

## Sexual Dimorphism in Clavicle Using Sternal and Clavicular End Morphometry: A Cross Sectional Study

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### Abstract

**Introduction:** Forensic anthropology can play an important role in identification of human remains in cases of natural or manmade calamity. The various manifestations of the morphological features in the skeleton which manifest differently according to sex and statistical differences, forms a basis for sex assessment. In cases, where the recovery of whole body or complete skeleton may not be possible, the forensic anthropologists have to give their opinion based upon the available skeletal remains. **Objective:** The purpose of the study was attempted to evolve a formula to enable the assessment of sex in clavicles and to know about the comparative differences between right and left clavicles of known sex, by using the various metrical parameters. **Materials and Methods:** A cross sectional study was conducted in Western Maharashtra medical college. During the study, a total of 200 adult dried clavicles extracted from cadavers used during dissection. Maximum clavicular length was measured by digital caliper. Identification point were calculated from the actual range whereas Demarking point, a calculated range, was calculated by using the formulae Mean  $\pm$  3SD because this range covered maximum sample size (99.75%) and gave more accurate results. **Results:** In the present study, the mean of the length of the clavicle was found to be 141.63 in males and 128.70 in females. The mean of the male subsets has been found to be greater even when the sample was categorized into right and left. The maximum length of clavicle was statistically significant when compared with the clavicle of females. **Conclusion:** Determination of sex the clavicle has a great medico legal importance to the forensic people. And it also helps the orthopaedic implant manufacturers and orthopaedic surgeons to decide correct size and shape of plates and intramedullary nails for clavicular fractures in open reduction method.

**Keywords:** Clavicle, Identification point, Demarking point, Anthropometry.

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### Introduction

The Clavicle or "Collar bone" is a unique long bone and it receives its name from the Latin word "Clavicula" (Latin diminutive of clavis meaning little key) because the shaft of the clavicle is gently curved and in shape it resembles the italic letter "f". The bone is quite unique as it has many features which distinguish it from other bones of the body. The bone is well developed in the human race, varying greatly in size shape from person to person, in male and female throughout the span of life [1]. Determination of age and sex with the help of skeletal remains has always been a fascination for the forensics and anthropologists. The need for reliable methods distinguishing males from females based upon various skeletal elements is evident in cases of commingled, eroded and/or missing remains. The correct determination of sex from unidentified human skeletal remains, after a mass disaster or natural calamity, is a challenge and inescapable requirement for anthropologists and forensic investigators. The present study of the morphometry of length of the clavicle has been undertaken to compare the results of this study with similar studies conducted nationally and internationally.

### Material and method

This was a cross sectional observational study conducted in the

Department of Anatomy of a Medical College in Western Maharashtra Region. 200 clavicles (72 females and 128 male) were collected from the cadavers of known sexes, used for the routine dissection. Clavicle showing any pathology, e.g. a healed fracture or malunion, was excluded. The midpoints at the sternal and acromial ends were obtained and were marked as points 'a' and 'b' and were joined by a straight line 'a' & 'b'. The length of the clavicles which was the maximum distance between the two ends of the clavicles, was measured with the help of a Vernier calliper. Data was collected using metrical method in which standard parameter was measured and subjected to statistical analysis. Sex identification is complicated by metrical and non-metrical variations seen between and within the population. Hence it is important that the criteria used should be free from subjective bias which was achieved by using Identification point and Demarking point. Identification point was calculated from the actual range whereas Demarking point, a calculated range, was calculated by using the formulae Mean  $\pm$  3SD because this range covered maximum sample size (99.75%) and gave more accurate results [2]. The formulae Mean  $\pm$  3SD gives the maximum and the minimum limit. By this formula, maximum and the minimum limits of each parameter for the males and the females of both sides can be fixed separately. It is noted that the maximum and the minimum points of the range for the males are higher than that of the females. Thus, it is statistically possible to fix a measurement above which no female clavicle can be found and another measurement below which no male clavicle can be found. This value of the maximum point of

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female and minimum point of male calculated by Mean  $\pm$  3SD can be termed as demarking point. The Demarking points of the various parameters if crossed by any clavicle would identify the sex with

certainty which is of paramount importance in medico-legal cases. Even if a single parameter crosses the demarking point, it would identify the sex of the unknown bone with 100% accuracy.



**Fig 1:** Measurement of the length of the clavicle. Point 'a' Sternal end, Point 'b' Acromial end

### Results - Length of the clavicles

**Table 1:** Length of the Clavicle

Parameters		N	Mean	Std. Deviation	Std. Error Mean	t	P-Value
Length of the Clavicle	Male	128	141.63	10.90	0.96	6.563	<0.0001
	Female	72	128.70	14.59	1.72		

Table no 1 shows the observation of the length of the clavicle. The sample size consisted of 128 male clavicles and 72 female clavicles. The mean of male subset was found to be 141.63 with a standard deviation of 10.90 and standard error of mean of 0.96 whereas the

mean value for female subset was 128.70 with a standard deviation of 14.59 and standard error of mean as 1.72. The p value was <0.0001 hence the results were significant.

**Table 2:** Statistical measurement of length of clavicle (n=200)

Statistical parameters	Left		Right	
	Females	Males	Females	Males
N	35	54	37	74
Mean	130.76	142.83	126.75	140.76
Std. Error of Mean	2.36	1.54	2.48	1.23
Median	125.06	145.86	125.07	142.05
Mode	157.40	144.890	107.730	115.000
Std. Deviation	13.97	11.34	15.08	10.56
Variance	195.12	128.70	227.40	111.44
Skewness	.483	-.663	.770	-.635
Std. Error of Skewness	.398	.325	.388	.279
Kurtosis	-.535	-.482	-.272	.310
Std. Error of Kurtosis	.778	.639	.759	.552
Range	46.64	40.79	49.71	43.44
Minimum	110.76	120.21	107.73	115.00
Maximum	157.40	161.00	157.44	158.44
Identification Point	<120.21	>157.40	<115.00	>157.44
% of identified bones	20.00%	5.56%	18.92%	5.41%
Calculated range	88.85 -172.66	108.79 - 176.86	81.51 - 171.99	109.09 - 172.43
Demarking point	<108.79	>172.66	<109.09	>171.99
% beyond demarking point	0%	0%	10.81%	0%

The male and female subsets were again recategorized into right and left subsets and a statistical analysis of the length of the clavicle was done as shown in Table 2. It was seen that on the left side the mean value for females is 130.76 and that in males is 142.83 whereas for the right side, the mean value for female clavicles is 126.75 and for male clavicles was 140.76. This indicates a higher value for the male subsets as compared to that of the female subsets. However, in a normal distribution, the maximum and the minimum limits can be safely calculated by the formula (mean  $\pm$  3S.D.) given by Jit I et al where mean +3S.D. gives the maximum value and mean -3 S.D. gives the minimum value. This range includes 99.75 percent of the sample. [2] Assuming that 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.

### Discussion

In the present study an effort has been made to determine the sex of

clavicle and the comparative differences between the right and left clavicles of male and female subsets from the length of the clavicle in Western Maharashtra population. Similar studies have been undertaken in western countries by Parson FG, Terry RJ, Oliver G and Singh S [3-7]. In the present study, the mean of the length of the clavicle was found to be 141.63 in males and 128.70 in females. The mean of the male subsets has been found to be greater even when the sample was categorized into right and left. The findings of the present study, the finding was found to be in accordance with all other population studied so far except USA Negros, USA Whites, American Negros, American whites, Amritsar, Varanasi and the Chandigarh zone Table 3.

### Determination of sex

**Identification point** - In the present study, the left sided clavicles of females were found to be having identification point of less than 120.21, and male clavicles more than 157.40. For the right sided

subset, the female clavicles were found to be having with identification point less than 115, and those of males were found to be more than 157.44. On applying Identification point 5.56% of the male clavicles of left side and 5.41% of the male clavicles could be identified. Further 20% of the female clavicles of left side and 18.92% of the female clavicles of the right side could be identified. On the basis of the IP, the calculated range was taken out. For left sided male clavicle, the range was found to be 108.79 – 176.88 while for the range for female clavicle was found to be 88.85 – 172.66. Similarly, for the right sided male clavicle the calculated range was found to be

109.09 – 172.43 and for the female clavicle it was found to be 81.51 – 171.99.

**Demarking point** - On the basis of calculated range, for both right and left subsets, any clavicle measuring less than 108.79 can be ascertained as female and more than 172.66 can be ascertained as male clavicle. Further for the right subset, any clavicle measuring less than 109.09 can be classified as female clavicle and measuring more than 171.99 can be classified as male clavicle. Thus on applying DP, only 10.81% of the right sided female clavicle could be sexed in the present study.

**Table 3:** Mean value of length of clavicle as compared to other studies conducted by different workers

Author	Region	Side	Mean Length (in mm)	
			Male	Female
Terry RJ	USA Negroes	Rt	153.3	140.98
		Lt	155.8	141.78
Terry RJ	USA Whites	Rt	152.9	138.6
		Lt	154.1	140.4
Doengen RV [8]	Australia	Rt	139.5	125.1
		Lt	139.5	125.1
Jit I & Singh S	Amritsar Zone	Rt	145.5	130.36
		Lt	147.5	129.8
Singh S & Gangrade	Varanasi Zone	Rt	141.1	125.78
		Lt	144.1	127.77
Singh S	American Negroes	Rt	155.7	137.6
		Lt	157.3	140.8
Singh S	American Whites	Rt	151.4	133.68
		Lt	153.3	134.84
Jit I & Sahni D	Chandigarh Zone	Rt	148	132.4
		Lt	149.8	134
Sayee R et al [9]	Bangalore zone	Rt	137	123.9
		Lt	141.5	128.2
Padeyappanavar KV et al	North Karnataka	Rt	141.9	125.4
		Lt	143.5	129.7
Kaur H et al [10]	Chandigarh zone	Rt	149.40	134.53
		Lt	151.14	136.21
Present study	Maharashtra	Rt	140.76	126.75
		Lt	142.83	130.76

### Conclusion

Statistical tests are applied ( $\pm$  standard deviation, P value) were applied and metrical data were obtained to assess whether the difference between the means of male and female of right and left clavicles with respect to their lengths are statistically significant or not. The demarking points for identification of sex was worked out for this population using a formula mean  $\pm 3$  S.D. The observations in the present study was that the left clavicle was longer than the right clavicle and the male subsets were longer than the female subsets. This will be useful in deciding the sex of unknown sample in future, which is an often required in medico legal cases. However, the sex overlap is observed in all the parameters and indices because of genetic, nutritional and socioeconomic status.

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