IJCMBS

THE INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND BIOLOGICAL SCIENCES e-ISSN: 2791-8815

Original Article

The Relationship of Inclination and Anteversion Angles in The Femur with Other Osteometric Parameters

Femurda İnklinasyon ve Anteversiyon Açılarının Diğer Osteometrik Parametreler İle İlişkisi

Gamze Taşkın Şenol[1]*, İbrahim Kürtül[1], Gülçin Ahmetoğlu[1], Abdullah Ray[1]

[1]Department of Anatomy, Faculty of Medicine, Bolu Abant Izzet Baysal University Bolu/TURKİYE

Corresponding author:

Gamze TAŞKIN ŞENOL

Adress:

Bolu Abant İzzet Baysal University, Faculty of Medicine, Department of Anatomy, Gölköy Campus, Bolu/TURKEY

E-mail:

rumeysagamzetaskin@ibu.edu.tr

Received: 09/01/2023

Accepted: 04/04/2023

Cite as: SENOL. GT and et al. The Relationship of Inclination and Anteversion Angles in The Femur with Other Osteometric Parameters IJCMBS 2023;3(2):82-8 doi.org/ 10.5281/zenodo.7919252

Highlights

- In clinically, anthropometric measurements are significant.
- At this point, it's essential to do clinical and anatomical research.

Abstract

Background: The aim of this study is to demonstrate the morphometry of the femur, the component of the bony framework of the hip and knee joint, as a basis for clinically successful and accurate analysis.

Materials and Methods: The study included 65 dry femur bones and parameters determined; the femur length (FL), length of the bicondylar femur (LBF), diameter of the caput femoris (DCF), anterioposterior diameter of the corpus femoris (APDCF), transverse diameter of the corpus femoris (TDCF), circumference of the corpus femoris (CCF), inclination angle (IA), anteversion angle (AA), circumference of the caput femoris (CACF), femoral neck width (FNW), anterior femoral neck length (AFNL), femoral neck axis length (FNAL), intertrochanteric distance (ID), femoral body length (FBL), femoral body width (FBW), bicondylar distance (BD), width of the condylus lateralis (WCL), width of the condylus medialis (WCM), height of the fossa intercondylaris (HFI), width of the fossa intercondylaris (WFI) and fossa intercondylaris shape index (FISI) were measured. **Results:** Mean±SD values of the determined parameters; FL; 42.2±2.7, LBF; 72.7±6.3, DCF; 74.5±6.1, APDCF; 44±4.1, TDCF; 27±2.3, CCF; 30.8±3, IA; 8.6±0.6, AA; 43.6±4.8, CACF; 16.5±4.4, FNW; 13.2±1.8, AFNL; 27.4±8.5, FNAL; 32.8±4.2, ID; 94.7±8.4, FBL; 73.4±8.8, FBW; 32.5±2.4, BD; 8.9±0.8, WCL; 32.6±4.4, WCM; 35.2±4.3, HFI; 16.7±4.1, WFI; 10.1±3.and FISI was calculated 0.6±0.2.**C onclusion:** The analysis of the parameters will add clinical depth to many surgical approaches such as more accurate analysis of femoral anomalies and fractures, strain and tendinopathies occurring in soft tissues. **Keywords:** Femur, morphometry, inclination angle, anterversion angle, index.

ÖZ

Amaç: Bu çalışmanın amacı kalça ve diz ekleminin temel bileşeni olan femur morfometrisini, klinik bilimlere temel veri niteliği sağlamasına zemin teşkil etme açısından ortaya koymaktır. **Gereç ve Yöntem:** Çalışmaya 65 adet kuru femur kemiği dahil edildi. Femur üzerinden belirlenen parametreler; femur uzunluğu (FU), bicondiler femur uzunluğu (BFU), caput femoris çapı (FBÇAP), corpus femoris anterior-posterior çap (CFAPÇ), corpus femoris transvers çap (CFTÇ), corpus femoris çevre (CFÇ), inklinasyon açısı (İA), anteversiyon açısı (AA), caput femoris çevresi (FBÇEV), collum femoris genişliği (CFG), collum femoris ön uzunluğu (CFÖU), collum femoris eksen uzunluğu (CFEU), intertrochenterik mesafe (İTM), corpus femoris uzunluğu (CFU), corpus femoris genişliği (CFEG), bicondiler mesafe (İEM), condylus lateralis genişliği (CLG), condylus medialis genişliği (CMG), fossa intercondylaris genişliği (FİY), fossa intercondylaris genişliği (FİG) ve fossa intercondylaris şekil indeksi (FİI) olarak ölçülmüştür. **Bulgular:** Belirlenen parametrelerin ort ± ss değerleri; FU; 42.2±2.7, BFU; 72.7±6.3, FBÇAP; 74.5±6.1, CFAPÇ; 44±4.1, CFTÇ; 27±2.3, CFÇ; 30.8±3, İA; 8.6±0.6, AA; 43.6±4.8, FBÇEV; 16.5±4.4, CFG; 13.2±1.8, CFÖU; 27.4±8.5, CFEU; 32.8±4.2, İTM; 94.7±8.4, CFU; 73.4±8.8, CFEG; 32.5±2.4, İEM; 8.9±0.8, CLG; 32.6±4.4, CMG; 35.2±4.3, FİY; 16.7±4.1, ve FİG ; 10.1±3 olarak bulunmuştur. Ayrıca FİI; 0.6±0.2 olarak hesaplanmıştır**.** **Sonuç:** Analiz sonuçlarının femur anomalileri ve kırıkların daha doğru analiz edilmesinde, strain ve tendinopatiler gibi birçok cerrahi yaklaşıma klinik açıdan derinlik katacağı düşünülmektedir**.** **Anahtar Kelimeler:** Femur, morfometri, inklinasyon açısı, anterversiyon açısı**,** indeks.

Introduction

The femur, the longest and strongest bone of the body, has two end parts called extremitas proximalis and extremitas distalis and a body called corpus femoris. The femur begins the ossification process after the clavicle and ossifies from five centers: corpus, caput, trochanter major, trochanter minor and extremitas distalis (1).
The upper end of the femur where the structures called caput femoris, collum femoris, trochanter major and trochanter minor are located is called the proximal femur. This is followed by the corpus femoris, which is almost cylindrical. The lower end, called extremitas distalis, is wider than the upper end and has tuberous structures called condylus medialis and condylus lateralis on the sides (2,3). The femur, together with the tibia and patella, forms the knee joint, the largest joint in the body. It makes the tibiofemoral joint with the tibia and the patellofemoral joint with the patella in the quadriceps tendon. The knee joint, which is surrounded by a fibrous capsule, provides mobility and carries body weight (3,4). The femur forms the hip joint, which connects the body to the lower extremity with the os coxae and can move in three axes and perform circulation (5). The femoral inclination angle (FA) occurs between the long axis of the collum femoris and the corpus femoris (6). It averages 126 degrees and varies during the growth process, in different geographical areas, in different periods and in different populations at a wide range of ages (7). This angle changes throughout early development and decreases with age and is lower in women than in men because the pelvic structure is wider (8). The clinical condition in which the IA increases is called coxa valga and the condition in which it decreases is called coxa vara. IA enables the caput femoris to adapt to the acetabulum and the body weight to be distributed evenly, thus ensuring coordinated movements in the hip. It has also been an important determinant in hip prosthesis designs (6). In the literature, it is also referred to as the collodiaphyseal angle or the neck-shaft angle (7). The femoral anteversion angle (AA) is defined as the inclination of the femoral neck axis on a plane projected perpendicular to the shaft axis with reference to the knee axis, or as an angulation with an opening between the femoral neck axis proximally and the axis passing through the femoral condyles distally (7). The anteversion angle is 30 degrees after birth and is expected to decrease to 15 degrees by adulthood. If this angle is greater than 20 degrees, it not only affects hip rotation, but also causes a decrease in hip external rotator and extensor muscle strength control (9). Anteversion, antetorsion, or anterotation to the clinical condition in which the anteversion angle increases anteriorly; The clinical condition in which it increases posteriorly is called retroversion, retrotorsion or retrorotation, and the absence of any angulation is called the neutral version (7). The femoral anteversion angle (AA) is defined as the inclination of the femoral neck axis on a plane projected perpendicular to the shaft axis with reference to the knee axis, or an angulation between the femoral neck axis proximally and the axis passing through the femoral condyles distally, with the opening facing forward (7). The anteversion angle is 30 degrees after birth and is expected to decrease to 15 degrees until adulthood. When this angle exceeds 20 degrees, it affects hip rotation and causes a decrease in hip external rotator and extensor muscle strength control (9). The clinical condition in which the anteversion angle increases anteriorly is called anteversion, antetorsion or anterotation; the clinical condition in which it increases posteriorly is called retroversion, retrotorsion or retrorotation, and the absence of any angulation is called neutral version (7). The femur is directly or indirectly involved in many clinical cases due to its morphologic features and position. Some problems that occur especially at the proximal end of the bone, which participates in the formation of the hip joint proximally and the knee joint distally, not only cause diseases related to the hip joint, but also cause rotational changes in other bones of the lower extremity, which may lead to abnormal conditions such as knee joint diseases and gait disturbance (2,3). In this study, the morphometric parameters, anteversion and retroversion angles of dry femur bones, which are clinically important, were measured. It is thought that the results of the analysis of the parameters determined in the study may be useful as a database for future anthropometric studies and may be useful in hip and knee prosthesis designs and in the correct analysis of hip and knee anomalies and fractures.

Materials and Methods

The study was initiated with the permission of Clinical Research Ethics Committee with decision number 2022/54.
In the present study, sixty-five (65) dry bone femurs of unknown age, sex and identity were measured in the anatomy laboratory. Partially broken, fragmented or damaged parts of the dry bones were not measured. A digital caliper (Baker 0-150 mm) with a sensitivity of 0.01 millimeter was used for the measurements on the femur and the values found were recorded as mm.

Measured Parameters (Figure 1):

• The femur length (FL)	• Intertrochanteric distance (ID)
• Length of the bicondylar femur (LBF)	• The femoral body length (FBL)
• Diameter of the caput femoris (DCF)	• The femoral body width (FBW)
• Anterioposterior diameter of the corpus femoris (APDCF)	• Bicondylar distance (BD)
• Transverse diameter of the corpus femoris (TDCF)	• Width of the condylus lateralis (WCL)
• Circumference of the corpus femoris (CCF)	• Width of the condylus medialis (WCM)
• Inclination angle (IA)	• Height of the fossa intercondylaris (HFI)
• Anteversion angle (AA)	• Width of the fossa intercondylaris (WFI)
• Circumference of the caput femoris (CACF)	• Fossa intercondylaris shape index (FISI).
• The femoral neck width (FNW)	• The anterior femoral neck length (AFNL)
• The femoral neck axis length (FNAL)	

Figure 1. Variables representation; A: AA (anteversion angle), **B:** FBL (femoral body length), **C:** FL (femur length), **D:** IA (inclination angle), **E:** FNW (femoral neck width), **F:** DCF (diameter of the caput femoris), **G:** FNAL (femoral neck axis length), **H:** HFI (height of the fossa intercondylaris), **I:** WFI (width of the fossa intercondylaris), **J:** WCM (width of the condylus medialis), **K:** WCL (width of the condylus lateralis), **L:** BD (bicondylar distance).

Statistical Analysis

Statistical analyses were performed using Minitab® 21.2 (64-bit) package program. The compatibility of the variables with normal distribution was tested with Anderson Darling test. Mean and standard deviation values were calculated for normally distributed variables and minimum, maximum and median values were calculated for non-normally distributed variables. The relationship between the variables was analyzed by Pearson correlation test. For directional discrimination of bones, Two Simple T Test was used for normally distributed variables and Mann-Withney U test was used for non-normally distributed variables.

Results

According to Anderson-Darling analysis, FL, APDCF, TDCF, IA, AA, CACF, FNW, AFNL, FNAL, ID, FBL, FBW, BD, WCM, WFI, FISI variables were not normally distributed, whereas LBF, DCF, CCF, WCL and HFI variables were normally distributed. The minimum (min), maximum (max), median and p value according to the Mann-Whitney U test results of the variables that did not show normal distribution are shown in **Table 1**.

The mean, standard deviation (Sd) and p-value of two simple t-test results of LBF, DCF, CCF, WCL and HFI variables are shown in the table. According to two simple t test results, no significant difference was found for the right and left bones **(Table 2).**

The Pearson correlation result table showing the relationship between IA and AA variables of the right femur and other variables is given below. According to the table, no correlation was found between the IA angle and other variables. According to the Pearson correlation test result, a moderate positive correlation was found between the AA variable and the FNW variable **(Table 3).** The Pearson correlation result table showing the relationship between IA and AA variables of the left femur and other variables is given below **(Table 4).** According to the table, no correlation was found between IA and other variables. There was a moderate positive correlation between the AA and HFI **(Table 4).**

Table 1. Variables that do not show normal distribution: direction, number of bones, minimum, maximum, median and p value*

Variables	Minimum		Maximum		Median		p
Direction (n)	R (39)	L (26)	R (39)	L (26)	R (39)	L (26)	
FL	35.3	36.3	48.4	46.9	42.3	42.2	0.32
APDCF	33.9	33.7	53.0	50.1	44.6	43.3	0.05[a]
TDCF	23.5	23.3	32.9	32.0	27.3	26.7	0.28
IA	7.6	7.6	10.2	9.7	8.7	8.6	0.54
AA	35	36	53	52	41.8	46.5	0.001[a]
CCF	7	8	25	22	18.2	14.2	0.001[a]
FNW	8.3	11.5	16.3	16	13.1	13.5	0.45
AFNL	16.4	21.7	36	44.7	22.4	34.1	0.001[a]
FNAL	24.6	26.4	41.2	40.6	32.7	32.8	0.99
ID	76.7	82.4	109.5	121.5	92.7	97.7	0.001[a]
FBL	48.1	43.1	91.1	88.3	74.2	72.3	0.10
FBW	28.7	27.3	40.8	36.1	32.6	32.4	0.12
BD	7.8	7.8	13.1	10.0	9.1	8.6	0.008[a]
WCM	27.2	29.8	45.8	45.3	34.1	37.0	0.002[a]
WFI	6.1	5.5	16.1	16.8	10.2	10.0	0.56
FISI	0.4	0.3	1.0	1.7	0.6	0.6	0.57

Abbreviations: (*): FL: Femur length, APDCF: Anterioposterior diameter of the corpus femoris, TDCF: Transverse diameter of the corpus femoris, IA: Inclination angle, AA: Anteversion angle, CCF: Circumference of the corpus femoris, FNW: Femoral neck width, AFNL: Anterior femoral neck length, FNAL: Femoral neck axis length, ID: Intertrochanteric distance, FBL: Femoral body length, FBW: Femoral body width, BD: Bicondylar distance, WCM: Width of the condylus medialis, WFI: Width of the fossa intercondylaris, FISI: Fossa intercondylaris shape index, R: Right, L: Left, n: Number of bones, ([a]): A significant difference was found as a result of the t-test.

Table 2. Direction, number of bones, mean, standard deviation (Mean±Sd) and p value of two simple t test result of normally distributed variables*

Variebles	**Mean±Sd**		**p**
Direction (n)	R (39)	L (26)	
LBF	72.3±6.7	73.4±3.8	0.43
DCF	74.5±6.5	74.5±3.7	0.97
CACF	30.9±2.7	31.7±2.6	0.21
WCL	32.0±3.8	33.5±3.9	0.14
HFI	17.0±3.9	16.3±3.8	0.45

Abbreviations: (*): LBF: Length of the bicondylar femur (LBF), DCF: Diameter of the caput femoris, CACF: Circumference of the caput femoris, WCL: Width of the condylus lateralis: HFI: Height of the fossa intercondylaris (HFI), R: Right, L: Left, n: Number of bones.

Table 3. Pearson correlation test result for the right femur bone*

	FL	**LBF**	**DCF**	**APDCF**	**TDCF**	**CCF**	**IA**	**AA**	**CACF**	**FNW**	**AFNL**
LBF	0.55										
DCF	0.57	0.94									
APDCF	0.23	0.16	0.14								
TDCF	0.44	0.40	0.40	0.10							
CCF	0.35	0.25	0.26	0.15	0.71						
IA	0.07	-0.19	-0.19	-0.01	-0.26	-0.08					
AA	0.16	0.26	0.19	0.05	0.33	0.27	0.08				
CACF	0.14	0.22	0.24	-0.06	0.13	-0.03	-0.08	0.07			
FNW	0.40	0.34	0.33	0.26	0.36	0.58	0.20	0.57	-0.14		
AFNL	0.25	0.03	0.02	0.02	0.27	0.50	0.10	0.20	-0.45	0.50	
FNAL	0.55	0.37	0.39	0.28	0.29	0.38	-0.21	0.07	-0.16	0.42	0.26
ID	0.44	0.32	0.28	0.37	0.30	0.36	0.21	0.06	-0.004	0.26	0.10
FBL	0.27	0.15	0.17	0.56	0.25	0.21	0.06	0.12	0.30	0.23	-0.09
FBW	0.56	0.24	0.27	0.27	0.34	0.21	0.07	0.29	0.16	0.33	0.23
BD	0.25	0.32	0.37	0.21	0.14	0.18	-0.14	-0.24	0.19	-0.01	-0.12
WCL	0.36	0.48	0.51	-0.04	0.16	0.10	0.03	0.07	0.13	0.21	0.02
WCM	0.31	0.46	0.45	0.06	0.17	0.12	0.06	0.10	0.10	0.24	0.06

HFI	0.40	0.36	0.39	0.05	0.17	-0.03	-0.26	0.03	-0.04	0.13	-0.003
WFI	0.30	0.22	0.25	-0.01	0.10	-0.12	-0.008	-0.14	0.20	-0.08	-0.08
FISI	-0.04	-0.08	-0.09	-0.05	-0.04	-0.10	0.24	-0.18	0.28	-0.19	-0.08
	FNAL	**ID**	**FBL**	**FBW**	**BD**	**WCL**	**WCM**	**HFI**	**WFI**		
LBF											
DCF											
APDCF											
TDCF											
CCF											
IA											
AA											
CACF											
FNW											
AFNL											
FNAL											
ID	0.17										
FBL	0.22	0.41									
FBW	0.30	0.38	0.51								
BD	0.39	0.44	0.20	-0.06							
WCL	0.24	-0.03	0.02	0.10	0.12						
WCM	0.21	0.01	0.02	0.11	0.05	0.90					
HFI	0.34	0.25	0.24	0.32	0.13	-0.01	-0.08				
WFI	0.14	0.17	0.35	0.33	0.14	-0.24	-0.31	0.57			
FISI	-0.16	-0.06	0.16	0.11	-0.01	-0.27	-0.26	-0.35	0.55		

Abbreviations: (*): FL: Femur length, APDCF: Anterioposterior diameter of the corpus femoris, TDCF: Transverse diameter of the corpus femoris, IA: Inclination angle, AA: Anteversion angle, CCF: Circumference of the corpus femoris, FNW: Femoral neck width, AFNL: Anterior femoral neck length, FNAL: Femoral neck axis length, ID: Intertrochanteric distance, FBL: Femoral body length, FBW: Femoral body width, BD: Bicondylar distance, WCM: Width of the condylus medialis, WFI: Width of the fossa intercondylaris, FISI: Fossa intercondylaris shape index, LBF: Length of the bicondylar femur, DCF: Diameter of the caput femoris, CACF: Circumference of the caput femoris, WCL: Width of the condylus lateralis: HFI: Height of the fossa intercondylaris.

Table 4. Pearson correlation test result for the left femur*

	FL	**LBF**	**DCF**	**APDCF**	**TDCF**	**CCF**	**IA**	**AA**	**CACF**	**FNW**	**AFNL**
LBF	0.53										
DCF	0.55	0.91									
APDCF	0.55	0.41	0.40								
TDCF	0.05	0.07	0.13	0.27							
CCF	0.31	0.28	0.38	0.47	0.64						
IA	0.01	0.02	0.03	0.10	0.40	0.01					
AA	0.35	0.26	0.10	0.45	0.11	0.09	0.09				
CACF	0.28	0.20	0.16	0.09	0.06	0.12	0.32	0.15			
FNW	0.64	0.44	0.38	0.91	0.29	0.42	0.04	0.39	0.21		
AFNL	0.33	0.34	0.28	0.45	0.17	0.15	0.002	0.32	0.34	0.50	
FNAL	0.55	0.33	0.28	0.83	0.11	0.37	0.02	0.38	0.14	0.87	0.58
ID	0.77	0.45	0.44	0.54	0.17	0.29	0.14	0.30	0.26	0.63	0.14
FBL	0.57	0.41	0.41	0.87	0.11	0.34	0.04	0.42	0.02	0.83	0.56
FBW	0.87	0.43	0.44	0.57	0.19	0.21	0.24	0.40	0.28	0.61	0.45
BD	0.33	0.39	0.35	0.60	0.65	0.58	0.26	0.25	0.29	0.76	0.22
WCL	0.46	0.47	0.60	0.42	0.17	0.14	0.27	0.22	0.03	0.36	0.46
WCM	0.43	0.32	0.48	0.36	0.11	0.19	0.16	0.03	0.05	0.36	0.43
HFI	0.65	0.43	0.32	0.52	0.08	0.41	0.08	0.52	0.07	0.52	0.12
WFI	0.23	0.10	0.06	0.23	0.19	0.20	0.19	0.17	0.12	0.27	0.14
FISI	0.46	0.30	0.25	0.19	0.23	0.07	0.10	0.22	0.07	0.17	0.22
	FNAL	**ID**	**FBL**	**FBW**	**BD**	**WCL**	**WCM**	**HFI**	**WFI**		
LBF											
DCF											
APDCF											
TDCF											

CCF											
IA											
AA											
CACF											
FNW											
AFNL											
FNAL											
ID	0.42										
FBL	0.73	0.42									
FBW	0.58	0.67	0.57								
BD	0.60	0.42	0.53	0.30							
WCL	0.44	0.40	0.35	0.55	0.12						
WCM	0.47	0.28	0.35	0.43	0.12	0.82					
HFI	0.58	0.48	0.45	0.60	0.32	0.25	0.20				
WFI	0.17	0.38	0.05	0.23	0.23	0.008	0.18	0.27			
FISI	0.34	0.05	0.33	0.42	0.03	0.19	0.36	0.57	0.51		

Abbreviations: (*): FL: Femur length, APDCF: Anterioposterior diameter of the corpus femoris, TDCF: Transverse diameter of the corpus femoris, IA: Inclination angle, AA: Anteversion angle, CCF: Circumference of the corpus femoris, FNW: Femoral neck width, AFNL: Anterior femoral neck length, FNAL: Femoral neck axis length, ID: Intertrochanteric distance, FBL: Femoral body length, FBW: Femoral body width, BD: Bicondylar distance, WCM: Width of the condylus medialis, WFI: Width of the fossa intercondylaris, FISI: Fossa intercondylaris shape index, LBF: Length of the bicondylar femur, DCF: Diameter of the caput femoris, CACF: Circumference of the caput femoris, WCL: Width of the condylus lateralis: HFI: Height of the fossa intercondylaris.

Discussion

In our study, there was no significant difference between the right and left femur on the normally distributed variebles, a significant difference was found between right and left bones in APDCF, AA, CCF, AFNL, ID, BD, WCM parameters.

In addition, a moderate positive correlation was found between AA angle and FNW variable on the right side, while a moderate positive correlation was found between AA and HFI variables on the left side.

There are two important aspects that affect hip joint movements and therefore hip joint space width. The inclination angle (collodiaphyseal angle) is the measure of the medial inclination of the proximal femur and acts as a lever especially for the abductor muscle group. In the anteversion angle (declination angle), the hip external rotator and extensor muscles are of great importance. Therefore, it is of great importance to evaluate the parameters of the femur, especially IA and AA.

In a study, those with and without hip fracture were compared and it was found that the mean values of IA and femoral neck width were higher in patients with hip fractures. They also stated that FNAL and FBW values were lower in those with hip fractures (10).

In another study investigating the IA value, 171 (83 right, 88 left) dry femurs were analyzed and AFNL was measured as 28.4 mm and IA was 126.7°, and the strong positive correlation between these two values ($r=0.773$, $p<0.001$)) can be used in the determination of IA during the prosthesis design phase in the surgical treatment of hip fractures (11).

When the literature was examined, no significant difference was found in the comparison of the right-left side in a study in which IA and femoral parameters were evaluated. In the same study, a significant negative correlation was found between the anterior and axial length of the femoral neck and IA ($r=-0.255$, $p=0.005$; $r=-0.190$, $p=0.038$). In addition, a strong positive correlation was observed between other proximal femur parameters except IA (6).

In our study, a moderate positive correlation was found between AA and FNW on the right side, and a moderate positive correlation between AA and HFI on the left side. In addition to these data, no correlation was found between IA and other variables on the left and right sides.

As a result of the inability to identify the dry femur bones that we used to make measurements in our study, the gender and age were not known, which limited our study. Due to this limitation, the accuracy rate of the measurement results in the estimation of age and gender could not be determined. In addition, the fact that the measurement results, which did not show a statistically significant difference between the right and left sides in our study, are not known how they are distributed according to age and gender limits their use, especially in the clinical field. We think that a study that includes femoral shape variations and the distribution of IA and AA values according to gender and age may yield more meaningful results.

Study Limitation

The study was severely constrained by the lack of information regarding the age, gender, and living circumstances of the individuals whose bones were included in the study.

Conclusion

This study is a cross-sectional study and although it does not reflect the entire population of Turkey, it gives general information in the context of the Bolu example. The literature review and the data obtained show that among long bones, sex determination from the femur gives the highest accuracy rates. The morphometric data obtained from the femur by various methods can be a reference for the studies planned for the problems encountered in the fields of anthropology, radiology, physiotherapy-rehabilitation and in the clinic. In addition, it has the potential to be a guiding resource for a better understanding of the radiological anatomy of the femur, for femoral fractures and conditions affecting the knee and leg, as well as for various operations such as knee joint prosthesis surgery and surgical interventions such as grafting. In the field of forensic medicine, these data provide data on the average dimensions of the femur. Moreover, knowing the anatomical localization of important arteries, veins and nerves associated with the sub-anatomical structures included and measured in femur-based topography will help prevent possible complications. We hope that the data obtained in our study will form a database for many clinical and basic science studies on femur morphology and morphometry. In addition, we think that it will be a source of inspiration for future studies on this subject.

Acknowledgements: None

Ethical Approval: *Permission was obtained from Bolu Abant Izzet Baysal University Clinical Research Ethics Committee with decision number 2022/54.*

Author Contributions: *Concept: GTS Literature Review: GTS, GA, AR Design: GTS, IK, GA, AR Writing manuscript: GTS, IK, AR, GA Critical revision of manuscript: GTS, IK*

Conflict of Interest: *The authors have no conflicts of interest to declare.*

Financial Disclosure: *Authors declared no financial support.*

References

1. Terzidis I, Totlis T, Papathanasiou E, Sideridis A, Vlasis K, Natsis K. Gender and Side-to-Side Differences of Femoral Condyles Morphology: Osteometric Data from 360 Caucasian Dried Femori. Anat Res Int. 2012;2012(1):1–6.
2. Muratlı HH, Selçuk E. Pediatrik femur diyafiz ve distal femur kırıkları. TOTBID Derg. 2019;18(10):431–42.
3. Senol RGT, Yucel AH. Evaluation and Categorization of Femur Morphometry with Digital Measurement Method. J Evol Med Dent Sci. 2019;8(41):3064–9.
4. Babacan S, Deniz M. Femur morphometry and correlation between proximal and distal parts. Cukurova Med J. 2022;47(1):50–61.
5. Oğuz B, Kartal E, Desdicioğlu K. Morphometric Investigation and Clinical Evaluation of the Proximal Femur and Acetabulum Structure. Turkish J Heal Res. 2021;1(3):20–32.
6. Açar G, Digilli B. Kuru femur kemiklerinde kollodiyafiz (inklinasyon) açı ile diğer osteometrik ölçümler arasındaki ilişki ve klinik önemi. Antropoloji. 2021;41:87–98.
7. Utkan A, Iğdir V, Arslan A, Esmer TŞ, Özkurt B. Fit assessment of two different anatomically contoured distal femur plate sets on cadaveric bones. Eklem Hast ve Cerrahisi. 2019;30(2):137–42.
8. Yarar B, Malas MA. Comparison of Measurements Made According to Anatomical and Proximal Femoral Axis in Terms of Femoral Collodiaphyseal Angle and Femoral Head Horizontal Offset. Kafkas J Med Sci. 2020;10(2):91–8.
9. Biswas A, Bhattacharya S. A morphometric and radiological study of the distal end of femur in West Bengal population. Ital J Anat Embryol. 2017;122(1):39–48.
10. Elkeiy MM, Khamis AA, El-Gamal MM, Abo Gazia MM, Zalat ZA, El-Magd MA. Chitosan nanoparticles from Artemia salina inhibit progression of hepatocellular carcinoma in vitro and in vivo. Environ Sci Pollut Res. 2020;27(16):19016–28.
11. Isaac B, Vettivel S, Prasad R, Jeyaseelan L, Chandi G. Prediction of the femoral neck-shaft angle from the length of the femoral neck. Clin Anat. 1997;10(5):318–23.