

Morphometric Analysis and Sex determination from Clavicles in Gujarati Population

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Abstracts: Background and Objectives : To determine sex from unknown skeletal remains is vital. Various methods to do this on different bones of human skeleton have been extensively studied. In general male bones are heavier larger and muscular markings are more prominently seen as compared to female bones. The objective of this study was to find out comparative differences between the right and left clavicles from certain metrical parameters and to enable assessment of sex from unknown clavicles. **Methods:** The study was conducted on 213 adult clavicles, out of which 96 were of the right side and 117 were of the left. The maximum length of clavicles in mm was taken and demarking points were established by adding and subtracting $3 \times SD$ from means. **Results:** The mean length of right clavicle was $142.28 \text{ mm} \pm 11.40 \text{ mm SD}$ and that of left clavicle was $145.14 \text{ mm} \pm 11.87 \text{ mm SD}$. It has been observed that left clavicle is longer than right clavicle by 2.82mm. Depending upon length of clavicle the sex can be decided in 3.13% male and 2.08% female in right clavicles and 1.71% male and 1.71% female in left clavicles. **Conclusion:** The left clavicle was longer compared to right clavicle. Demarking points give 99.75% accurate data, measured by adding & subtracting $3 \times SD$ from means. Demarking points for length of clavicles were $>176.48 \text{ mm}$ for male & $<108.08 \text{ mm}$ for female on right side and $>180.75 \text{ mm}$ for male & $<109.53 \text{ mm}$ for female on left side for this study. This study is useful for medico legal and anthropological examination of bones and for academic studies in anatomy. [Chavda H et al NJIRM 2013; 4(6) : 18-22]

Key Words: Clavicle, Demarking points, Sex determination, Vernier calliper,

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Introduction: Determination of sex of an unknown individual is one of the critical questions addressed when human skeletal remains are found, both in forensic investigation and archaeological studies.¹ Therefore the study of sexual dimorphism of bones in human population is a matter of interest not only for the anatomists but also for the anthropologists and forensic experts.¹ The determination of sex by using whole skeleton or bony remnants had been explored by many workers since more than a century and individual bones including clavicle, may help at least in part if not whole, in this regard. The female clavicle is shorter, thinner, less curved and smoother and its acromial end is carried lower than the sternal in comparison with the male. In males the acromial end is on a level with or slightly higher than, the sternal end when the arm is pendant. Midshaft circumference of clavicle is the most reliable indicator of sex; a combination of this measurement with weight and length yields better results.² The purpose of this study was to find out an easy formula for determination of sex from unknown clavicles and to know about comparative

differences between the right and left clavicles from length of clavicles.

Material and Methods: Two hundred and thirteen dry, normal, adult clavicles of unknown sex were taken for study from various medical colleges of Gujarat. There were 96 right and 117 left clavicles. They were undamaged and with no altered pathology. The maximum length of the clavicle in mm was taken. The length of the clavicle which was the maximum distance between two ends of the clavicle was measured with the help of a vernier calliper.³ The midpoints at the acromial and sternal ends were obtained and were marked as points 'A' and 'B' and were joined by straight line 'AB' as shown in figure-1. The data were entered in Microsoft office 2007 Excel worksheet. Then the analysis was done to derive mean and standard deviation on right and left sides separately. Significance of difference between mean length of right and left clavicles was tested by students 't' test. 'P' value of less than 0.05 was considered as significant. Demarking points (D.P.)⁴ were worked out from the calculated ranges (Mean \pm 3SD) and percentages of clavicles identified beyond D.P. were noted.

Figure:1. Measurement of maximum length of clavicle(distance between points 'A' and 'B') with vernier calliper



Result:

Table: 1 Statistical measurements of the length of clavicles (n=213)

Measurements	Right	Left
Numbers	96	117
Range	106-179 mm	109-182.5 mm
Mean	142.28	145.14
SD	11.40	11.87
Mean±3SD (Range)	108.08-176.48	109.53-180.75
Demarking points (D.P.)	Male=>176.48 Female=<108.08	Male=>180.75 Female=<109.53
% clavicles beyond D.P.	Male=3.13% Female=2.08%	Male=1.71% Female=1.71%
'P' value	>0.05	
	't' value = 1.88	

All the measurements are in mm.

Table:1 shows the results of the present study. It shows that the length of right clavicle varies from 106mm to 179mm with an average of 142.28mm±11.40 mm SD. The length of left clavicle varies from 109mm to 182.5 mm with an average of 145.14±11.87 mm SD. It has been observed that the left clavicle was longer than the right clavicle by 2.86 mm. The length of left clavicle is slightly more than that of the right clavicle, but the differences were statistically insignificant.

From calculation of Mean±3SD, it was noticed that the maximum and minimum points of the range of

males are higher than the maximum and minimum points of the range for females. These measurements are termed as demarking points.⁴ These range could apply to 99.75% of the sample.⁴ Thus we got a measurement above which no female clavicles can be found and another measurement below which no male clavicles can be found. These measurements can be termed as demarking points. The length of right clavicles varies from 106mm to 179mm with the mean 142.28 mm±11.4 mm SD. On the basis of this criteria (Demarking Point= Mean±3SD), the range was 108.08mm-176.48mm. Therefore, a right clavicle having length of more than 176.48 mm should be considered as male. Only three out of 96 (3.13%) right clavicles of the present study with length more than 176.48mm can be considered as definitely male. Right clavicle having length less than 108.08mm can be female. Only 2 out of 96 clavicles can be considered as females. Sexing is not possible, if the lengths of the clavicles are between 108.08mm and 176.48mm. The length of left clavicles varies from 109mm to 182.5mm with the mean 145.14mm±11.87 mm SD. On the basis of this criteria (Demarking Point= Mean±3SD), the range was 109.53mm-180.75mm. Therefore, a left clavicle having length of more than 180.75 mm should be considered as male. Only 2 out of 117 (1.71%) left clavicles of the present study with length more than 180.75mm can be considered as definitely male. Left clavicle having length less than 109.53mm can be female. Only 2 out of 117 clavicles (1.71%) can be considered as females. Sexing is not possible, if the lengths of the clavicles are between 109.53mm and 180.75mm

Discussion: In the present study, emphasis has been put to determine the sex of unknown clavicles and to know about comparative differences between right and left clavicles from the length of clavicles.

I. Length of Clavicle

In the present study the mean length of right clavicles was 142.28±11.40mm and that of left clavicles was 145.14±11.87mm. Though the mean length of left clavicle was slightly more, it was statistically insignificant. The mean values of length of clavicles were compared with the values of other studied as shown in Table 2 and 3.

While doing comparison of the work of other authors regarding the mean length of clavicle, it is seen that the length of clavicle was not the same in different population and races.

In the present study the mean length of right clavicle was 142.28 ± 11.4 mm which was less than the mean length of right clavicles in France (146.05mm)⁵, U.S.A. Negros study done by Terry RJ ($147.14 \pm 0.79\text{mm}$)⁶, U.S.A. Whites study done by Terry RJ ($152.90 \pm 0.88\text{mm}$)⁶, England (145mm)⁷, and U.S.A. Negros study done by Singh S (146.66mm)⁸. Therefore the right clavicle of Gujarati population was shorter than the above population.

Table: 2: Comparison of mean values of the length of clavicles in different countries .

Population	Mean length of clavicles in mm	
	Right	Left
French (Olivier G) ⁵	146.05	146.85
U.S.A. Negros (Terry RJ) ⁶	147.14 ± 0.79	148.82 ± 0.47
U.S.A. Whites (Terry RJ) ⁶	152.90 ± 0.88	154.10 ± 0.91
English (Parsons FG) ⁷	145	146.50
U.S.A. Negros (Singh S) ⁸	146.66	149.06
U.S.A. Whites (Singh S) ⁸	142.54	144.10
Nepal (Haque MK et al) ³	143.21 ± 11.13	145.53 ± 11.04
Present Study	142.28 ± 11.40	145.14 ± 11.87

In the present study the mean length of left clavicle was 145.14 ± 11.87 mm which was less than the mean length of left clavicles in France (146.85mm)⁵, U.S.A. Negros study done by Terry RJ ($148.82 \pm 0.47\text{mm}$)⁶, U.S.A. Whites study done by Terry RJ ($154.10 \pm 0.91\text{mm}$)⁶, England (146.50mm)⁷ and U.S.A. Negros study done by Singh S (149.06)⁸. Therefore the left clavicle of Gujarati population was shorter than the above population.

There was a very little difference in Mean values of length of right and left clavicles of U.S.A. Whites study done by Singh S⁸, Nepalese population study done by Haque et al³ and present study. (Table: 2)

It is apparent from the Table:3 that the mean values of the length of clavicles in Varanasi zone study done by Singh et al⁹, Amritsar zone study done by Jit et al⁴, Chandigarh Zone study done by Jit I et al¹⁰ and Chandigarh zone study done by Kaur H et al¹¹ were less than the present study both for right and left sides.

These differences in the length of clavicles in present study compared to four zones of India may be due to the fact that the people of Gujarat may be well nourished compared to others.

Findings of present study supported the findings of other studies, that the length of left clavicle was usually longer than the right clavicle. (Table:3, Table:4) Explanation for this is that with the use of right hand, the curve of right clavicle became greater than that of left side which led to a shorter right bone compared to left.¹³

Table: 3: Comparison of mean values of the length of clavicles in different zones of India

Population	Mean length of clavicles in mm	
	Right	Left
Varanasi zone (Singh et al) ⁹	138.63 ± 7.85	135.97 ± 8.05
Amritsar zone (Jit et al) ⁴	137.97 ± 8.85	138.69 ± 5.51
Chandigarh zone (Jit I et al) ¹⁰	140.20 ± 8.50	141.90 ± 8.25
Chandigarh zone (Kaur H et al) ¹¹	141.96 ± 9.29	143.67 ± 9.18
Present Study (Gujarati population)	142.28 ± 11.40	145.14 ± 11.87

II. Determination of Sex: The female clavicle is shorter, thinner, less curved and smoother in comparison with male clavicle.²

In present study, an attempt has been done to assess sex from unknown clavicles by length of clavicles. In a normal distribution the maximum and minimum limits can be safely calculated by the formula $MEAN \pm 3S.D.$ by Jit et al where $mean + 3S.D.$ gives the maximum value and $mean - 3S.D.$ gives the

minimum value. This range includes 99.75% of the sample.⁴

Assuming that the measurements on clavicles are all distributed normally, the maximum and minimum values of the measurements on clavicles for both males and females separately can be fixed.

It is apparent from the table:1 that we got a measurement above which no female clavicles can be found and another measurement below which no male clavicles can be seen. These measurements are termed as demarking points.³

As seen from table:1 that on right side mean \pm 3S.D. range for length of clavicle is 108.08mm-176.48mm and on left side this range is 109.53mm-180.75mm. On the basis of criteria of demarking points, a right clavicle having length of more than 176.48mm should be considered as male. Only 3 out of 96 (3.13%) right clavicles of present study with length more than 176.48mm can be considered as definitely male.

Right clavicle having length less than 108.08mm can be female. Only 2 out of 96 clavicles (2.08%) can be considered as females. Sexing is not possible, if the lengths of the clavicles are between 108.08mm and 176.48mm.

As seen from table:1 that on left side on the basis of this criteria (Demarking Point= Mean \pm 3SD), the range was 109.53mm-180.75mm. Therefore, a left clavicle having length of more than 180.75 mm should be considered as male. Only 2 out of 117 (1.71%) left clavicles of the present study with length more than 180.75mm can be considered as definitely male. Left clavicle having length less than 109.53mm can be female. Only 2 out of 117 clavicles (1.71%) can be considered as females. Sexing is not possible, if the lengths of the clavicles are between 109.53mm and 180.75mm

Table:4 shows that in the present study only 3.13% male clavicles and 2.08% female clavicles can be found out from right clavicles and only 1.71% male clavicles and 1.71% female clavicles can be found out from left clavicles. Sexing was not possible in 94.79% right clavicles and 96.58% left clavicles.

Table:4 Comparison of percentage of clavicles identified as males and females by Demarking points in different studies

	Right		Left	
	Male	Female	Male	Female
Kaur K et al ¹²	18%	3%	19%	3%
Jit I et al ⁴	8.3%	13.7%	19.8%	11.5%
Haque MK et al ³	13.33%	4.44%	16.39%	9.83%
Present study	3.13%	2.08%	1.71%	1.71%

As seen from table:4 that in the present study sex can be identified from very few percentages of clavicles on both the sides compared to study by Kaur K et al¹², Jit et al⁴, and Haque MK et al³.

Conclusion: From the present study it can be concluded that, the left clavicle was longer than the right clavicle. From this we can infer that with the use of right hand, the curve of the right clavicle became greater than that of left clavicle. There are many characters from which we can determine the sex of an individual. In present study, depending upon the length of clavicle the sex can be determined in 3.13% male and 2.08% female from right clavicles and 1.71% male and 1.71% female from left clavicles. This study is useful to the anthropologists, toxicologist and anatomists.

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