and parameters like scapular index and infraspinous index were calculated . This indices may help in the comparative anatomy and defining the race.

Key words-scapular index; infrascapular index , projection length

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I. Introduction

The scapula is a large , flat triangular bone which lies on the posterolateral aspect of the chest.[1].Scapula , the large triangular flat bone links the axial skeleton to the appendicular skeleton of the upper limb along with clavicle. It shows modifications in its shape in the evolutionary process from quadrupeds to bipeds. Scapular index which indicates the relationship of breadth to the length of the bone has been used to note such modifications[2]. This index is extremely high in the pronograde, where the scapula is long and narrow , but due to its increasing breadth, it progressively falls as we approach the orthograde, such as man, in which the forelimb has been completely freed. It will be noticed that changes in shape are almost exclusively confined to that portion of the scapula which lies below its spine. These changes are demonstrated by the infraspinous index which, therefore, progressively rises. The supraspinous portion of the scapula is altered little. The form of the scapula in man and a considerable series of mammals has been called attention to, and the principal differences in the shape of the bone formulated by establishing an index or numerical expression of proportion between its chief diameters-the length and the breadth of scapula.

The exact dimensions of the scapula and its geometry , however , are of fundamental importance in the pathomechanics of rotator cuff disease, total shoulder arthroplasty and recurrent shoulder dislocation. Determination of sex using scapular measurements is very useful in medicolegal cases, natural disasters and in circumstances where other bones are fragmented or not available. Scapular measurements can be used for comparative anatomy, for surgical procedures and for manufacturing prosthesis. The dimensions of scapula are important in case of rotator cuff diseases, shoulder arthroplasty and in recurrent shoulder dislocation. Scapular indices is also useful to compare racial differences. For these reasons we had made an attempt to analyse the morphometry of scapula in south Indian population particularly among Tamilians.

II. Aims And Objectives

The aim of the present study is

[i] to measure the anthropometric measurements of the scapula.

[ii]to calculate the scapular index and the infraspinous index.

[iii] to help the orthopedicians and prosthesisists in better understanding of the shoulder pathology and in designing and fitting of glenoid components for total shoulder arthroplasty and also the anthropologists when studying about the evolution of the bipedal gait.

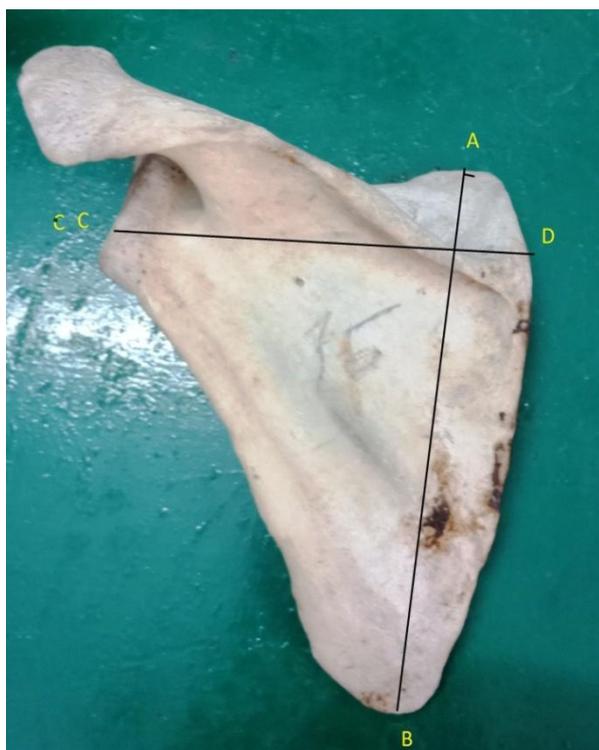


Figure 1. Length [AB] and breadth [CD] of scapula spine[EF]



Figure 2. Projection length of scapular spine



Figure3. Method of measuring the breadth of scapula.

III. Material And Methods

The study was done on 100 dry , unpaired adult human scapulae of unknown sex. 52 scapulae belonged to the right side and 48 to the left side. The study was done in the Coimbatore Medical College, Coimbatore and Government Medical College and ESIC hospital, Coimbatore.

The parameters related to scapula were measured using vernier calipers. They were

- I. Length of scapula is taken as the distance between the summit of the superior angle and the inferior angle.[Figure.1-AB]

- II. Breadth of the scapula is the distance between the point where the spine intersects the medial border of the scapula and the middle of the outer border of the glenoid cavity.-[Figure..1-CD]
- III. Infraspinous length: For measuring the infraspinous length , a horizontal line was drawn at the point where the spine intersects the vertebral border and another horizontal line was drawn at the summit of the inferior angle of the scapula. Then the distance between these two points was measured with the scale and the reading of the infraspinous length was recorded.
- IV. Projection length of the scapular spine is measured from the medial edge of the scapular spine to the lateral edge of the acromion process.[Figure.2-EF]
- V. Scapular index was measured using the above readings as follows:Scapular index= breadth X100/ length.
- VI. Infraspinous index= breadth X 100/ infraspinous length.All the measurements were taken to the nearest millimeter using the vernier calipers which is accurate to 0.1 millimeter. Microsoft office excel 2007 computer program was used to calculate the mean and the standard deviation of the scapular length ; scapular breadth ; infraspinous length and projection length of the scapular spine.
- VII.

IV. Results

[i]**Length of the scapula:**In the present study,the length of the scapula was ranging from 135-167mm. The mean length of the scapula and the standard deviation observed were 141.34 mm and 8.5 mm respectively. Maximum number of scapulae were in the range of 135 to 145 mm while least number were in the range of 165 mm to 175mm.

[ii] **Breadth of the scapula:**The breadth of scapula were ranging from 90.3 mm to 110.2mm. The mean and standard deviation were 103.3 and 6.9 respectively . The breadth range of 100mm to 105 mm had the maximum number of scapulae, followed by 105mm to 110mm , followed by the minimum number were noted in the range of 90 to 100mm range.

[iii] **Infraspinous length:**The infraspinous length were ranging 101.5 to 110.7mm. The mean and standard deviation were 106.7 and 3.5 respectively.

[iv] **Projection length of the scapular spine:** The mean projection length of the scapular spine and the standard deviation observed were 122.53mm and 4.3mm respectively. The projection length of the scapular spine varies from 105.73 and 135.64 mm. The range of 125mm to 135mm had the maximum number of scapulae [48%] followed by 115mm to 125mm [36%] while the minimum number were noted in the range of 105mm to 115mm range [16%].

The results are tabulated in Table.No.1

Table .no.1.Osteometric measurements of scapula in the present study

s.no	Parameter	Mean	Standard deviation	Minimum	Maximum
1	Length of the scapula	141.34	8.5	135	167
2	Breath of the scapula	103.3	6.9	90.3	110.2
3	Infraspinous length	106.7	3.5	101.5	110.7
4	Projection length of the scapular spine	122.53	4.3	105.73	135.64

[v] **Scapular index:** The correlation between the breadth and the length of the scapula was expressed as scapular index which was in the range of 67.16mm to 80.63mm in the present study. Mean and standard deviation of the scapular index were 71.24 and 3.1 respectively. Maximum number of scapulae were found in the range of 71 to 74 [46%] followed by 74-77[26%]; followed by 77 to 80 [14%]; followed by 68 to 71[6%] followed by 65 to 68 [4%]while only 2% were in the range of 63 to 65 and 80 to 83.

[vi] **Infraspinous index:** The correlation between the breadth and the infraspinous length of the scapula was expressed as infraspinous index which was in the range of 93.50 to 104.5 in the present study. Mean and standard deviation of the infraspinous index were 98.30 and 4.58 respectively.

Maximum number of scapula were found in two groups [ie] in the range of 95-97 [36%] followed by 97 to 99 [28%] followed by 99 to 101 [22%] followed by two groups in the range of 93.5 to 95 [6%] and 101 to 103 [6%] followed by 103 to 105 [2%].

V. Discussion

[i]**Length of the scapula-** The mean length of scapula observed in the present study was 141.34 mm with a SD of 8.5 mm.

Table no.2 gives the comparison of the length of the scapula measured by various authors and their region of study.

Table no.2. Comparison of scapular length in present study with other studies

	Authors	Mean Length of scapula and standard deviation respectively	Region of study
1	Anatzberger et al[3]	10.5 cm	
2	Sitha et al [4]	131.1mm	Thai
3	Swapna chavan [5]	137 mm and 13.67mm	Maharashtra
4	Peter et al [6]	141.49mm	Telangana
5.	Geetha singh et al [7]	141.7 mm and 8.9 mm	Jam nagar
6.	Neetha [8]	141.94 mm and 12.76mm	Delhi
7.	Krishnaiah et al[9]	143.25 mm and 11.44mm	Andhra
8.	Kavitha et al [10]	145.1mm	
9	Paraskevas et al [11]	147.6mm	Greeks
10	Wael et al [12]	151.16mm	Egyptians
11.	Polguy et al [13]	155mm	
12.	Flower et al [14]	155.54mm	Europeans
13.	Present study	141.34 mm and 8.5mm	Tamil nadu

The present study coincided with the findings of Peter et al, Geetha et al; Neeta et al; and closer to the finding of Krishnaiah and Swapna chavan. All the above are Indian authors. However the finding differs from the findings of Anetzberger; Sitha et al Paraskevas et al; Wael et al; Polguy et al and Flower et al. This implies the scapular length of Thais, Egyptians and Europeans region differs from that of Indian population. This may be due to population variation.

The minimum length of scapula observed was 10.5 cm by Anetzberger et al [3] and the maximum length was found out Flower et al [14] in Europeans.

[ii] **Breadth of the scapula:** In the present study the breadth of scapula ranged from 90.3 mm to 110.2 mm. The mean and standard deviation were 103.3 and 6.9 mm respectively. Table no.3 gives the comparison of the breadth of the scapula measured by various authors and their region of study.

These findings are very similar to those observed by Neeta et al [8] ; Flower et al [14]; Paraskevas et al [11]; Kavitha et al [10] and Krishnaiah et al [9]. But this finding differ from the findings of Sithal et al and Geeta singh et al. The minimum scapular breadth was observed by sithal et al in Thais [4] and the maximum scapular breadth observed was 105.59 by Krishnaiah et al from the people of Andhra [9]. These different values could be due to racial, ethnic, and regional variations. This data can be used for demographic studies, comparative studies among different population groups and forensic cases.

Table.no.3 Comparison of breadth of scapula in present study with other studies

s.no	Author	Breadth and standard deviation in mm	Region
1.	Sithal et al [4]	95.7	Thais
2.	Geetha singh [7]	96.4+/-7	Gujarat
3	Peter [6]	98.69 and 6.98	Telungana
4.	Swapna [5]	99.32 and 10.11	Maharashtra
5.	Flower [14]	101.42	
6.	Paraskevas [11]	101.9	Greeks
7.	Neeta [8]	103.65 and 6.82	
8.	Kavitha et al [10]	105.58	Indians
9.	Krishnaiah et al [9]	105.59	Andhra
10	Present study	103.3 and 6.9	Tamil nadu

[iii] **Infraspinous length-** The mean and the standard deviation of infra spinous length observed in the present study was 106.7 and 3.5 respectively. Krishnaiah [9] reported the mean infraspinous length and standard deviation to be 107.71 and 7.6mm. Swapna chavan [5] found the mean infraspinous length and standard deviation to be 98.54 and 10.41 on the left side and 99.32 and 8.02 mm on the right side. The present study is nearly equal with the finding of Krishnaiah [9] but differs with the finding of Swapna chavan.[5]

[iv] **Projection length of scapular spine :** Measured from the medial edge of the scapula to the lateral edge of the acromion process. The projection length of the scapular spine in the present study is 122.53 and 4.3 mm. It ranges from 105.73 and 135.64.

Peter et al [6] found the projection length of scapular spine to be 123.35mm.

The projection length of the scapular spine found by Swapna chavan et al [5] was 123.02 and standard deviation is 11.29. Minimum length of projection spine was found by swapna 89.05 and the maximum was 151.3.

Polgaj et al [13] found the projection length of the scapula to be 132.43mm and 134.36mm in scapulae with longer maximum depth and in scapulae with longer superior transverse diameter respectively. The present study coincides with the findings of Peter et al [6] and Swapna chavan [5], but varies with the findings of Polgaj.[13] [V] **Scapular index.** The correlation between breadth and length of scapula is expressed as scapular index which was in the range of 67.16 to 80.63 in the present study. Mean and standard deviation of scapular index were 71.24 and 3.1 respectively.

Table .No.4 gives the comparative study of scapular index by various authors and in various regions.

Table.no.4. Comparison of scapular index in present study with various authors

S.No	Authors	Region	Scapular index and standard deviation respectively
1	Inman[2]		64.0
2	Sheridan [15]		68.1
3	Krishnaiah [9]	Andhra	73.99 and 4.63
4	Susan varghese [16]	Kerala	70.01 and 4.09 on right side and 67.72 and 3.72 on left side
5	Geetha singal [7]	Jam nagar	68.5 and 4
6	Present study	Tamil nadu	71.24 and 3.1

The present study is nearly equal with the study of Krishnaiah et al [9] ;Geetha singal [7] and Sheridan [15], but differs with that of Inman[2]. Susan varghese[16] reported the scapular index to be 70.01 and 4.09 on right side and 67.72 and 3.72 on the left side. But the present study is not side specific. Table.No.5 compares the range of scapular index in the present study with that of Krishnaiah.[9]

Table .no.5. Scapular index Comparison

Rangen of scapular Index	Percentage in present study	Percentage (%) in Krishnaiah study
63-65	2	---
65-68	4	6
68-71	6	4
71-74	46	52
74-77	26	26
77-80	14	8
80-83	2	4

The above table gives the comparison of the scapular index percentage in the present study with the study done by Krishnaiah in the Andhra population. The readings shows no major difference in the readings of scapular index except that the scapular index in the range of 71-74 is 46% in the present study whereas it is 52% in Krishnaiah's study and that in the range of 77-80 is 14% in the present study whereas it is 8% in Krishnaiah's study. Further in the present study we found the incidence of scapular index in the range of 63-65 in 2% whereas it is not found in Krishnaiah's study.

Infraspinous index

The correlation between breadth and infraspinous length of scapula is expressed as Infraspinous index which was in the range of 93.50 mm to 104.5mm. Mean and standard deviation were 98.30 and 4.58 respectively. Table.No.6 compares the infraspinous index found by various authors in different regions

Table.no.6 Comparison of Infra spinous index in present study with various authors

S.No	Authors	No.of scapula observed	Race/region	Mean Infrascapular index and sd
1	Turner 1893 [17]	25	European	89.4
2	Turner 1893[17]	-	Maori	88.5
3	Inman 1944 [2]	-	-	120
4	Geetha singal [7]	162	Saurashtra	94.6
5	Krishnaiah [9]		Andhra	98.33 and 5.86
6.	Susan varghese[16]			90.93 and 4.96 on left side and 91.90 and 5.48 on right
7	Present study	100	Tamil Nadu	98.30 and 4.58

The present study coincides with the study of Krishnaiah [9] of Andhra and nearly equal to that of Geetha singal [7] but differs from that of Susan Varghese [16], Turner[17] and Inman[[2].

The Table.No.7 gives the comparison of the infrascapular index percentage in the present study with the study done by Krishnaiah in the Andhra population.

Table.no.7 Infraspinous index Comparison

Infraspinous index	Percentage in present study	Percentage (%) by Krishnaiah
93-95	6	8
95-97	36	30
97-99	28	30
99-101	22	20
101-103	6	8
103-105	2	4

The readings shows no major difference in the readings of infrascapular index except that the infrascapular index in the range of 95-97 is 36% in the present study whereas it is 30% in Krishnaiah's study.

VI. Conclusion

The precise measurements of various parameters of the scapulae in the region of Tamil Nadu, India have been summarised and presented in this article. Comparison with studies in people from different regions revealed variations in the osteometric values of the scapula, the basis of which could be attributed to racial and ethnic differences. Knowledge of the normal osteometric values and variations of the scapula is important for medical practitioners to understand, treat different shoulder joint disorders, and help in designing implants for the shoulder joint. This data can also be used for demographic studies, assist in forensic cases, and rehabilitation of players who sustain sports injuries. Our study did not attempt to use them in characteristics of race, sex and age in man, prosthetic products and surgical procedures such as hardware fixation and prosthetic positioning. So further studies can be carried out to explore such different areas concerned with human scapular measurements and indices.

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