Determination of Sex from Ulna by Univariate Analysis

Dope Santoshkumar A.*

Gaikwad Jyoti R. **

Laeeque M. ***

Diwan C.V. ****

ABSTRACT

Background: Determination of sex is one of the key questions to be answered in cases of un-identified bodies in medicolegal cases or anthropological studies. A number of studies are available in this regard. The studies being population specific and in general are of not universal help. Present study is an attempt to establish metrical parameters of ulna for the determination of sex.

Materials & Methods: 193 adult human ulnae comprised 133 male and 60 female from the Bone Bank of Govt. Medical College Aurangabad, were used for the present study. Parameters like Length of Ulna (L), width of Proximal Ulnar width (PWD), Distal Ulnar Width (DWD) and Head Circumference (HC), Olecranon Anterioposterior Diameter (OAPD), were recorded and analyzed statistically. Mean, SD, P values and demarking points for male and female are obtained. Cross validation of the ulnae is done using the obtained Demarking points.

Results: All the parameters are found to be statistically significant and Demarking points are found to be valid in sorting the ulnae. Conclusion: The Metrical parameters of long bones including ulnae are of immense help in determination of sex of deceased person specially in cases where skeletal remains available are very less.

Key Words- Sexual Dimorphism, Demarking Points, P Value, Forensic Anthropology, Skeletal Collection

INTRODUCTION

Long before the word 'Anthropology' was introduced, many people tried to determine the sex of the skeletal remains .Various studies have indicated that sexual dimorphism can be found in skull[1], pelvis[2], sternum[3] and other bones of the body. As a general rule definitive sexual traits in the skeleton do not manifest until after the full achievement of the secondary sexual traits that appear during puberty. The dividing line between immaturity and maturity is somewhere around 15-18 years. Prior to this age sexing the bones has been inconclusive. Hence the description of the sex differences is to be limited to the ages above 18 years.

Literature indicates that sex determination from skeletal remains started in 18th century A.D. since then various studies have shown sexual dimorphism in skull [1], pelvis [2], sternum [3] & other bones. Ulna is Latin word meaning elbow. The Ulna is a medial bone of the forearm.

The present study aims at usefulness of Total Length (L), Proximal Ulnar Width (PWD), Distal Ulnar Width (DWD), Head Circumference (HC), and Olecranon Anterioposterior Diameter (OAPD) for sex determination of ulnae and compares the study with other studies carried out on

Authors Affilation: * Assistant Professor, Dept of Anatomy, Government Medical College, Latur. ** Assistant Professor, Dr.Vasantrao Pawar Medical College, Adgaon. Nashik. *** Assistant Professor & ****Professor & HOD, Govt. Medical College, Aurangabad.

Reprints requests: Dr. Dope Santoshkumar A**.,** Assistant Professor, Dept of Anatomy, Government Medical College, Latur- 413512(Maharashtra) Contact No-09423538580 & 08087410010 Email-drdopesantosh@yahoo.co.in

males and females were significant (P<0.001). A discriminant analysis was carried out with good results.

Aims and Objectives:

- Aim of present study is to achieve the highest possible accuracy in establishing sex from ulna with the available resources.

- To study the Sexual differences in metrical parameters of Ulnae.

- To study the usefulness of various parameters and indices of ulna for sex determination

MATERIALS & METHODS

One hundred ninety three adult human ulnae of known sex available in the Bone Bank of the Department of Anatomy, Government Medical College, Aurangabad are used for the present study. Out of 193 ulnae, 60 are of females and 133 of males. All the ulnae are dry, free of damage or deformity and are fully ossified. The personal records of all the ulnae for age, sex & race are available with the Bone Bank.

The instruments which are used for the measurements of various parameters of ulna are as follows:-
1. Scale.
2. Osteometer.
3. Sliding Vernier Calipers.
4. Standardized flexible Steel tape.
5. Threads, marker pencils & pens.

Following measurements are taken for each ulna.

1. **Total Length (L)**
   Total length from top of olecranon process to tip of styloid, measured parallel to the shaft, this is achieved by applying top of olecranon to osteometer wall and the sliding pointer is used to mark the tip of styloid and length is recorded in mms.

2. **Proximal Ulnar Width (PWD)**
   The maximum breadth of the upper end of ulna, it is measured by the vernier calliper in mms.

3. **Distal Ulnar Width (DWD)**
   The maximum breadth of the distal articular surface excluding the styloid process.

4. **Head Circumference (HC)**
   The circumference of Head of ulna is measured by marking a fixed point just above the base of styloid process of ulna with a marker pencil and running the non-elastic thread along the circumference of head starting from the fixed point and back to it. The length of thread then recorded on scale in mms.

5. **Olecranon Anterioposterior Diameter (OAPD)**
   The maximum distance perpendicular to the shaft between the anterior surface of the olecranon and the most posterior point distal to the middle of the trochlea. The arms of the callipers are held parallel to the shaft axis. All values are recorded in mms. The values of Range, Mean & Standard Deviation are obtained, Demarking Points are calculated. Subsequently 't' test applied and P values were obtained for male and female ulnae. Cross validation of the data was done using the obtained demarking points.

"Demarking Point": The concept derived by Singh et al (1974) [6] in which minimum and maximum limits of a given dimension were determined by taking three standard deviations around the mean. Thus, if a bone has a value outside these limits, correct identification of sex would be 99.75 percent that the bone is male (greater than the maximum limit) or female (less than the minimum limit).

RESULTS

Ulnae of known sex are studied and various dimensions are measured. All the parameters are tabulated and statistically analyzed. Mean, standard deviations, range, demarking points are obtained for all male and female ulnae and values of these are mentioned in table no 1. The 't' test is applied for evaluating the statistical significance.

S.D. = Standard Deviation, D.P. = Demarking

Table 1. Statistical Analysis of all Parameters									
Parameters \ Measurements (in mm)	Mean		S.D.		Mean ± 3 S.D		D.P.		't' test
	M	F	M	F	M	F	M	F	
Total Length Of Ulna (L)	267	242	13.23	15.94	227-306	194-290	>290	<227	P<0.001
Proximal Ulnar Width (PWD)	23.6	20	1.72	1.97	18-28	14-25	>25	<18	P<0.001
Distal Ulnar Width(DWD)	16	14	1.39	1.19	11.9-20	10-17	>17	<11.9	P<0.001
Head Circumference of Ulna(HC)	56	49	3.7	3.6	45-68	39-61	>61	<45	P<0.001
Olecranon Anterioposterior Diameter (OAPD)	25	22	1.86	1.25	19-30	18-25	>25	<19	P<0.001

From the above table it is observed that value greater than Mean ± 3S.D of female is of male and value less than Mean ± 3S.D of male is of female. So by Total length of ulna, the percentage of ulnae sorted is 3.76% & 18.4% in males and females respectively. The percentage of ulnae sorted by proximal width of ulna is 12.8% & 31.7% in males and females respectively. Distal width of ulna, the percentage of ulnae sorted by this parameter is 13.5% & 1.7% in males and females respectively. The percentage of ulnae sorted by Head circumference of ulna is 9.8% & 3.3% in males and females respectively. And Olecranon anterioposterior diameter, the percentage of ulnae sorted by this parameter is 41.4% in males and none in females.

DISCUSSION

In common with other long bones of the extremities, ulna also is not preferred for sexing of the skeleton, as sexual variations are not as obvious as with pelvis[2] or skull[1]. In the present study an attempt has been made to sex the skeleton on the basis of a study of ulnar parameters. We have analyzed the data obtained by the routine statistical method and compared the results with different authors. Comparative values of various authors are mentioned in table no 2.

Total Length of Ulna (L)

The range of mean ± 3 S.D. (see table no 1) shows overlap and hence the percentage of bones identified with 100% accuracy using demarking points of length alone are 3.76% in male and 18.4% in females. Above table-2 showed a comparison of findings of present study with findings of others scientists. The percentage of bones identified by Singh et al [6] using total length is 12% in male and 33% in female. The Population groups for study of Panse (1979) [7] & Rao (1987) [8] and present study are same and it can be observed by comparison that the values are almost identical in the three studies. It is evident that the mean values are more in European races which can be explained on the basis of racial differences whereas the results obtained by Indian Anatomists are identical.

Proximal Ulnar Width (PWD)

India seen in North, Central and South India).

Head Circumference (HC)

Previous work is not available for this parameter, so we cannot have a comparative analysis.

The range in males is 46-66 mm and in females it is 42-57 mm respectively. The percentage of ulna sorted by this parameter alone with 100% accuracy is 9.8% of male and 3.3% of female respectively.

OlecranonAnterioposterior Diameter(OAPD)

For determination of sex the olecranon anterioposerior diameter is also studied for the first time in present study. The range of mean $\pm$ 3 S.D. (see table no 1) in males is 19 – 30 mm and in females it is 18 – 25 mm. The percentage of ulna identified by this parameter alone with 100% accuracy is 41.4 % of male but none of the female ulnae is sexed.

SUMMARY AND CONCLUSION

The present study for determination of sex of ulna is done by univariate analysis. 193 adult human ulnae of known sex are studied, 133 of them being male and 60 female. This study is based on five parameters, all these parameters are analyzed statistically and the percentage of ulnae sexed with 100% accuracy using individual parameters is calculated. It is observed that by Demarking point method 41.4 % of male ulnae are sorted by Olecranon anterioposterior diameter, followed by distal ulnar width 13.5% and accuracy in head circumference 9.8%. proximal ulnar width sorts 31.7% of female ulnae, followed by accuracy in total length is 18.4% , As is obvious from the above, although all parameters are significant statistically, majority of ulnae are in the overlap zone so practically 41.4%% of male ulnae and 31.7% female ulnae sorted using single parameter .It is evident that the values are more in European races which can be explained on the basis of racial differences whereas the results obtained by

values of these studies is because of the racial variations. Sorting of ulnae can be increased by applying multivariate analysis.

REFERENCES

1. Hanihara N. Sex diagnosis of Japanese skulls and scapulas by means of discriminant function analysis, Journal of Anthropological Society of kippona. 1959; 67 (722): 21-27.

2. HannaR.E.&Washburn,S.L.Determination of sex of skeletons, as illustrated by a study of the Eskimo Pelvis. Human Boil. 1953; 25: 21-27.

3. Dwight, T. The sternum as an index of sex and age. J. Anat. 1881; 15(3): 327-330.

4. Krogman W.M. The human skeleton in Forensic Medicine. Charles C. Thomas Springfield, Illionois U.S.A. J. Forensic Sci. 1962; 53-54.

5. Mall G, Hubig M, Buttner A, Kuzhik J, penning R. Graw M. Sex determination and estimation of stature, from the long bones of the arm, Forensic Sci Int. 2001; 117 (1-2): 23-30.

6. SinghS.,SinghG.,SinghS.P.,"Identification of sex from the ulna" Indian J. Med Res. 1974; 62(5): 731-735.

7. Panse A.A. "Estimation of stature and determination of sex from appendicular skeleton" M.S. Anatomy dissertation 1979.

8. Rao S.S. "A study of diaphysial nutrient foramina in human long bones": M.S.

Anatomy dissertation, 1987.

9. Holman D J, Bennett K.A. Determination of sex from arm bone measurements. Am. J. phys Anthropol. 1991; 84 (4): 421-426.

10. Leopold D. (Ed), (1998), Identification Unbekannter Torer. Schmidt Romhild Verlag, Lubeck.

11. Celis o agritmish. Estimation of stature and determination of sex from radius and ulnar bone lengths in a Turkish corpse sample. Forensic Sci Int. 2006; 158: 135-139.

12. Purkait R. (2001), "Measurements of ulna – a new method for determination of sex" J.

Forensic Sci. 2001; 46(4): 924-927.

13. Introna F Jr, Dragone M, Frassanito P, colonna M. "Determination of skeletal sex using discriminant analysis of ulnar measurements" Boll Soc. Ital. Biol. 1993; 69(9): 517-23.

14. Hasan Uz., Osman. "Estimation of stature and determinatio of sex from the radius and ulna." Journal of Forensic Medicine, 2002; 16 (1).

15. Berrizbeitia EL. Sex determination with the head of the radius, J. Forensic Sci. 1989; 34: 1206-1213.