Research Article

Determination of sex from humerus in Marathawada Region

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Abstract

Introduction: Identification of sex is one of the most important steps while evaluating decomposed bodies or skeletal remains. The humerus is the largest bone of upper limb and can be used to distinguish among ethnic groups and between sexes. The purpose of this study was the osteometric assessment of sexual dimorphism in population of Marathawada region of Maharashtra and to find out standard statistical values to determine sex from humerus. **Method**: 200 humeri (100 male and 100 females) available in the departments of Anatomy of Medical colleges from Marathwada region were studied. Ten anthropometric parameters were taken from each humerus. **Result**: After analyzing the data statistically it is concluded that using univariate analysis maximum accuracy in calculating sex from humerus was 45.5% while multivariate analysis gives overall 94% accuracy in determining sex from humerus. **Discussion**: Thus multivariate analysis was found much better in sexing humerus than univariate analysis. The study will be helpful to anatomists, anthropologists and forensic experts for sex determination during identification when only humerus is available.

Keywords: humerus;sex; marathwada region; multivariate analysis.

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INTRODUCTION

Numerous studies have clearly demonstrated that skeletal characteristics vary in different population. To identify deceased person is the most common and critical problem faced by anatomists, anthropologists and forensic experts. Bony skeleton retains its morphological structure even after decomposition or putrefaction, so experts use skeletal remains for identifying deceased person. Determination of sex is a very important component of any human skeletal analysis[1]. Populations differ in size and proportions and these differences affect the metric assessment of sex[2]. Humerus has rarely been tapped as a site for sex determination even though it has often demonstrated greater diagnostic accuracy than other long bones including femur[3]. Present study is our humble attempt to enhance the accuracy of sexing the humerus.

MATERIAL AND METHOD

In the present study, 200 adult dry humeri of known sex (100 male and 100 female) available in the departments of Anatomy of Medical colleges from Marathwada region were studied. Humeri chosen for the study were of known sex, dry, free of damage and deformity and fully ossified. Ten anthropometric parameters such as length, weight, vertical and transverse diameter of superior articular surface, circumferences of head and surgical neck, mid shaft and least shaft circumferences, transverse diameter of lower articular surface and epicondylar width were taken from each humerus. All the values were tabulated and analyzed statistically by routine statistical methods. The values of mean, range, standard deviation were obtained for each variable. Demarcating point was obtained from mean $\pm$ 3 S.D. Then t – test was applied to each of the parameters. Percentage of humeri sexed correctly by demarcating point was calculated. For second part of study standard computer program which analyses the values like mean, range, standard deviation was prepared according to multivariate linear discriminant function as proposed by Armitage[4]. The principle of multivariate linear discriminant function is, measured variables are considered as independent where as sex is considered as dependent variable.

The formula used for calculating discriminant functional score (Z) was

$$Z = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n$$

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(Where b_0 was constant, b_1, b_2 ...b_n were coefficient and X_1, X2.....X_n were variables of parameters and n was number of variables used). Sum of product and sum of squares[5] (SPSS) was used for calculating multivariate linear discriminant analysis. A mean discriminant functional score for male (Z_m) and female (Z_f) humeri were obtained by subjecting mean values of all variables of male and female humeri to discriminant function respectively in the above formula as

$$Z_m = b_0 + b_1 Xm_1 + b_2 Xm_2 + \cdots + b_n Xm_n$$
$$Z_f = b_0 + b_1 Xf_1 + b_2 Xf_2 + \cdots + b_n Xf_n$$

The arithmetic mean of mean values of males and females when used in place of variables in the formula gives sectioning point

$$Z_0 = b_0 + b_1 \frac{(X_1 m_1 + X_1 f_1)}{2} + b_2 \frac{(X_2 m_2 + X_2 f_2)}{2} + \cdots + b_n \frac{(X_n m_n + X_n f_n)}{2}$$

Any humerus falling on male side of sectioning point Z_0 was categorized as male humerus and that falling on female side of Z_0 was be categorized as female humerus.

OBSERVATIONS AND RESULT

Table 1: Result of Univariate Analysis

Sr. No	Parameters	Percentage of Humeri Sexed Correctly			P Value
		Male	Female	Overall	
1	Length of Humerus	12%	15%	13.5%	<0.001
2	Weight Of Humerus	10%	23%	16.5%	<0.001
3	Vertical Diameter of Head	Nil	53%	26.5%	<0.001
4	Transverse Diameter of Head	Nil	17%	8.5%	<0.001
5	Circumference of Superior Articular Surface	12%	11%	11.5%	<0.001
6	Circumference of Surgical Neck	20%	24%	22%	<0.001
7	Mid-Shaft Circumference	4%	9%	6.5%	<0.001
8	Least Shaft Circumference	2%	23%	12.5%	<0.001
9	Transverse Diameter of Lower articular Surface	6%	85%	45.5%	<0.001
10	Epicondylar Width	9%	37%	23%	<0.001

Table 2: Result of Multivariate analysis

Sex of humeri	Percentage of humeri sexed correctly
Male	92%
Female	96%
Overall	94%

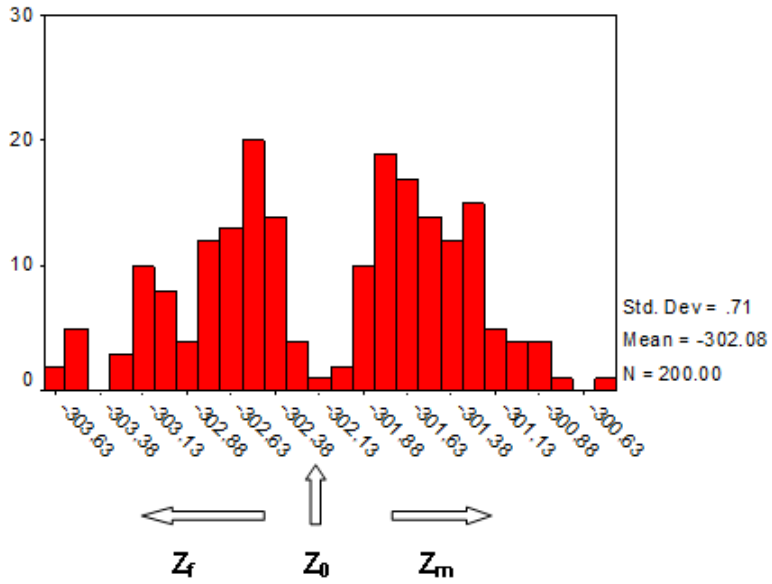

Figure 1: Showing the distribution of differential functional scores (Z) of male and female humeri of present study

Result of univariate analysis is shown in table no 1. When t test was applied, p value was found to be highly significant (<0.001) for each variable. In univariate analysis, circumference of surgical neck gave highest 20% accuracy in identifying male humeri. Transverse diameter of lower articular surface gave highest 85% accuracy in sexing female humeri. No parameter gave more than 50% accuracy in sexing humeri. Thus univariate analysis was not found much helpful in sexing humeri. Discriminant functional score was obtained using means of all variables. This was called as sectioning point (Z_0), the value of which was found to be -302.082. Discriminant functional score using means of male parameters (Z_m) was found to be -301.509. Discriminant functional score using means of female parameters (Z_f) was found to be -302.656. Thus if the value of differential functional score of any unknown humerus obtained was > -302.082 the humerus was of male and if it was <-302.082 the humerus was of female as shown in graph (fig no 1). The result of multivariate analysis is shown in table no 2.

DISCUSSION

In present study we analyzed all the 200 humeri (100 male and 100 female) by using univariate as well as multivariate statistical methods. In univariate analysis only one variable determines the sex of humeri. M.Y.Iscan[6] *et al*. (1998) in their study observed that length, vertical diameter of head and epicondylar width of humerus was highly significant in determining sex from humerus with p value <0.001 in Chinese, Japanese and Thai population. Maryna Steyn and M Yasar iscan[7] (1999) found maximum length as best parameter to differentiate sex in blacks of South Africa. Girish Patil[3] (2011) found maximum length as most discriminating variable in sex determination, with 90% accuracy rate. Weight of humerus and mid shaft circumference was found to be best discriminating measurement for identification of male bone by S. Singh and S.P. Singh[8]. Humeral head diameter was also single best discriminator (90%) for prehistoric samples from California as observed by Jean Dattrick[9] (2005). Mean transverse diameter of superior articular surface of humeri of present study did not match with Thomas Dwight[10]. Using multivariate analysis, Rios frutos L[11] (2005) got higgest i.e 98.2% accuracy in sexing humeri. M.Y. Iscan *et al*[6] (1998) got more than 90% accuracy in sexing humeri. Using univariate analysis maximum accuracy in calculating sex from humeri was 45.5% while multivariate analysis gives overall 94% accuracy in determining sex from humeri. Thus multivariate analysis was found much better in sexing humerus than univariate analysis.

REFERENCES

1. Parikh C K; Parikh's Text Book of Medical Jurisprudence and Toxicology, Identification. 5th edn. CBS publishers and Distributors, New Delhi 1992, 30-49.
2. Christopher A K, Iscan M Y, Loth S R, Metric and Comparative Analysis of Sexual Dimorphism in the Thai Femur. Journal of Forensic sciences 1998, 954-958.
3. Patil G, Kolag S, Ramadurg U, Sexual Dimorphism in the Humerus: A study on South Indians. Journal of Clinical and Diagnostic Research. 2011; 5(3): 538-541.
4. Armitage P, Statistical method in medical research. Oxford, Blackwell.1971; 332-335.
5. SAS Institute, Statistical Analysis Software, Version 9.1.3. SAS Institute Inc., Cary, North Carolina.2004.
6. Iscan M Y *et al*, Sexual dimorphism in the humerus: A comparative analysis of Chinese, Japanese and Thais. Forensic Science International. 1998;98: 17–29
7. Steyn M, Yasar M, Osteometric variation in the humerus: Sexual dimorphism in South Africans. Forensic Sci Int. 1999; 106 (2): 77-85.
8. Singh Shamer and S. P. Singh. Identification of Sex From the humerus. Indian Journal of Medical Research; Jul 1972.
9. Dittrick J, Suchey J M, Sex determination of pre historic central California skeletal remains using discriminant analysis of the femur and humerus.1986
10. Thomas Dwight, The size of articular surfaces of the long bones as characteristic of sex; an anthropological study. American journal of anatomy. 1905; 4:20-29.
11. Ríos Frutos L, Metric determination of sex from the humerus in a Guatemalan forensic sample. Forensic Sci Int. 2005, Jan 29;147(2-3):153-7.

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