

Identification of Sex of Human Clavicles from North Karnataka Zone

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ABSTRACT The sex determination of the individual is a primary criterion of identification but this is a very difficult problem and becomes even more challenging when only a single bone like the clavicle is available. The traditional methods of sexing bone are subjective and not of much help where 100% accuracy is required. Metrical analysis of sexing of clavicle by length measurement is done for this purpose. Lengths of 155 adult human clavicles of known sex were measured with the help of Vernier caliper and graph paper. The length of the male right clavicle ranged from 123-167 mm (mean of 142.1 ± 11.70 mm) where as that of the female ranged from 115-150mm (mean of 131.7 ± 12.22 mm). The length of the left male clavicle ranged from 120-162mm (mean of 143.8 ± 9.55 mm) and that of the left female clavicle ranged from 114.5 - 151 (mean of 132.7 ± 9.02). The length of the clavicle has a high significance in sex differentiation ($p < 0.001$). The prediction of correct sex by length of the clavicle alone is 62% for male and 63.30% for female right clavicles and 76% for male and 76.50% for female left clavicles.

INTRODUCTION

Sometimes only skeletal remains are available for forensic identification. The skeletal remains sent to forensic pathology to determine the identity are not always intact as in events such as plane crashes, natural disasters, explosions only certain body part are available for fixing the identity of the individual (Akhlghi et al. 2012). Determination of the sex is an important and essential step towards establishing identity of an unknown human from skeletal remains. In many studies, various skeletal remains have been used for identification but different accuracy of sex determination has been reported with clavicle (Patil 2005; Frutos 2005). Hence the present study is undertaken to assess the accuracy determination of sex using clavicle in north Karnataka population.

Objectives of Study

This study was carried out to assess the accuracy of length of clavicle for determination of sex in north Karnataka population.

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MATERIAL AND METHODS

A total of 155 dried clavicles of adult human bodies of known sex (85 male and 70 female) were obtained from the Anatomy Department, SSIMS and RC Davangere, JJM Medical College Davangere, S. N. Medical College, Bagalkot and Sri. B. M. Patil Medical College, Bijapur. The present study was conducted at the Department of Anatomy SSIMS and RC Davangere. Before the measurements were taken, the clavicles were cleaned and dried. Out of 85 male clavicles, 39 were right sided and 46 were left sided and out of 70 female clavicles, 30 were right sided and 40 were left sided.

Inclusion Criteria

Clavicles with known sex in a dried and fully ossified state collected from the Anatomy Departments of four medical colleges which belong to northern part of Karnataka namely SSIMS and RC Davangere, JJM Medical College Davangere, S. N. Medical College, Bagalkot and Sri. B. M. Patil Medical College, Bijapur. The pathological bones were not included for the study.

Exclusion Criteria

The clavicles which were incompletely ossified incompletely fused and those showing de-

formities like fracture, degradation etc. were excluded. Using Vernier calipers the length of clavicle was measured from the sternal end to the acromial end. The measurements were taken by using these standard anthropometric instruments in centimeters to the nearest millimeter. After all the measurements and observations were obtained, these data were statically analyzed by univariate discriminate analysis. The findings thus generated were compared with previous studies by different authors

The data was collected, analysed and subjected to statistical analysis using statistical package for social sciences (SPSS) to analyse the relation between the length of clavicle and the sex of the person. The approval from the institutional ethics committee was obtained at the beginning of the study.

RESULTS

In the present study, a total of 155 dried and cleaned adult human clavicles of known sex were studied by measuring their length. The values of the range and mean of most of the parameters of male clavicles were higher compared to female clavicles, even though there is consider overlap of the values between male and female clavicles. The clavicles having length more than that of the upper limit of range of female clavicles were identified as male clavicles, while the clavicles having length lesser than the lower limit of the range of male clavicles were identified as female clavicles. The sexing was also attempted by using the demarking point. By this method, the chances of misclassification of sex are minimal. As the clavicle is a single bone, which shows side related asymmetry, it was planned to analyse the sex differences of each parameter of the right and left side clavicles separately. By finding the demarking point and identification point,

the utility and limitations of the length of the clavices in estimating the sex are presented as follows.

Right Clavicle

In the present study, the length of the male right clavicles varied from 123 to 167mm (mean of $142.1\text{mm} \pm 11.70$) where as that of right side female clavicle ranged from 115 to 150mm (mean of $131.7\text{mm} \pm 12.22$). Thus the right male clavicle was longer than the female right clavicle with a mean difference of 10.4mm. Thus, the length of the right clavicle is statistically highly significant for sex determination ($p < 0.001$).

The prediction of correct sex by length of the clavicle alone was 62% for the male and 63.30% for the female right side clavicle. The right clavicle with length measuring more than 150mm was identified as a male and that measuring less than 123mm was identified as a female clavicle. Thus 31% of male and 23% female right clavicles did not show overlaps in their length measurement are correctly identified as male and female clavicles respectively.

Left Clavicle

The length of left male clavicles ranged from 120 to 162 mm (mean of 143.8 ± 9.55) and that of left female clavicles ranged from 114.5 to 151mm (mean of $132.7 \pm 9.05\text{mm}$). Thus, the mean length of the left male clavicle measured more than the female clavicle by a mean difference of 11.1mm. On statistical analysis, the length of the left clavicles had high statistical significance in sex differentiation ($p < 0.001$). The probable prediction of sex by length alone is 76% in male and 67.50% for female left clavicles. The left clavicle having a length of more than 151mm was identified as that of a male and the one with a length less than

Table 1: Discriminant analysis of length (mm) of clavicles of male and female

S. No.	Details of measurements	Right		Left	
		Males	Females	Males	Females
1.	No. of bones	39	30	46	40
2.	Range	123-167	115-150	120-162	114.5-151
3.	Mean	142.1	131.7	143.8	132.7
4.	SD	11.70	12.22	9.55	9.02
5.	“P” Value	$P < 0.001$ HS	$P < 0.001$ HS		
6.	Probability of prediction	62%	63.30%	76%	67.50%
7.	Identification point	>150	<123	>151	<120

120mm was identified as of a female, thus 18% of male and 3% of female left clavicles could be identified as that of males and females respectively.

DISCUSSION

The correct determination of the sex of a dead person is a critical requirement in the physical anthropology (Iscan 2005). Establishing the identification of the age, sex, stature and race of the person are the primary criteria's of identification. Among them, the determination of the sex is most important criteria, as it immediately excludes approximately half of the population (Knight 2002). As the obvious sex differences become apparent only after puberty, only the adult clavicles were selected for this study. When a complete skeleton is available for examination, it is not a difficult task to determine the sex. However, the accuracy of assessment of sex of the skeleton is directly proportional to the number of bones available (Krogman 1973). According to most authors, the female clavicle is shorter, thinner, less curved and smoother. The clavicle is thicker and more curved in male and manual workers. These traditional, non-metrical methods are not always helpful as these methods depend on an expert's ability and experience and show subjective variations (Jit and Sahni 1983), while material sexing of clavicle by length measurements will give good results (McCormick et al. 1991). Similar studies have been done in India on clavicles using their mid-shaft circumference length and weight (Jit 1983; Oliver 1951; Sayee et al. 1992; Singh 1966).

Even though many workers studied the morphometric data of the clavicles extensively in various parts of the world, the available literature clearly shows that there is a paucity of metrical data of the clavicle in this geographical region.

Using clavicular anthropometric parameters, they could determine sex with a 73.3%-88.3% accuracy and reported that sex can be determined using clavicle dimensions with relatively high accuracy, when only the clavicle bone is available due to explosion, plane crashes, mutilated bodies. (Akhlghi et al. 2012) It also reported better results in the sexing of clavicle than its weight. They found out that the length of right male clavicles varied from 127-175 mm and that of female clavicles was between 116-160mm. Sim-

ilarly the length of left clavicle varied from 127-176 mm in males and 117-149mm in females. According to them there was no overlap in length of the clavicles of the two sexes and concluded that a clavicle length of more than 160mm (right) and 149mm (left) would be that of a male (Jit and Sahai 1983).

In a work done at Varanasi Zone, they found that the length of right male clavicles varied from 116.8-166.2mm and that of right female clavicles varied from 103.3-148.3mm while that of left male clavicles varied 120.2-168.2mm and left female clavicles varied from 103.5-146.4mm. (Singh and Gangrade 1968) In the present study the length of the right clavicle varied from 123mm to 167mm in the male and 115mm to 150mm in the female clavicles while on the left side it varied from 120-162mm in male and 114.5 to 151mm in the female clavicles. As there is a considerable overlap between the length measurements of the male and female clavicles, the sex of the clavicle cannot be determined in every case. Only 62% of right, 76% of left clavicles male and 63.30% of right and 67.50% of left female clavicles could be sexed correctly. These results are also similar to the results of a study done by Jit and Singh (1966). The prediction of correct sex can be increased by including the length in multivariate analysis along with mid-shaft circumference, weight and volume of the clavicle. The difference in the length of clavicle may be due to the fact that American Negroes, Whites and North Indians are taller and well-built than the South Indian population.

The hips of adult women are broader than the shoulders and reverse in case of an adult male. Since clavicle contributes to the breadth of the shoulders, it is reasonable to predict that the clavicle in males will be larger and longer than in the females.

CONCLUSION

The length as a parameter of sex determination is statistically significant ($p < 0.001$) in differentiating the sex of the clavicle. The length gives better results than the weight of clavicle, as weight of the bone varies with age and health status of the individual. However, the prediction of correct sex by length alone is 4.34% for the male left clavicles and 2.5% of female left clavicles but none for the right clavicles. This shows that length of the clavicle as a single parameter

is not of much value ascertaining the sex of the bone in all cases.

RECOMMENDATIONS

The prediction of correct sex of the clavicle could increase on multivariate analysis of various morphometric parameters like volume, mid-clavicular circumference and weight of still more number of clavicles of both the sexes. Hence the researchers recommend multivariate analysis of larger samples of the human clavicles for a better and correct prediction of the sex.

LIMITATIONS OF THE STUDY

The current study has been carried out on dry skeletal remains, so in fresh cadavers these results should be interpreted with caution.

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