

## Study of clavicle : length and curvatures in South Indian population

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### Abstract

**Background and aim of the study:** The clavicle is a subcutaneous bone most frequently fractured at the junction of its lateral and middle third of the shaft. Anatomical variations of the curvatures of clavicle can be of relevance for surgical correction procedures like intramedullary or internal plate fixation. The aim of the present study was to observe variations of length and medial and lateral angles of curvatures of the clavicle in a sample of South Indian population. **Materials and methods:** One hundred and thirteen unpaired clavicles (50 left side, 63 right side) of unknown sex and age were studied from the bone collection available at Anatomy departments of Annapoorana Medical College, Vinayaka Mission's Medical and Homeopathy Colleges, Salem. To measure the angles, Parsons method and a protractor was used. Length of the clavicle was measured with a Vernier Calipers. **Observation:** The average length of the clavicle was found to be 13.74cm left side and 13.76cm on the right side. The average medial angle of the clavicle on the left side is  $146^\circ$  and right side is  $147.5^\circ$ . The average lateral angle on the left side is  $144^\circ$  and right side is  $142.05^\circ$ . The total average angle of the clavicle is  $290.30^\circ$  on left side and  $289.59^\circ$  on right side. **Conclusion :** The average length of the clavicle on the right side is more than the left side. The medial angle on the right side and the lateral angle on left side are more than corresponding opposite sides. These variations can be useful for the orthopaedic surgeons during the surgical correction procedures of clavicle fractures.

**Key words :** *medial angle, lateral angle, length of clavicle, Parsons method, midpoint of acromial*

*end*

### Introduction

Clavicle is a subcutaneous bone which lies horizontally at root of the neck. It acts as a prop which braces back the shoulder. It has a sternal and an acromial ends with italic letter "f" shaped shaft in between. The shaft of clavicle is curved with convexity forwards in its medial two-thirds and concavity forwards in its lateral one third. The female clavicle bone is shorter in length than the male bones<sup>1</sup>.

The clavicle changes its shape from being more tubular medially to flat laterally at the junction of the middle and outer thirds of the shaft, which is the commonest site for clavicular fractures<sup>2</sup>.

Clavicle fractures are very common injuries in adults (2-5%) and children (10-15%)<sup>3</sup> and represent the 44-66% of all shoulder fractures<sup>4</sup>. 70-80% of fractures occur at the junction of medial two-thirds and lateral one third of the shaft. Displacement occurs in about 73% of all midshaft clavicle fractures and the frequency of nonunions is about 5%, but can be much higher in the group with displaced fractures<sup>5</sup>.

Surgical intervention like plate fixation, intramedullary fixation with a titanium elastic nail are done presently in clavicular fractures where routine treatment fails and results in malunion and non-union<sup>6</sup>. These surgical interventions require a thorough knowledge of the anatomical variations of the clavicle bone.

Previous studies by Jit and Singh<sup>7</sup>, Kaur et al<sup>8</sup>, Haque<sup>9</sup> and Parsons<sup>10</sup> revealed that the average length of the left clavicles was greater than that of the right. Trotter et al<sup>11</sup>, Singh and Gangrade<sup>12</sup> differed by saying that right sided bones of the limbs are usually longer than

those of the left side. Haque<sup>13</sup> also mentioned that the angles of left clavicle are greater.

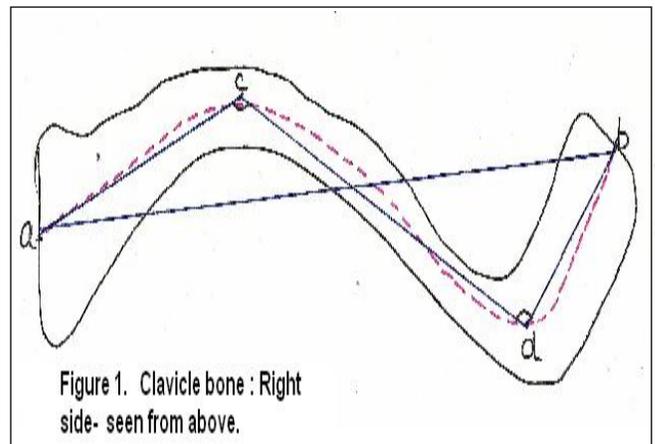
The measurement of curvatures of clavicle is an aid for surgical procedures like intramedullary nailing. Differing previous results and least research on the curvatures of the clavicle in south Indian population strongly motivated the study. This study was attempted to know about differences between the length of the clavicles and curvature angles of both sides in south Indian population. To the best of our knowledge, this study is first of its kind in this region.

### Materials and methods

One hundred and thirteen unpaired clavicles (50 left side, 63 right side) of unknown sex and age was studied from the bone collections available in the Anatomy departments of Annapoorana Medical College, Vinayaka Mission's Kirupananda Variyar Medical College, Vinayaka Mission's Homeopathy Medical College, Salem, Tamil Nadu after obtaining ethical clearance from Institutional ethical committee of Annapoorana Medical College, Salem.

The length of the bone was measured with the help of a Vernier Caliper which is the straight maximum distance between the two ends. To measure the curves of the clavicle, Parsons<sup>10</sup> method was followed. The clavicle was placed on a white paper with right and left ends in the same horizontal plane (**Figure-1**) An outline of the clavicle was drawn on the paper. The midpoints at the sternal and acromial ends was obtained and marked as points 'a' and 'b' and joined by a straight line, the central axis of the clavicle was drawn as a curved line, midway between the anterior and posterior borders throughout the length of the clavicle. This curved line has two convexities, the medial two-thirds convex anteriorly and the lateral one-third was convex posteriorly. The deepest points on the two curves of the clavicle where the convexities are the maximum are marked as points 'c' and 'd' which were joined by a straight line. Finally these

points were joined with midpoints 'a' and 'b' at the corresponding ends with lines c a and d b, thus two angles are formed: a medial angle a c d which gives the curvature of medial two-thirds, and a lateral angle c d b which indicates the curvature of the lateral one-third. Then the angles was measured with a protractor. The sum of the two angles constitutes the total curvature of the clavicle.



**Fig .1 :** Right Clavicle bone : Schematic diagram.

- a : Midpoint of sternal End
- b : Midpoint of acromial end
- c : Deepest point of Medial Curvature
- d : Deepest point of Lateral Curvature
- a c d: Medial Angle , c d b: Lateral Angle

Fractured and deformed bones were excluded from this study. Length, Medial and Lateral angles of right and left clavicles were measured. The data obtained from the study was analysed by SPSS 16.0 statistical package.

### Results

The data on length and angle of clavicles of both sides are compared in Tables 1 & 2. The average length of the right clavicles is more than the average length of the left clavicles; the average total angle of the left clavicle is more than that of right clavicle; when compared, the average medial angle of the right clavicle is more and the average lateral angle of the left clavicle is more.

**Table 1 : Comparison of data of length of the clavicle**

Data	Left clavicle	Right clavicle
Sample size	50	63
Average Length of the clavicle ± Standard deviation	13.74cm ±1.24969cm	13.76 cm ± 1.16388cm
Range	11.10 - 16.40cm	11 - 15.5cm

**Table 2 : Comparison of data of angles of the clavicle**

Data	Left clavicle		Right clavicle	
	Medial angle°	Lateral angle°	Medial angle°	Lateral angle°
Average mean of angles	146	144	147.5	142.05
Range	123 -160	126 - 158	135 - 159	118 - 158
Standard deviation	6.282	8.1911	5.673	9.0150
Average of Total angle with S.D	290.30 ± 10.079		289.59 ±11.415	

**Table 3 : Comparison of length of the clavicle bones of different population regions**

Author/ year of the study	Population region	Sample size	Length of the clavicle(average)(cm)	
			Left	Right
Parsons 1916	England	200	14.650	14.5
Terry 1932	American-Negroes	100	14.88	14.71
Terry 1932	American-Whites	50	15.41	15.29
Oliver 1951	French	170	14.68	14.60
Jit & Singh 1956	Amritsar	348	13.86	13.79
Singh & Gangrade 1968	Varanasi	97	13.59	13.86
Haque 2011	Nepal	257	14.55	14.32
Present author 2014	South India	113	13.74	13.76

**Table 4 : Comparison of angles of curvature in the clavicle bones of different population groups**

Author & year	Population group	Sample size	Total angle		Medial angle		Lateral angle	
			Right	Left	Right	Left	Right	Left
Parsons 1916,	English White	200	302.5	303.5	154	154	149	149.5
Terry 1932	America Negroes	100	292.94	296.42	152.32	152.60	141.24	144.68
Oliver 1951	France	170	294.25	294.4	150.6	151.40	143.40	143.00
Kaur 2002	Northwest India	165	292.55	297.18	151.68	151.89	143.96	148.46
Haque 2011	Nepal	257	290.73	293.23	150.97	151.50	139.76	141.73
Present Study, 2014	South India	113	289.59	290.73	147.5	146	142.05	144

**Statistical analysis**

The Pearson's correlation coefficient between the length of right and left clavicles was significant at 0.01 level by students paired "t" test. The Pearson's correlation coefficient of total angle of curvature between the right and left clavicle was significant at 0.05 level by students unpaired "t" test.

**Discussion**

The clavicle shows variation in its features in regional and international population. In the present study in south Indian population, the average length of the clavicle was found to be 13.748cm on the left side and 13.763cm on right side. The average length of right clavicle is slightly longer than that of left side. This finding differs from the findings of Jit and Singh<sup>7</sup>, Kaur et al<sup>8</sup> and Haque<sup>9</sup> who reported that left clavicles are longer than the right.

Kaur et al<sup>8</sup> observed that the length of the left clavicle was longer than the right in 61.6%, the right longer in 24.7% in adults and in 13.6%, the clavicles were of equal length in fetuses and newborns. Parsons<sup>10</sup> reported in his study of 100 paired bones that the left clavicle is longer than the right in 54%, right longer than left in 34% and clavicles were of equal length in 12%. In the present study of 113 unpaired clavicle bones, 50 bones were of left side and 63 were of right side. Among the left sided clavicles (average length 13.74cm), 50% were less and 50% were more than the average length found among the left clavicles. 38% of right clavicles were shorter, 1.5% were equal and 60.31% were more than the average length among the right clavicles (13.76cm).

The comparison of the average lengths of the clavicles from different populations is presented in Table. 3. The average length of the right clavicles is found to be more than that of the left in south Indian population which is similar with the findings of Trotter et al<sup>11</sup> and Singh, Gangrade<sup>12</sup>. The average length of the clavicle in south Indian population is less when compared to the north Indians<sup>8</sup>, English<sup>10</sup>, Nepalese<sup>13</sup>, American White & Negroes<sup>14</sup> and the French<sup>15</sup>. Auerbach and Ruff state that the racial and genetic differences play a great role in the variations of the features of the clavicle<sup>16</sup>. Other explanation offered for the patterns of bilateral asymmetry among clavicles is the role of mechanical forces<sup>11</sup>.

The comparison of the average angles of curvatures of the clavicles from different populations is presented in Table. 4. The average total angle of curvature of the right and left sided clavicles in this study is found to be the least when compared to all the previous studies and is in close range with the findings of Haque<sup>13</sup> in Nepalese population. The findings of the present study coincides with the findings of the previous authors<sup>8,9,10,14&15</sup> in regard to greater value of the total angle of curvature in the left sided clavicles. In the present study of south Indian population, the average medial angle of curvature in the right clavicles is more than that of the left clavicles in contrast to all the other previous studies<sup>8,9,10,14,15</sup> where

the length, medial, lateral and the total angle of curvature is greater in the left sided clavicles. The average lateral angle of curvature of the left clavicles is found to be greater when compared with the right clavicles and this finding coincides with the findings of the previous authors<sup>8,9,10,14</sup>. The values of the average lateral angle of curvature of left clavicles match with the findings of Terry<sup>14</sup> and are greater than Oliver<sup>15</sup> and Haque<sup>13</sup>.

The average length of the clavicles and the average total angle of the clavicles in the present study are less when compared to many previous studies. The reason could be that increased curvature of the clavicle leading to shorter clavicle in the south India region. Increased curvature and the shorter length probably lead to decreased value of the total angle of curvature. In the present study, on correlation between length and angle, the clavicles with smaller average length (left) had larger average total angle and vice versa. A future elaborate study to confirm this correlation can be planned.

Mohsin et al<sup>17</sup> states that the variations in adult clavicles are due to the factors that play their role after birth and not during the intrauterine life. According to Grisotti et al, the handedness of the upper limb may also influence or have a differential effect on the clavicle<sup>18</sup>.

The more average length of the right clavicles in the present study probably could be due to different sample size of the clavicles belonging to right and left sides and due to the mechanical forces acting on both the clavicles in the south Indian population. A future study on larger sample of paired clavicles with known sex is recommended.

### Conclusion

In the present study on clavicle, the average length of the clavicle on the right side is more than the left side; the average medial angle on the right side is more than that of left side; the average lateral angle and total angle of curvature on the left side are more than that of right side. These variations could be due to racial, genetic or mechanical factors. The orthopaedic surgeons should consider these variations as it will be useful during the surgical correction procedures of clavicle fractures.

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