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Research Article

A Osteometric Study of sex determination by epiphysial ends of Humerus in Western Rajasthan sample

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Abstract
Sex determination from human skeletal remains plays a very important role in medicolegal investigations.
Aims & Objective: Present study was conducted to determine sex by using measurements of the epiphysial ends of Humerus among Western Rajasthan Population.
Matrerial & Method: Fifty normal right humeri were taken from Department of Anatomy, Dr. S. N. Medical College & associated groups of hospitals, Jodhpur, Rajasthan. Out of 50 bones 25 were of males and 25 were of females. Two measurements of the vertical head diameter and epicondylar breadth were taken from each humerus. The measurements were statistically analyzed.
Results: The results revealed that the measurements of males were significantly higher than those of the females ($P<0.001$). The vertical head diameter was the most discriminating variable in sex determination, with a 92% rate of accuracy, followed by epicondylar breadth.
Keywords: Sexual dimorphisum, Humerus, Osteometry

1. Introduction

Determination of sex is an integral first step in the development of the biological profile in human osteology. Sex determination of skeletons has always been of importance in the field of Forensic and physical anthropology, bioarchaeology, palaeodemography and anatomy.

The general anatomical regions used for sex determination are the pelvic girdle, the skull, and long bones. Many times the pelvis, skull or other bony parts that point to fairly accurate conclusions regarding sex may be absent[8] Therefore it is necessary to formulate functions for other bones especially long bones that are frequently found in the collection.

Long bones have also demonstrated usefulness in sex estimation studies. Muscle attachments tend to be larger in males than females, and long bones tend to be longer and more robust in males than females. Postcranial osteometrics are more accurate than non-metric traits of the skull. However, because of the variation in the activities performed by each sex, the possibility that some females may develop larger muscle attachments than males, and variation in height within populations, long bone morphology is not always reliable for use in sex determinations. In such instances, the use of osteometry is often preferred.

Osteometry includes the measurements of the skeleton and its parts. The technique has been successfully used in the estimation of stature, age, sex and race in forensic and legal science. The present study has been conducted to explore the potential efficiency of improving sex estimation by epiphysis of humerus.

The humerus is the longest and most robust bone of the arm. The humerus has received a moderate amount of attention in the forensic and anthropological literature. The metric characteristics of the humerus have been studied frequently in order to set standards for the determination of sex[5,6,10] and have in general provided high classification accuracies. This indicates that size differences exist between male and female humeri.

Therefore, in the present study an attempt is made to determine the mean values and accuracy of right sided long bone of arm in Western Rajasthan population by using osteometry and compare with other populations which would assist in various medico legal and archaeological studies.

2. Material and Methods

Study was conducted at the Department of Anatomy, Dr. S. N. Medical College & associated groups of hospitals, Jodhpur on 50 right humerus. Out of 50 bones 25 were of males and 25 were of females. The bone samples were dissected and extracted from adult cadavers. The measurements were taken on epiphysial ends of humerus. Samples with any pathological changes, fractures, or the non union of the epiphysis of the head were excluded. Only right sided bones were considered for this study. The socio-economical status of the individuals whose bones were taken up for the study was not established.

Metric data of each humerus was collected while using 2 different anthropometric measurements as described below. These measurements were recorded in millimeters.

2.1 Vertical diameter of head – It is measured by using sliding caliper. The measurement is taken in millimeters. It measures the direct distance between the most superior and inferior points on the border of the articular surface.

2.2 Epicondylar breadth - It measures the distance between the highest laterally placed points on the lateral epicondyle to the tip of the medial epicondyle.

2.3 Statistical analysis:

The data obtained for various parameters were subjected to statistical analysis. The students test was used to determine the mean and Standard deviation for each variable in both the sexes. The T and P value were estimated. On the basis of mean values, charts were drawn to compare between the male and female bones studied. Then, the sensitivity, specificity and the accuracy for each variable were detected separately.

Accuracy- It is the degree of closeness of a measured or calculated quantity to its actual (true) value.

$$\text{Accuracy-} \quad \frac{\text{Correctly identified bones (males + females)}}{\text{Total sample (50)}}$$

$$\frac{TM + TF}{TM + TF + FM + FF}$$

TM = No. of true identified male bones in the sample
TF = No. of true identified female bones in the sample
FM = No. of false identified male bones in the female sample
FF = + No. of false identified female bones in the male sample

Accuracy has two components - sensitivity and specificity.

Sensitivity - it is the percentage of male bones in the sample which are correctly identified. A test is said to be sensitive when it identifies correctly all male bones.

$$\text{Sensitivity-} \quad \frac{\text{Correctly identified male bones}}{\text{Total sample of male bones}}$$

Specificity - it is the percentage of female bones in the sample which are correctly identified. A test is said to be specific when it identifies correctly all female bones.

$$\text{Specificity-} \quad \frac{\text{Correctly identified female bones}}{\text{Total sample of female bones}}$$

Fig-1: Sliding caliper

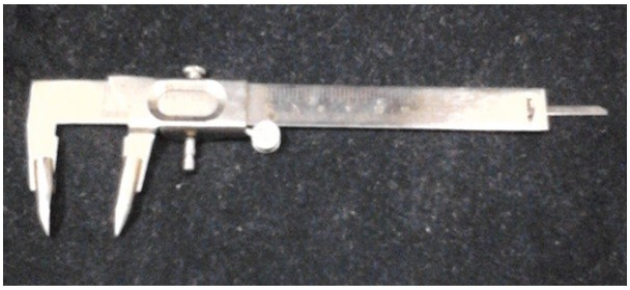


Fig-2: Measurements of Epicondylar Breadth of Humerus

Fig-3: Measurements of Vertical Head Diameter of Humerus

3. Result & Discussion

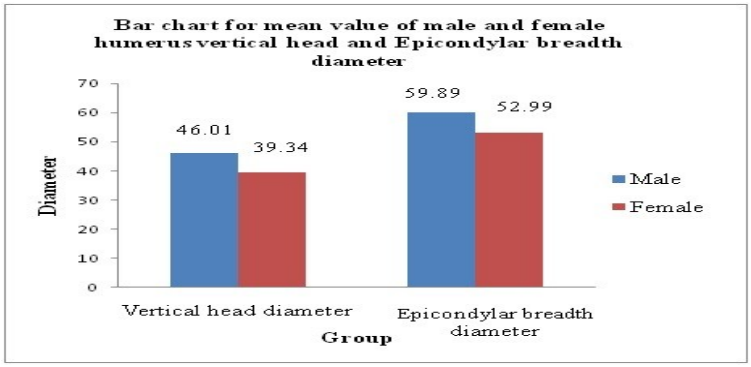
Krogman WM[1] did the pioneer work to set osteometric standards for sexual dimorphism. In addition, populations have different morphological and metric manifestations in both the sexes. Therefore, it is necessary to have population specific standards from skeletal collections[5]. The present study has been undertaken to assess sexual dimorphism in an upper limb bone, the humerus.

The results of the descriptive statistical analysis are represented in Table -1 which shows that the mean values of males were significantly higher than those of the females in all measurements ($p<0.001$). Direct analysis using single variables revealed the vertical head diameter as the best single parameter yielding 92 % accuracy (Table-2).

Table No-1 Distribution Of Humerus According to Mean Vertical Head Diameter & Epicondylar Breadth (in mms)

Group	Vertical head diameter Mean± S.D.	Epicondylar breadth Mean± S.D.
Male	46.012±2.25	59.896±3.472
Female	39.34±3.058	52.992±2.868
p value	<0.0001 (HS)	<0.0001 (HS)
t value	8.79	7.67

*HS = Highly Significant



Mean vertical head diameter (in mm) of male and female bones in the present study was 46.012±2.246 and 39.34±3.058 respectively. A statistically highly significant relation (t=8.792; p<0.0001) was observed (Table No.-1). In present study the humeral vertical head diameter was found the best sex discriminator with 92% accuracy (males 96% and females 88%) (Table No.-2).

Table-2 Percentage of correct group membership (sensitivity, specificity) and accuracy of humeral measurements

Measurements	Sensitivity % Males(25)	Specificity % Females (25)	Accuracy %
Vertical head diameter	96% (24)	88% (22)	92%
Epicondylar breadth	80% (20)	88% (22)	84.00%

Mean epicondylar breadth (in mm) of male and female bones in the present study was 59.896±3.472 and 52.992±2.868 respectively. A statistically highly significant relation (t=7.665; p<0.0001) was observed (Table No.-4) with the lowest accuracy of 84% (80% in males and 88% in females) (Table No.-2).

Iscan *et al*[7] found that the most effective single dimension, as determined by the direct discriminate analysis, was the vertical head diameter in the Chinese (81%) and epicondylar breadth in the Japanese and the Thai populations (90% and 93% respectively).

Also, Wu[10] reported the greatest dimorphism in the proximal and distal bone dimension during his study on the north eastern Chinese population. He found that the humeral head diameter was the most common sex discriminator (84%).

Kranioti E F, and Michalodimitrakis[2] studied 168 left humeri by the osteometric method and they found 92.3% accuracy in determining the sex. They found that the single most effective (89.9%) dimension was the vertical head diameter of the humerus.

Gargi Sonia *et al*[4] found that the most dimorphic single parameter on the basis of discriminant analysis was epicondylar width, with an accuracy of 80% in males and 87.5 % in females.

According to France[3] distal measurements are likely to reflect more sexual dimorphism in the humerus because this bone is subjected to greater functional or occupational stress. On the contrary studies of two different Japanese populations and a Thai population concluded that the distal part is more effective than the proximal. In present study proximal epiphysis has given more accurate results than distal epiphysis which is opposite to France's results.

4. Conclusion

The study of the osteometric data of the Western Rajasthan sample concludes that proximal epiphysis is the most dimorphic part with classification accuracy of 92 % followed by the distal epiphysis with classification accuracy of 84%. The present study deals with the accuracy for sex determination of long bone of upper limb using osteometry. The result reported here suggests that it is possible to determine the sex of skeletal remains using metric traits of long bone of upper limb.

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