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An Analysis of Anatolian Human Femur Anthropometry

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Abstract: Femoral anthropometry from two different ages of Anatolian population groups was evaluated according to normal parametric measurements. Eleven femoral measurements with collo-diaphyseal angles were obtained from 36 right and 36 left intact human adult femora of a contemporary Central Anatolian population. For this purpose, a sliding caliper, osteometric board, tapeline and gonometer were used. Obtained data were statistically analyzed by Student's t-test and the Pearson correlation coefficient. Our results were compared with a previous study's results obtained from human femora from the Şeyh Höyük area (southern Anatolia) dating back to the Chalcolithic Age (5100-3000 B.C). The results of this study showed no significant differences between the right and the left femora except that of the head vertical diameter (HVD). Only with the neck transverse diameter (NTD) did the collo-diaphyseal angle (CDA) showed a significant correlation ($p < 0.05$). The correlations between the other different parameters showed variable degrees of significant associations ($p < 0.05$). Results from the femora of contemporary and Chalcolithic Age individuals showed significant differences ($p < 0.05$) in collo-diaphyseal angle (CDA), head vertical diameter (HVD), head transverse diameter (HTD), midshaft circumference (MSC), midshaft transverse diameter (MSTD) and distal breadth (DB) measurements. Contemporary individuals have retained longer femora. Results indicate that femoral anthropometric measuerments could show differences between various populations belonging to different ages.

Key Words: Femur, Anthropometry , Anatolia, Chalcolithic Age

Introduction

It is commonly accepted that the examination and statistical analysis of femoral anthropometry among different populations reveals a great amount of variation due to the fact that femoral anthropometric measurements from different countries are likely to be affected by racial variations in diet, heredity, climate and other geographical factors related to life style (1). Anatomical and anthropological studies on the dimensions of the head of the femur have failed to establish a universal norm for all human races (2-6).

The purpose of this study was firstly to evaluate the morphometry of the femur of contemporary mid-Anatolian population groups who died during the twentieth century; secondly, to use the obtained osteometric data to estimate the bilateral differences between the right and the left bones; and thirdly, to develop a comparative statistical study between our data and data from the Şeyh Höyük area (southern Anatolia) obtained by Şenyürek who studied the anthropometry of 7 human femora of the Chalcolithic Age (5100-3000 B.C.) (7).

Materials and Methods

In this study, 72 (36 right and 36 left) intact human adult femora were obtained from the teaching skeletal collections at the Anatomy Department of the Medical School, University of Selçuk. All of the skeletal remains were brought from different locations around Central Anatolia, from people who died during the twentieth century. In the study, a total of 11 parametric variables related to the femora were obtained from the head, neck, shaft and distal end of the femur according to Martin and Saller (8), and Olivier and Vallois' (9) methods. The shaft–neck (collo-diaphyseal) angle was also evaluated. Measurements were designed as follows:

Maximum length (ML): maximum length from the head of the femur to the medial condyle (Fig. 1),

Trochanter length (TL): maximum length from the tip of the greater trochanter of the femur to the lateral condyle (Fig. 2),

Collo – diaphyseal angle (CDA): the angle between the longitidunal axis of the neck and the longitidunal axis of the shaft (Fig. 4),

Proximal breadth (PB): maximum width between the head of the femur and the greater trochanter (Fig. 2),

Head vertical diameter (HVD): maximum vertical diameter of the femoral head (Fig. 3),

Head transverse diameter (HTD): maximum antero-posterior diameter of the head of the femur (Fig. 1),

Neck vertical diameter (NVD): minimum diameter of the neck of the femur at the supero–inferior direction (Fig. 3),

Neck transverse diameter (NTD): minimum diameter of the neck of the femur at the antero-posterior direction (Fig. 1),

Midshaft circumference (MSC): a tape followed the contour of the midshaft point of the body of the femur (Fig. 2),

Midshaft antero-posterior diameter (MSAPD): minimum antero-posterior diameter at the middle of the shaft of the femur (Fig. 5),

Midshaft transverse diameter (MSTD): minimum transverse diameter at the middle of the shaft (perimeter at the middle) (Fig. 5),

Distal breadth (DB): maximum width between the epicondyles of the femur (Fig. 2).

To avoid mismeasurement and to reduce the rate of error, all measurements were taken by the same author. For measuring diameters, lengths, and circumferences of the femur, a digital sliding caliper, osteometric board and a tapeline were used. The collo-diaphyseal angles were measured by a gonometer. Data were summarized as means ± standard deviation. The SPSS for Windows 10.0 program was used for the statistical analysis. Student's t-test was used to compare between right-left and contemporary-Chalcolithic Age femoral measurements. To determine the relationships between the femoral measurements, Pearson correlation coefficients were calculated and analysed.

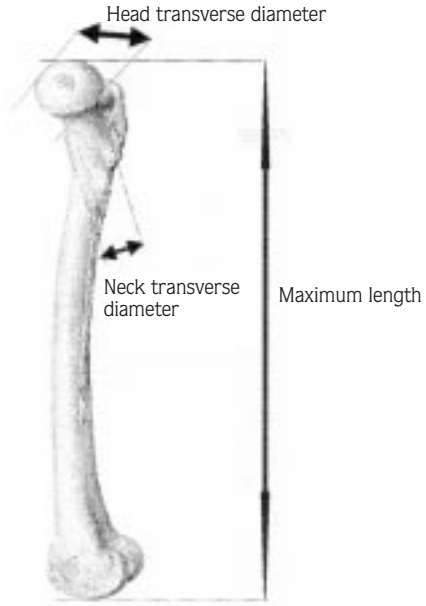

Figure 1. Illustrative diagram shows the maximum length, head transverse diameter and neck transverse diameter measurements of the femur.

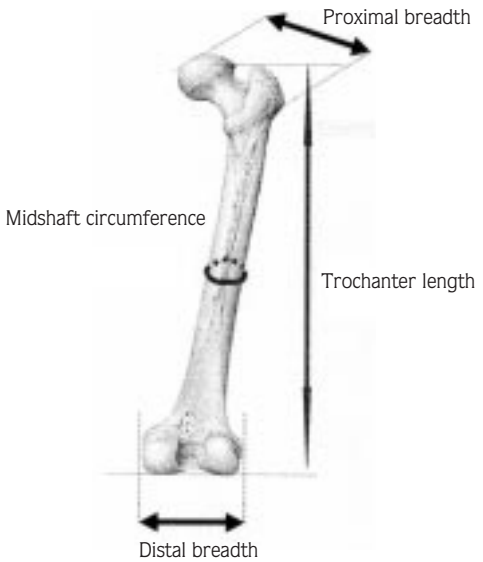

Figure 2. Illustrative diagram shows the trochanter length, midshaft circumference, proximal breadth and distal breadth measurements of the femur.

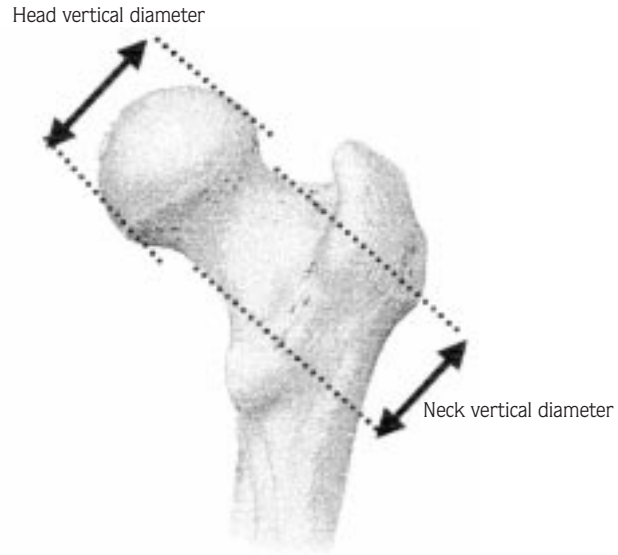

Figure 3. Illustrative diagram shows the head vertical diameter and neck vertical diameter measurements of the femur.

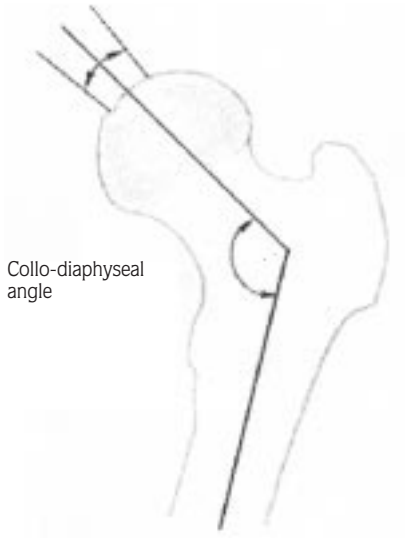

Figure 4. Illustrative diagram shows the collo-diaphyseal angle of the femur.

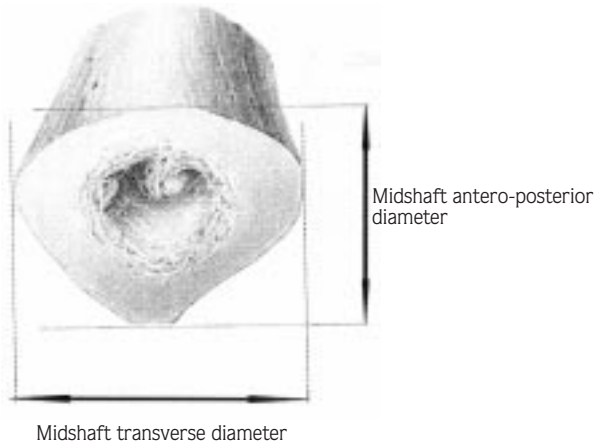

Figure 5. Illustrative diagram shows the midshaft antero-posterior diameter and midshaft transverse diameter measurements of the femur.

Results

Comparative statistics with the means and the standard deviations for each dimension of the contemporary individuals femora are presented in Table 1. The HVD of the right femur was significantly greater than the corresponding left femur ($p < 0.05$) (Table 1). The results of the measurements of the ML, TL, CDA, MSC, MSTD, and DB parameters of the left femur were generally shown to have greater values, but they were not significantly greater than the corresponding dimensions of the right femur. In contrast, although the measurements of the PB, HTD, NVD, NTD, and MSAPD in the right femur were not significantly greater than the corresponding dimensions of the left femur, they were shown to have higher values (Table 1). The statistical comparisons of the correlations of all measuring parameters are indicated in Table 2. Only with NTD, the CDA showed significant correlation ($p < 0.05$) (Table 2). All other parameters were significantly associated with each other ($p < 0.05$). The statistical results with the means and the standard deviation of 11 anthropometric measurements recorded from the study of 7 human femora from building layer IX of Şeyh Höyük, from the Chalcolithic Age are shown in Table 3. The comparative statistical results between the findings from the femora belonging to the Chalcolithic Age and those obtained from contemporary individuals showed significant differences in the CDA, HVD, HTD, MSC, MSTD and DB measurements. These results were found significantly greater in the contemporary individuals compared to the femora from the Chalcolithic Age ($p < 0.05$) (Table 3). Although mean values of ML, PB, NVD and NTD measurements did not significantly differ, the femora of contemporary individuals showed higher values than those from the Chalcolithic Age. In contrast, MSAPD was greater in the femora from the Chalcolithic Age but did not show a significant difference (Table 3).

Measurements	Left femur	Right femur	t	p
Maximum length	428.4 ± 24.9	416.8 ± 68.6	0.957	0.342
Trochanter length	405.4 ± 22.9	402.6 ± 28.1	0.461	0.642
Collo-diaphyseal angle	128.7 ± 4.7	127.6 ± 3.3	1.181	0.242
Proximal breadth	90.1 ± 7.0	90.2 ± 7.6	0.060	0.953
Head vertical diameter	43.4 ± 3.2	45.2 ± 4.0	2.055	0.044*
Head transverse diameter	44.3 ± 3.3	44.7 ± 4.1	0.546	0.584
Neck vertical diameter	30.6 ± 3.0	30.7 ± 3.6	0.082	0.935
Neck transverse diameter	25.5 ± 2.7	26.3 ± 3.1	1.233	0.222
Midshaft circumference	87.2 ± 7.6	86.2 ± 6.5	0.604	0.548
Midshaft antero-posterior diameter	26.8 ± 3.0	27.1 ± 3.0	0.460	0.647
Midshaft transverse diameter	26.8 ± 2.4	26.4 ± 2.4	0.790	0.432
Distal breadth	77.3 ± 5.2	76.8 ± 5.9	0.399	0.691

* $p < 0.05$

Table 1. Measurements of the femoral anthropometrics-Bilateral comparative results of the contemporary individuals femora. (mm, Mean ± SD).

Table 2. Correlation coefficients (r) between the femoral anthropometric measurements.

	DB	MSTD	MSAPD	MSC	NTD	NVD	HTD	HVD	PB	CDA	TL
ML	0.464*	0.277*	0.517*	0.453*	0.409*	0.420*	0.405*	0.497*	0.420*	0.224	0.481*
TL	0.497*	0.269*	0.569*	0.496*	0.516*	0.498*	0.457*	0.511*	0.486*	0.168	
CDA	0.169	0.057	0.194	0.184	0.248*	0.176	0.207	0.118	0.067		
PB	0.755*	0.579*	0.627*	0.758*	0.683*	0.717*	0.635*	0.804*			
HVD	0.835*	0.509*	0.621*	0.716*	0.814*	0.800*	0.714*				
HTD	0.646*	0.415*	0.486*	0.608*	0.547*	0.707*					
NVD	0.769*	0.534*	0.535*	0.709*	0.731*						
NTD	0.738*	0.534*	0.561*	0.667*							
MSC	0.769*	0.724*	0.754*								
MSAPD	0.576*	0.435*									
MSTD	0.624*										

* $p < 0.05$

Parameters	Contemporary İndividuals	Chalcolithic Age	t	p
Maximum length	422.5 ± 51.9	410.8 ± 27.2	0.584	0.561
Collo-diaphyseal angle	128.2 ± 4.0	119.6 ± 3.3	5.394	0.000*
Proximal breadth	90.2 ± 7.3	85.6 ± 8.7	1.545	0.126
Head vertical diameter	44.3 ± 3.7	41.2 ± 4.5	2.055	0.043*
Head transverse diameter	44.5 ± 3.7	40.0 ± 4.0	3.024	0.003*
Neck vertical diameter	30.6 ± 3.3	30.2 ± 3.4	0.287	0.775
Neck transverse diameter	25.9 ± 2.9	25.3 ± 2.2	0.483	0.631
Midshaft circumference	87.7 ± 7.0	80.9 ± 8.6	2.047	0.044*
Midshaft antero-posterior diameter	26.9 ± 3.0	27.7 ± 3.6	0.657	0.513
Midshaft transverse diameter	26.6 ± 2.4	24.2 ± 1.8	2.542	0.013*
Distal breadth	77.1 ± 5.5	70.2 ± 6.6	3.056	0.003*

* $p < 0.05$

Table 3. Femoral anthropometric measurements in contemporary (Central Anatolian) and Chalcolithic Age (Şeyh Höyük) individuals-Comparative results (mm, Mean ± SD).

Discussion

In the present study, the mean values of the lengths for the right and the left femora were found to be similar. Although the left femora were generally showed larger values than the right femora, they were not significantly greater, these results are in accordance with those of Strecker et al. (10). The statistical analysis of all measured parameters showed no significant differences between the right and left femora except for the vertical diameter of the right femoral head, which was significantly greater than those of the corresponding left femur. Femoral anthropometry from the two different time periods revealed a great amount of variations that are likely to be the results of variable factors such as nature of work, mode of life, continuous modifications that may affect the characteristics of man as well as the effects of civilization on the composition of the human body in both positive and negative ways. The appearance of the primitive traits in the long bones from Şeyh Höyük area were observed by Şenyürek (7). The study on the archaeobiology of bones and four anthropometric measurements of 2 human femora from building layer X of the Aksaray Acemhöyük area that was placed on the Assyria-Mesopotamia-Phoenicia trade routes (2000 B.C.) were performed by Deniz (11). These 4 anthropometric measurements of the 2 femora showed differences in their mean values when compared with the corresponding measurements of the contemporary femora, they were lower in their ML, higher in their DB and showed no differences in MSAPD and MSTD measurements (11). Studies by Steyn and İşcan reveal that all dimensions of the femur were larger in males than in females (12), but the determination of the sex of an individual from a single femur was a more difficult task (1). In our present study, the absence of any records that could help us in the determination of the sex of bones was the main obstacle to include. It seems obvious that anthropometric measurements could show differences between various populations from different ages, and these may considered to be constantly updated. The means of the ML measurement of the femora indicated that Central Anatolian contemporary individuals have retained longer femora when compared with those from Şeyh Höyük (5100-3000 B.C.).

However, it should be kept in mind that the present study and the previous studies have a small number of femora and while the results showed significant differences, it is worthwhile to perform a similar further study with a large number of bones from different age periods and from diverse population zones in Anatolia.

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