Research Article

# Determination of Sex by Discriminant Linear Regression Analysis of Clavicle in Vidarbha Region

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## Abstract

Clavicle, a collar bone also known as 'beauty bone' is unique in its features as it is the only long bone which lies horizontally in humans. It has its own peculiarities in relation to ossification, as it has two primary centres, develop in membrane and it is the first bone to ossify. Various parameters like length, weight and midshaft circumference is studied in present study of both sex to assess the sex of that particular bone. The study was conducted at GMC, Nagpur from 2003 to 2006. The objective of this study to assess the sex of clavicle from unknown clavicle by taking certain medical parameters. This study is useful in medico legal and anthropometric study of clavicle.

## Introduction

Sex of a particular deceased from available bones is a challenging task for anatomist and forensic experts. If whole skeleton is available for medico legal cases then it is easy to deliver the sex and for further studies, but if very few bones or only small bone are available, in that case it is very difficult to assess the sex. According to Stewart, sex can be delivered correctly in 90%-95% instances when entire adult skeleton or adult pelvis or one hip bone is available. Krogman et al. [1] stated that accuracy of sex identification is 98% when complete skeleton was available, 95% pelvis alone, 92% skull alone, 98% skull plus pelvis, 80% long bone alone. Thus determination of sex using whole skeleton or bony reveals had been invented by many workers, but a single bone like clavicle is a comparative challenging task. Jit et al. [2] have used the multivariate discriminate function analysis for accurate sex of clavicle. Singh et al. [3] has opined the volume of the clavicle as single parameter is not of much in ascertaining sex of clavicle greatly increased. In present study attempt was made to review all the available and established parameters regarding sex of clavicle. Three important measurements have been taken and analyzed statistically by applying statistical method of obtaining demarking point.

## Aim and Objective

1. Determination of sex by discriminant multi variant analysis of clavicle.
2. Determination of sex by demarking points.

## Materials and Methods

1. The study was carried out in Department of Anatomy, GMC and Nagpur.
2. It consists of completely ossified clavicles from 60 cadavers-48 males (96);12 females (24)
3. Various parameters like length, weight and mid-shaft circumference.

The length was measured with the help of osteometric board in mm without taking into consideration the bony curves. Weight is recorded with the help of single pan balance and measured in grams. MID shaft circumference, taking mid point of the straight length, the mid clavicular circumference was measured with a strip of graph paper. All these parameters were analyzed statistically by the formulae so as to obtain mean, Standard Deviation (SD) and Demarking Points (DP).

## Results

Sexual dimorphism of human clavicle [Table 1].

### Maximum length of clavicle

**Right clavicle:** The maximum length of the clavicle on the right side in males varied from 123 mm to 156 mm with a mean of 140.77 mm and SD ± 8.04. In females the range was 108 mm to 136 mm, with a mean of 125.83 and SD ± 7.72. In this study the maximum length of clavicle on the right in females was 136 mm and right female clavicle was above this value. But 70.8 of male right clavicle had their length exceeding 136 mm. Similarly the smallest male right clavicle was 123 mm and 33% of the female right clavicles were less than this value. Thus by these Identification Points (IP) 70.8% male and 33.0% female right clavicle could be identified. But on the basis on the Demarking Points (DP=Mean ± 3 SD), 8.7% male and 8.3% female bone could be sexed correctly. [4]

**Left clavicle:** In males the maximum length of left clavicle varied from 124 mm to 154 mm, with a mean of 141.64 mm, S. D ± 8.54. In females the maximum length of the left clavicle varied between 108 mm to 138 mm with a mean 128.0 and S. D ± 8.32. Here 64.5% left male clavicles were larger than 138 mm whereas 25% of left female clavicles were having values smaller than 124 mm. However by demarking points only 17.0% male and 8.3% female left clavicles could be sexed accurately [Table 2]. [5,6]



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### Weight of the clavicle

**Right clavicle:** In males on right side the weight of the clavicle ranged from 11 gm to 25.7 gm with a mean of 18.04 gm and SD ± 3.47, whereas in that of females ranged from 10.2 gm to 17.3 gm with a mean of 12.93 gm and SD ± 2.51. Here 58.3% of right male clavicle showed the weight to be more than 17.3 gm while 11.0% of right female clavicles showed weight to be less than 11 gm, However by demarking points only 25% male and none of the female right clavicle could be identified.

**Left clavicle:** The weight of the clavicle on the left in males varied from 12 gm to 25 gm with mean of 18.28 gm and SD ± 3.55, whereas in that of females varied from 9.0 gm to 16.3 gm with an average of 12.3 gm and SD ± 2.49. Here 58.3% of left male clavicle showed weight more than 16.3 gm, while 41.67% of the left female clavicles showed weight to be less than 12.2 gm. However by demarking points only 29.1% of male and none of the female left clavicles could be identified by the method.

### Mid-clavicular circumference

**Right Clavicle:** In males on right side the mid-clavicular circumference ranged from 28 mm to 42 mm with mean of 34.52 mm and SD ± 3.42, whereas that of female ranged from 24 m to 34 m with mean of 28.25 mm and SD ± 2.83. Here 50.0% of right male clavicle showed the circumference to be more than 34 mm. While 58.33% of right female clavicles showed the circumference to be less than 28 mm. However by demarking points only 39.6% male and 8.3% o the female right clavicles could be identified.

**Left Clavicle:** The mid-clavicular circumference on left in males varied from 29 mm to 49 mm with a mean of 34.6 mm and SD ± 3.95, whereas in that of female varied from 25 mm to 33 mm with an average of 24.79 and SD ± 2.62. Here 60.4% of left male clavicles showed the mid-clavicular circumference to be more than 33 mm. While 75% of left female clavicles showed the circumference to be less than 29 mm. However by demarking points 50.0% of male and none of female left clavicles could be identified by this method [7-9] [Table 3].

**Table 2: Table showing measurements of weight of clavicle.**

| Detailed measurements | Right | | Left | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| No. of bones | 48 | 12 | 48 | 12 |
| Range | 11.0-25.7 | 10.2-17.3 | 12.2-25.9 | 9.0-16.3 |
| Mean | 18.04 | 12.93 | 18.28 | 12.3 |
| SD | 3.47 | 2.51 | 3.55 | 2.49 |
| IP | >17.3 | <11.0 | <16.3 | <12.2 |
| % of identified bones | 50.3 | 41.67 | 31.25 | 50 |
| Calculated range | 7.63-28.45 | 5.4-20.46 | 7.63-28.93 | 4.83-19.77 |
| DP | >20.46 | <7.63 | >19.7 | <7.63 |
| % beyond DP | 25 | Nil | 29.1 | Nil |

## Discussion

The study consisted of 96 male and 24 female clavicles belonging to the dissection hall cadavers. Different measurements of various parameters were taken to determine the sexual dimorphism. Jit

**Table 3: Table showing measurements of mid-clavicular circumference.**

| Detailed measurements | Right | | Left | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| No. of bones | 48 | 12 | 48 | 12 |
| Range | 28-42 | 24-34 | 29-49 | 25-33 |
| Mean | 34.52 | 28.25 | 34.6 | 27.79 |
| SD | 3.42 | 2.83 | 3.95 | 2.62 |
| IP | >34 | <28 | >33 | <29 |
| % of identified bones | 50 | 58.33 | 60.4 | 75 |
| Calculated range | 24.20–44.91 | 19.75–36.74 | 22.7–46.4 | 19.9–35.6 |
| DP | >36.74 | <24.21 | >35.6 | <22.7 |
| % beyond DP | 39.6 | 8.3 | 50 | Nil |

**STATISTICAL FORMULAE FOR CALCULATION**

- **Mean** $\longrightarrow \bar{X} = \frac{\sum x}{n}$

  Where $\bar{x}$ = Mean
  x = Individual value
  n = Number of observations
  $\sum x$ = The sum of measurement
- **Standard deviation** S.D.= $\sqrt{\frac{\sum(X - \bar{X})^2}{n}}$
- **Standard error** $\longrightarrow \frac{S.D.}{\sqrt{n}}$
- **Demarking point** $\longrightarrow$ = Mean $\pm$ 3 S.D.

**Figure 1**: Statistical formulae for calculations.

**Table 1: Showing measurements of length of clavicle.**

| Detailed measurements | Right | | Left | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| No. of bones | 48 | 12 | 48 | 12 |
| Range | 123–156 | 108–136 | 124–154 | 108–138 |
| Mean | 140.77 | 125.83 | 142 | 128 |
| SD | 8.04 | 7.72 | 8.54 | 8.32 |
| IP | >136 | <123 | <138 | <124 |
| % of identified bones | 70.8 | 33 | 64.5 | 25 |
| Calculated range | 116.65-164.89 | 102.67-148.99 | 116.62-168.00 | 102.49-152.35 |
| DP | >148.99 | <116.65 | >152.5 | <117.0 |
| % beyond DP | 8.7 | 8.3 | 16.67 | 8.3 |

**Table 4: Table showing the percentage of clavicles identified by demarking point by various parameters.**

| parameters | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | Right | Left | Mean | Right | Left | Mean |
| Lengthof clavicle | 8.70% | 16.67% | 12.68% | 8.30% | 8.30% | 8.30% |
| Weightof clavicle | 25.00% | 29.10% | 27.05 | None | None | None |
| Mid-clavicular circumferce | 39.60% | 50.00% | 44.80% | 8.30% | None | 8.30% |

et al. first time described the maximum and minimum limits within the parameters, which could be determined on the basis of mean ± 3 SD and which they have named "Demarking Point" (DP) it has great value in determining the sex of clavicle with 100% accuracy. The value of each parameter of the clavicle was discussed below by consideration of each value, its definitive values for males and females, statistical significance and comparison with other studies. The present study reveals that the best metrical character for determination of sex from the clavicle is mid-clavicular circumference of clavicle for males, which could identify 39.6% right male, 50.0% of left male clavicle, whereas in case of females length of clavicle is best character for determination of sex which could identify 8.3% right female and 8.3% left female clavicle. Weight of the clavicle also could determine the sex. Similar findings were reported by Jit et al. and Singh et al. The weight of the clavicle was also found to be next useful parameter in determining sex in males, also showed by Jit et al. and Singh et al. The length of the clavicle was found to be useful in females for determination of sex, reported by Jit et al. The mid-clavicular circumference was also found to be useful in determining the sex of clavicle in females, as shown by Jit et al. [Table 4].

## Conclusion

Three parameters have been studied separately for male and female specimen. Values of these measurements have been subjected to obtain mean, standard deviation, range and from this the demarking point through Jit and Singh's method. Sexual dimorphism in clavicle was studied by demarking points as per the method by Jit et al. which identified the bone with accuracy for the present series. Demarking points vary for each zone and also differ according to sex and side of the bone and thus DP gives high degree of accuracy for sexual dimorphism. Mid-clavicular circumference of the clavicle was the best parameter for estimation of sex in males as it could identify 39.6% right male, 50% left male clavicle and 8.3% right female clavicle. Hence it has got the importance in determination of sex. Also the length and weight are useful parameters for determination of sex. The best metrical parameters for determination of sex from clavicle are

1. Mid-shaft circumference-In males

Length of clavicle-In females

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