

Determination of Sex from Upper End of Humerus

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Abstract

Identification of sex from remains of skeleton is an important demographic assessment in medico legal investigations and anatomists are frequently consulted by law enforcement authorities for it. Present study is conducted on 50 human humeri (all are dry, and undamaged. 25 are male and 25 are female) Five parameters are studied. The mean values of all parameters are significantly higher in males than in females ($P < 0.001$) with univariate analysis. Not a single parameter gives us an idea of sex of humerus with 100% accuracy. The single best parameter is CA (Circumference of anatomical neck of humerus) with an accuracy of 64 % in males and 68 % in females.

Keywords: VDH (Vertical Diameter of Humerus); CS (Surgical Neck of Humerus); DP(Demarcating Points); SD(Standard Deviation); Skeleton; Anatomist; Univariate; Osteometer.

Introduction

Identification of sex from skeletal is of great medico legal and anthropological significance.

Anatomists are consulted frequently by law enforcement authorities regarding identification of skeleton found under suspicious circumstances while anthropologist are also interested in finding the age, sex, stature and other details about skeleton remains found during archeological excavations [1].

Traditional methods for assignments of sex on pattern of skeletal morphology do not have an explicit basis. Visual impression of bones can seldom be accurate because of many pitfalls associated with subjective assessment of the observer. Identification of sex from skeleton is an important demographic assessment in medico legal investigation.

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Although the analysis of DNA is the most reliable method for sex determination but it is expensive and time consuming [2]. In the absence of DNA, results of sex of skeleton can be identified either by anthropometric method or morphological method.

Morphological approach is based on examination of bones and is not always reliable as age affects the skeleton. It also depends on experience of examiner. Anthropometric analysis relies on bone measurements [3].

The determination of sex, age and estimation of stature from bones play an important role in identifying unknown bodies, part of bodies or skeletal remains [4]. Determination of sex of the skeletal remains of an individual from an examination of single bone except the hip bone is considered to be difficult task and has been the subject of continuous investigations. Even when the entire human body, pelvic and skull are available, not more than 95% accuracy can be achieved.

In medico legal practice statements on probable sex of decomposed body or part of bodies are often expected even during autopsy for sexing the skeleton. Various studies have been done on various bones. The accuracy of sex determination depends on the type and condition of the bone, age of the subject, the degree of fragmentation of the bones and biological

variability [5]. Obviously more the quantity of skeletal remains available more accurately one can comment on sex of an individual.

Humerus is the longest and the largest bone in the upper limb [6]. It has expanded upper and lower ends with a shaft. Upper end consists of head, lesser and greater tubercle, upper part of intertubercular sulcus (bicipital groove) and neck. Head is articular, spheroidal and forms about one-third of a sphere. It articulates with glenoid cavity of scapula to form shoulder joint. Lesser tubercle presents a smooth muscular impression which projects forward just beyond the head. The lateral margin of the lesser tubercle is sharp and is separated from the greater tubercle by the upper part of the intertubercular sulcus. Greater tubercle occupies the most lateral part of the upper end and its convex lateral surface forms the rounded contour of the shoulder.

Humerus has anatomical neck and surgical neck. Anatomical neck is a constriction that immediately succeeds the head. Surgical neck is a constriction between the expanded upper end and the cylindrical shaft of the humerus.

Many workers have studied humerus in past but all that can help us in identifying sex of only 80% humerus, moreover many parameters show overlap between male & female values and make it more difficult to comment on sex with 100% accuracy. This may be due to genetic nutritional and socioeconomical difference in individual or may be due to hypo masculinity in female humerus and hyper masculinity in male [3]. Present study is focused on measurements of humerus and evaluates the difference on sex present in the morphology through statistical analysis. In this study we have also compared present data with other workers.

Aim of Present Study

To achieve highest possible accuracy in establishing sex from humerus with available resources.

Materials and Methods

50 adult humeri of known sex are studied from Bone Bank of Department of Anatomy MGM Medical College, Aurangabad. All are dry, free of damage or deformity. The personal records of all humeri for age sex and race are available with the bone bank.

The Instruments which are Used for Measurements of Various Parameters of Humerus are as Follows.

1. Scale
2. Osteometer
3. Vernire caliper
4. Scientific balance and weight
5. Non elastic thread
6. Marker pencil

The following measurements are taken for each humerus.

Weight(W)

Weight of each dried humerus is recorded with the help of scientific balance in grams

Total Length(L)

Functional length of humerus i.e. distance between upper and lower end in anatomical position is recorded in mms with the help of osteometer.

Circumference of head of anatomical neck (CA)

The circumference of the anatomical neck of the humerus is measured by marking a fixed point at groove opposite to the greater tubercle on the anatomical neck with a marker pencil and running the non-elastic thread along the groove starting from the fixed point and back to it. The length of the thread is recorded on scale in mms.

Circumference of surgical neck (CS)

It is measured at a point 1cm below the lowest point of the margin of articular surface of the head of humerus: the point is in line with medial epicondyle. It is measured with the help of non-elastic thread by the same method as that of CA

Vertical diameter of head (VDH)

This is the maximum diameter of head, in vertical plane of head of humerus. This is measured by Vernier caliper in mms.

Observations

In present study 50 fully ossified ,dried,non damaged humeri of known sex from Bone Bank of M. G. M Medical. College are studied Each humerus is measured for five parameters. The measurements are tabulated and statistically analyzed. For each parameter mean standard deviation, demarcating points are calculated.

Table 1: Statistical Analysis of Various Parameters of Male Humeri

Measurements	Mean	SD	Range	95 % of CI	DP
W (gms)	115	12.3	99-141	109-121	>125
L(mms)	314	13.4	285-349	308-320	>314
CA(mms)	133	6.23	120-143	130-136	>132
VDH(mms)	43.7	2.07	39-47	43-45	>43
CS(mms)	91.8	6.53	78-106	89-95	>96

Table 3: Statistical Analysis of Various Parameters of Female Humeri

Measurements	Mean	SD	Range	95% of CI	DP
W(gms)	74.1	16.2	51-125	68-80	<95
L(mms)	286	16	250=325	280-292	<280
CA(mms)	116	8.03	102-132	113-118	<120
VDH(mms)	37.8	2.79	33-43	37-39	<38
CS(mms)	79.9	7.02	68-96	77-83	<75

Discussion

Humerus is commonly studied long bone. In present study we have analyzed the data, compared the results with previous study. We measured five parameters of humerus and from these parameters we have determined the sex of humerus.

Weight

Though weight has been emphasized in the past as an important and reliable parameter for determination of sex but with all resources available we could get only study done by Singh et al with which weight measurements compared.

Table 3: Comparison of Weight of present study with different workers

Sr. No.	Name of Worker	Male				Female			
		N	Mean	SD	DP	N	Mean	SD	DP
1	Singh et al	216	132	26	7133	74	82	17	64
2	Present Study	50	115	12.3	7125	50	74.1	16.1	95

The percentage of humeri identified with 100% accuracy by weight alone is 24% for male and 96% in female. Weight is highly significant in present study with $p < 0.001$

Length of Humerus

Length of humerus is statistically very much significant parameter with $p < 0.001$

Following table 4 shows comparison of present

Table 4: Comparison of Length of Humerus of present study with different workers

Sr. No	Name of worker	Male				Female			
		N	Mean	S.D	D.P	N	Mean	S.D	D.P
1	Thiem	-	338	-	-	-	305	-	-
2	Khan	-	322	-	-	-	290	-	-
3	Singh et al	216	313.9	14.3	>324.4	74	279	14.9	<271
4	Panse A.A	71	312.54	17.4	>318.8	29	283.4	11.8	<253.1
5	Mall G et al	64	334			79	307		
6	Present study	50	314	13.4	>314	50	286	17.3	<280

study with different workers. It is evident that mean, S.D. and demarcating point values are more in European races. Percentage of humeri identified with 100% accuracy by using length alone is 52% in males and 36% in females in present study.

It is also appreciated from the table that mean

lengths are approximately same in all Indian studies.

Vertical Diameter of Head (VDH)

Vertical diameter of head is most commonly studied parameter of humerus and is anonymously relied by all workers.

Table 5: A comparison of mean VDH values observed by different workers

Sr. No.	Name of Worker	Male				Female			
		N	Mean	SD	DP	N	Mean	SD	DP
1	Khan (1959)	-	48	-	-	-	40.5	-	-
2	Panse A. A. (1979)	71	43.1	3.1	756.5	29	39.4	5.7	< 33.8
3	Mall G. 2001	-	50	-	-	-	44	-	-
4	Maryan Sten excel	55	49	3.2	746.02	48	43.2	2.5	< 46.02
5	Present study	50	43.7	2.07	743	50	37.8	2.79	< 38

A comparison of mean VDH values observed by different workers can be seen in table 5. Panse A. A [7] in her conclusion stated that vertical diameter of humerus is a reliable parameter for determination of sex of humerus, mean values observed in present study are close to the study of Panse A. A.

In present study humeri identified with 100%

accuracy by this parameter alone is 45.9% in males and 56.5% in females

Circumference of Head at Anatomical Neck (CA)

Roths P. Petalx [8] studied this parameters in 49 cases and concluded that it is significant parameter.

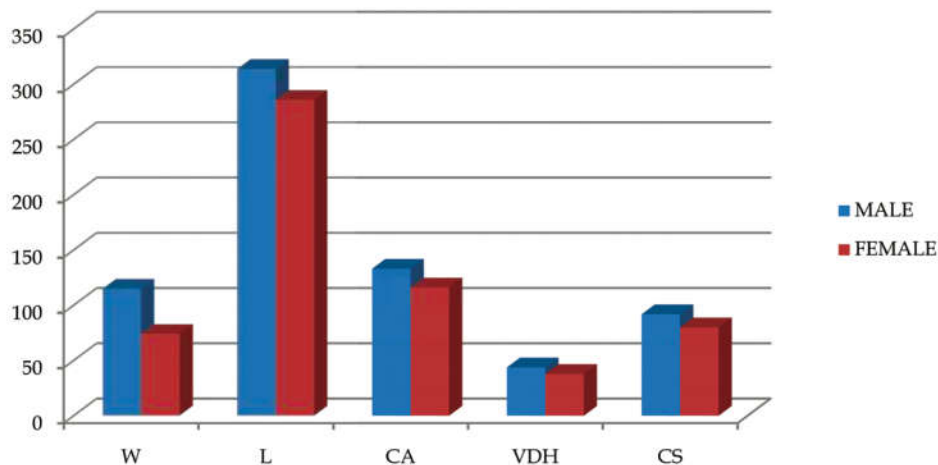
Table 6:

Male				Female			
N	Mean	S.D.	D.P.	N	Mean	S. D.	D. P.
25	133	6.23	>132	25	116	8.03	<120

In present study, percentage of humeri identified with 100% accuracy by this parameter is 64% in males & 68% in females.

Circumference of Surgical Neck of Humerus (CS)

This parameter was studied for first time in this study. The percentage of humeri sorted by this

**Graph 1:** Bar chart showing mean values of male and female measurements

parameter alone with 100% accuracy is 28% in male and 20% in female. It has been observed that not a single parameter gives us 100% accuracy about the sex of humerus and hence all parameters are considered together.

Conclusion

Five parameters are studied in 50 human humeri

of known sex. Measurements obtained are compared with values obtained by previous workers. All these parameter are analyzed statistically and percentage of humeri sorted with 100% accuracy using individual parameter is calculated.

Circumference of anatomical neck of humerus is found to be most reliable parameter with 64% accuracy in male and 68% accuracy in female.

Parameters like Weight, Length VDH, CS can be

helpful in sorting sex of humerus.

References

1. Krogman W. M. (1962): 'The human Skelton in forensic medicine.' 3rd edition Charles C.Thomous Springfield, Illinois U.S.A.
 2. Gibbon V, Paximadis M, Ruff Pet al Novel methods of molecular sex identification from skeletal tissue using the amelogenin gene Forensic Sci Int. Genet. 2009; 3:74-9.
 3. Zelina Basic, Lvana ANteric et al sex determination in skeletal remains from medieval Eastern Adriatic coast- discriminant function analysis of humeri. Croatian Medical Journal 2013.
 4. Modi(2001): Modi's Medical Jurisprudence and Toxiology. 22nd edition.
 5. Study of sexual dimorphism of humerus in Tamilnadu region Anil kumar Reddy, Sheela G.J. International journal of Medical Research and Health Sciences. 2013; 3(1).
 6. Susan Standring's 40th edition of GRAY'S Anatomy. The anatomical basis of clinical practice: pg796-797.
 7. Panse A.A."Estimation of strature and determination of sex from appendicular skeleton".
 8. Rother P. "The determination of age and sex from measure of the humerus Anat. Anz. 1977; 142(3):243-54.
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