Determination of Sex Using Humeral Dimensions and Radiographic Measurements of the Humerus in Egyptian Population, Fayoum Governorate

Marwa Ali Mwaheb[1], Eman Ali Ali Abd El-Meguid[2], Mohammed Ahmed Moussa[3], Enas Mohammed Morsi [1]

[1]Department of Forensic Medicine and Clinical Toxicology, Faculty of medicine Fayoum University, Egypt, [2]Department of Anatomy and Embryology, Faculty of Medicine, Fayoum University, [3] Department of Orthopedic, Faculty of Medicine, Fayoum University

Abstract

Background: Sex determination of unidentified skeletal stays from crime scenes or uncovering destinations is a significant part in the improvement of the natural profile in criminology and human science.

Aim of work: The purpose of this research was to determine if sexing of obscure grown-up human humerus bones can be done by applying estimations of morphometric parameters produced by present investigation on these bones of grown up humans of known sex. Also, it aimed to discover the best parameters for sex determination.

Method: This study was conducted on 52 humeri of 28 males and 24 females and 98 radiographs of patients (48 males and 50 females) from the population of Fayoum governorate in Egypt. Humeri bones used in this study were collected from the Anatomy Department, Faculty of Medicine, Fayoum University.

Results: The study illustrated that no statistically significant differences with p-value >0.05 were found between bone and X-ray findings as regards age and sex distribution. Also, no statistically significant differences with p-value >0.05 were reported between both findings regarding other measures including TDMS, UEB, VDH, and ad ML measures. On the other hand, statistically significant differences with p-value <0.05 were reported between different genders regarding EP, TDMS, UEB, VDH, ML, and CT with higher mean values noticed among males.

Conclusion: It is presumed that the distal humerus is a viable bone for sex estimation, even if the bone is in a fragmentary state.

Keywords: *Sex determination, Humerus, Radiograph, Egypt*

Introduction

Sex determination is the initial phase in the identification procedure of a person in legal assessment. This phase is of a very high importance. Age, race, and stature, when identified from the different human remains, are among the few key parameters which should be quickly determined and incorporated in the organic profile. [1, 2] Previous studies reported that the humerus bone can be utilized in sex determination.

The sexing accuracy for various bones reported in literature is 80–92% for cranium, 90% for skull and mandible, 95–98% for pelvis and 80% for long bones. [3,4] Larger limb bones may provide clear evidence of sex particularly if other individuals of same race and of both sexes are available for comparison. Marked sexual dimorphism is exhibited by several bones and they are suitable for sexing skeletons with high accuracy.[5]

Populations contrast in size and extent of human bones; these differences influence the metric assessment of sex[6]. The degree of sexual varieties among Egyptians has not been evaluated and no measurement guidelines have been presented for the distal humerus bones.

The humerus is one of the important long bones of the skeleton because of its quality, even in a divided state, in addition to being conceivable to be recuperated in a measurable case. Old style osteometric methods have been utilized to estimate the humerus length from its sections (7, 8) and affirm the presence of sexual dimorphism in this bone. (9, 10) In anthropometric examinations, the humerus is a tolerably-contemplated bone. It has a fundamental job in sex distinguishing proof, stature estimation, scientific examinations, etc. (11)

This is the first study in the Egyptian governorate, Fayoum, designed to assess the accuracy of sex determination from the length of right and left humeri by evaluating normal anatomy in adults to establish metric standards for sex assessment from the X- ray radiographs of the distal humerus in the population of Fayoum.

Methods

This study was conducted on 52 humeri of 28 males and 24 females and 98 radiographs of patients (48 males and 50 females) from the population of Fayoum. Humeri bones used in this study were collected from the Anatomy Department, Faculty of Medicine, Fayoum University. These bones were selected in a dried and fully-ossified state. The humeri having deformity atrophy or pathological lesions were excluded from the study. The age for both sexes included in this study ranged from 20 to 70 years. The present study was done on dry human bones, so ethical issues were not raised. Radiographs used in this study were taken from an anteroposterior view and collected from a private radiology centre in Fayoum. X-rays with deformities, fractures, recent surgery, or bone tumours were excluded from this study. The age range of patients whose X-rays were used in this study was from 16 to 66 years.

Right and left humeri from bones (11, 12) and radiographs (13) were subjected to the following measurements (in centimetres):

1. Maximum length (ML): Straight distance from the most superior point on the head of the humerus to the most inferior point on the trochlea.

2. Vertical diameter of the head (VDH): Direct distance between the highest and the lowest point on the articular margin of the head measured.

3. Transverse diameter at the middle of the shaft (TDMS): Distance between the medial and lateral margins of the humeral shaft at the middle.

4. Upper epiphyseal breadth (UEB): Obtainable distance between the medial-most point on the articular surface of the head and the lateral-most point on the greater tubercle.

5. Epicondylar breadth (EB): Distance between the most lateral point on the lateral epicondyle and the tip of medial epicondyle.

The maximum length of each humerus was measured roughly using a metal ruler, while other measurements were taken by digital caliper. The digital Vernier caliper provides precision readings from 0.01 mm and 0.000500 through a clear liquid–crystal dis-play. (11) All radiographic measurements were taken by a metal ruler

Results

Table (1) illustrated that there were no statistically significant differences with p-value >0.05 between bone and X-ray findings as regards age and sex distribution. While in **figure (1), it is** demonstrated that there was a statistically significant difference with P value <0.05 between X-ray and bone measurements as regards EP with higher mean value observed among bones. On the other hand, no statistically significant differences with p-value >0.05 were reported between bone and X-ray measurements as regards other measures such as TDMS, UEB, VDH, and ad ML measures. Moreover, statistically significant differences with p-value <0.05 were reported in **table (2)** between different genders as regards EP, TDMS, UEB, VDH, ML, and CT with higher mean values noticed among males. No statistically significant differences with p-value >0.05 were found between bones and radiographs as regards other measures (such as MT).

Moreover, statistically significant differences with p-value <0.05 were reported between males and females among the cases assessed by X-rays as regards EP, TDMS, UEB, VDH, ML, and CT with higher mean values noticed among males, while no statistically significant differences with p-value >0.05 were reported between males and females among these cases as regards other measures (MT) as shown in **Table (3)**. **Table (4)** illustrated that there were statistically significant differences with p-value <0.05 between males and females among the cases assessed by bone measurements as regards EP, TDMS, UEB, VDH, and ML with higher mean values among males. In addition, statistically significant differences with p-value <0.05 were reported between right and left sides among case regarding TDMS, UEB, VDH, MT, and CT with higher mean values noticed among the right side. On the other hand, no statistically significant differences with p-value > 0.05 were found between the right and left sides as regards other measures (EP and ML) as shown in **table (5).**

Table (6) documented that there were statistically significant differences with p-value <0.05 between the right and left sides among cases assessed by X-rays as regards TDMS, UEB, VDH, MT, and CT, with higher mean values noticed among the right side. On the other hand, no statistically significant differences with p-value >0.05 were reported as regards other measurements including EP and ML.

Table (1): Comparisons of demographic characters in different study groups.

Variables	X -ray (N=98)		Bone (N=52)		p-value	Sig.
Age (years)						
Mean /SD	39.5	16.3	41.8	17.8	0.4	NS
Sex						
Male	48	49%	28	53.8%	0.6	NS
Female	50	51%	24	46.2%		

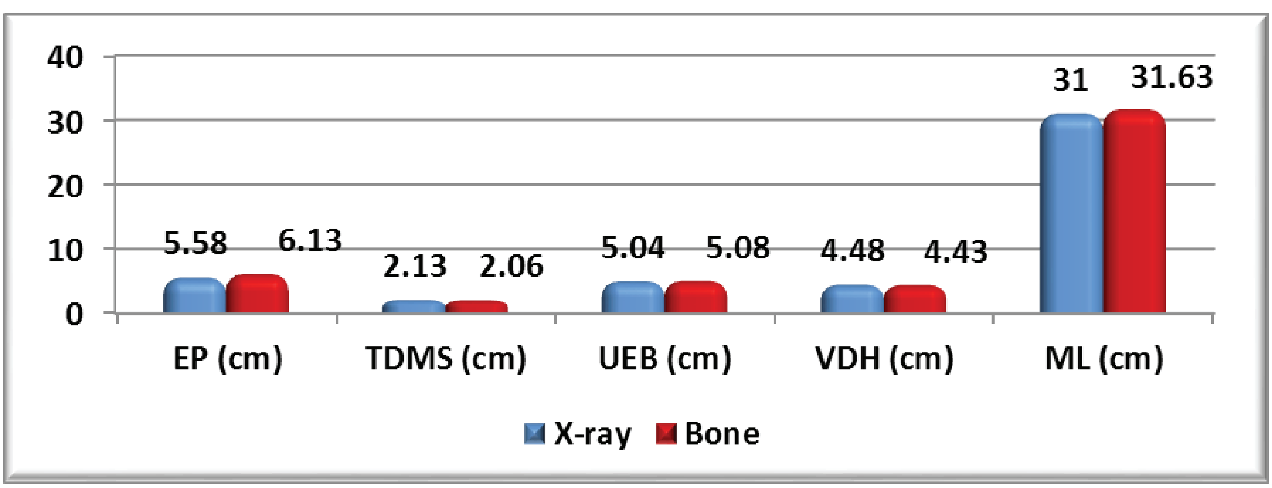

Figure (1): Comparisons of different variables in different study groups.

Table (2): Comparisons of different variables in different gender.

Variables	Males (N=76)		Females (N=74)		p-value	Sig.
	Mean	SD	Mean	SD		
EP (cm)	6.06	0.56	5.48	0.43	<0.001	HS
TDMS (cm)	2.21	0.24	2	0.21	<0.001	HS
UEB (cm)	5.35	0.36	4.76	0.36	<0.001	HS
VDH (cm)	4.72	0.33	4.19	0.31	<0.001	HS
ML (cm)	32.23	1.86	30.20	1.69	<0.001	HS
MT (ml)	7.29	1.22	6.92	1.17	0.1	NS
CT (ml)	3.71	0.54	3.24	0.59	<0.001	HS

Table (3): Comparisons of different variables in different gender assessed by x-ray.

Variables	Males (N=48)		Females (N=50)		p-value	Sig.
	Mean	SD	Mean	SD		
EP (cm)	5.72	0.38	5.44	0.41	0.001	HS
TDMS (cm)	2.2	0.25	2.1	0.19	0.01	S
UEB (cm)	5.3	0.38	4.8	0.36	<0.001	HS
VDH (cm)	4.69	0.39	4.3	0.28	<0.001	HS
ML (cm)	31.6	1.6	30.4	1.5	<0.001	HS
MT (ml)	7.3	1.2	6.9	1.2	0.1	NS
CT (ml)	3.7	0.54	3.24	0.59	<0.001	HS

Table (4): Comparisons of different variables in different gender assessed on bone.

Variables	Males (N=28)		Females (N=24)		p-value	Sig.
	Mean	SD	Mean	SD		
EP (cm)	6.63	0.27	5.56	0.45	<0.001	HS
TDMS (cm)	2.23	0.21	1.85	0.15	<0.001	HS
UEB (cm)	5.5	0.24	4.6	0.31	<0.001	HS
VDH (cm)	4.77	0.16	4	0.30	<0.001	HS
ML (cm)	33.2	0.19	29.7	2	<0.001	HS

Table (5): Comparisons of different variables in different sides.

Variables	Right (N=98)		Left (N=52)		p-value	Sig.
	Mean	SD	Mean	SD		
EP (cm)	5.7	0.55	5.9	0.62	0.1	NS
TDMS (cm)	**2.2**	0.25	2	0.21	<0.001	HS
UEB (cm)	**5.1**	0.42	4.9	0.51	0.004	HS
VDH (cm)	**4.5**	0.40	4.3	0.4	0.004	HS
ML (cm)	31.4	2.1	30.9	1.9	0.1	NS
MT (ml)	7.3	1.1	6.7	1.3	0.04	S
CT (ml)	**3.6**	0.6	3.2	0.58	0.02	S

Table (6): Comparisons of different variables in different sides assessed by x-ray.

Variables	Right (N=72)		Left (N=26)		p-value	Sig.
	Mean	SD	Mean	SD		
EP (cm)	5.55	0.41	5.67	0.45	0.2	NS
TDMS (cm)	2.18	0.23	1.98	0.17	<0.001	HS
UEB (cm)	5.13	0.39	4.8	0.43	0.001	HS
VDH (cm)	4.5	0.41	4.31	0.35	0.01	S
ML (cm)	31.2	1.8	30.6	1.4	0.1	NS
MT (ml)	7.3	1.1	6.7	1.3	0.04	S
CT (ml)	3.6	0.61	3.2	0.58	0.02	S

Discussion

The estimations of long bones' length are crucial for evaluating an individual's stature. These estimations have an important role in medico-lawful examinations for recognition of missing people. Because the humerus is the longest, biggest, and most grounded (even in a divided state) bone of the chest area, stature estimation should be done from this bone without other appropriate long bones such as the femur bone. [14]

In this research, our results revealed that the mean humeral length was of statistically significant difference (p-value <0.05) between males and females among cases assessed by X-rays as regards EP, TDMS, UEB, VDH, ML, and CT where higher mean values were noticed among males compared to females. This finding agrees with the results of other studies in which all measurements were significantly higher in males than females. Also, our findings are in conformity with the findings reported by Singh [15, 13].

This research also documented statistically significant differences between males and females among the cases assessed by X-rays as regards EP, TDMS, UEB, VDH, ML, and CT, with higher mean values noticed among males. This is in agreement with other researches [16, 17] that illustrated that the following parameters: ML, VDH, circumference of the head, transverse diameter at the middle of the shaft [TDMS], TDUS, TDLS, upper shaft circumference, MSC, lower shaft circumference, upper epiphyseal breadth, and EB were inspected and statistically significant differences were reported, with the mean values of these parameters higher in males compared to females.[18]

This study demonstrated that there were statistically significant differences between right and left sides among cases assessed by bone measurements as regards TDMS, UEB, VDH, MT, and CT, with higher mean values noticed among the right side. Also, statistically significant differences were observed among cases assessed by X-rays as regards TDMS, UEB, VDH, MT, and CT, with higher mean values noticed among the right side. These findings disagree with other studies which reported no statistically significant differences regarding all the investigated values in the comparison carried out between the right and left humera. [19]

Conclusion

the estimations of the humerus seem, by all accounts, to be acceptable discriminators of sex right now by stepwise and coordinate discriminant work investigation.

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