Int. J. Morphol.,
44(1):276-282, 2026.

Sex-Based Morphometric and Morphological Insights into the Head of Femur and Fovea for Ligament of Head of Femur

Perspectivas Morfométricas y Morfológicas Basadas en el Sexo de la Cabeza Ósea Femoral y de la Fóvea de la Cabeza Ósea Femoral

Esra Tekmen[1]; Sinem Nur Sever[2]; Mustafa Tolga Cirak[3]; Murat Golpinar[4]; Ibrahim Deniz Canbeyli[5] & Begumhan Turhan[1]

TEKMEN, E.; SEVER, S. N.; CIRAK, M. T.; GOLPINAR, M.; CANBEYLI, I. D. & TURHAN, B. Sex-Based morphometric and morphological insights into the head of femur and fovea for ligament of head of femur. *Int. J. Morphol., 44(1)*:276-282, 2026.

SUMMARY: This study investigated the sex-based morphometric and morphological parameters of the fovea for ligament of head of femur *(Fovea capitis ossis femoris)* (FCF) and head of femur (*Caput ossis femoris*). Measurements from 72 dry femurs were obtained using calipers and ImageJ software (Version 1.53q) on digital images. Results showed that, except for the head of femur area (FHA) and the vertical diameter of the head of femur (FHD-V) ($p>0.05$), most parameters were similar across sexes. Males exhibited significantly higher values of FHD-V and FHA ($p<0.05$). In contrast, females had higher mean values for the area of the FCF (A-FCF), foramina number, and both the longitudinal (LL-FCF) and transverse (TL-FCF) lengths of the FCF, but these differences were not statistically significant ($p>0.05$). Overall, the findings indicate that while most parameters did not differ significantly between sexes, males had larger vertical diameters and areas of the head of femur, whereas females tended to show higher but non-significant values in FCF-related parameters. These results provide valuable insights into the anatomical variations of the FCF and head of femur, highlighting subtle sex differences with potential clinical and anatomical relevance.

KEY WORDS: Head of femur; Hip joint; Fovea for ligament of head of femur; Ligament of head of femur.

INTRODUCTION

The fovea for ligament of head of femur (FCF) is generally located on the posteroinferior aspect of the head of femur. It serves as the attachment site for the ligamentum teres, also known as the ligamentum capitis femoris or the round ligament of the hip (Singh & Yadav, 2025). After originating from the FCF, the ligamentum teres inserts into the transverse acetabular ligament, which is a non-cartilaginous extension of the acetabular labrum located on the inferior aspect of the hip. Although its importance in hip stability is still debatable, isolated injuries, which make approximately 4–15 % of sports-related injuries, can cause hip pain. Congenital absence and attachment-site fractures are examples of lesions. The FCF is clinically significant for the preoperative identification of such lesions since the ligamentum teres is situated close to the fovea for ligament of head of femur (Cerezal *et al*., 2010; Singh & Yadav, 2025).

Several studies have emphasized that hip dislocation may be associated with rupture of the ligamentum teres. Hip dislocation commonly compromises the vascular supply to the head of femur, which is typically maintained by 2 to 4 arteries originating from the deep branch of the medial femoral circumflex artery. The lateral femoral circumflex artery also significantly contributes to vascularization. Additionally, it is shown that the profunda femoris artery supplies the head of femur via branches to the medial femoral circumflex artery (Zhao *et al*., 2021; Sun *et al*., 2023). Moreover, the obturator artery supplies the hip joint by the acetabular branch. The foveolar (ligamentum teres) artery, originating from the posterior branch of the obturator artery, supplies only the perifoveal region. In adults, it is typically vestigial and contributes minimally (Rajive & Pillay, 2015; Zhao *et al*., 2021).

[1] Baskent University, Faculty of Medicine, Department of Anatomy, Ankara, Turkey.
[2] Atilim University, Faculty of Medicine, Department of Anatomy, Ankara, Turkey.
[3] Hitit University, Faculty of Humanities and Social Sciences, Department of Anthropology, Corum, Turkey.
[4] Hitit University, Faculty of Medicine, Department of Anatomy, Corum, Turkey.
[5] Kirikkale University, Faculty of Medicine, Department of Orthopedics and Traumatology, Kirikkale, Turkey.

Received: 2025-09-26 Accepted: 2026-01-11

There are also nutrient foramina on the FCF, which serve as entry points for arteries supplying the head of femur. In conditions affecting the FCF, avascular necrosis can impair the development and formation of the head of femur. However, a higher number of nutrient foramina may lower the risk of osteonecrosis (Zhao *et al*., 2021; Gölpınar, 2022; Singh & Yadav, 2025). Alterations in the FCF have also been associated with hip dysplasia and osteoarthrosis (Gölpınar, 2022; Singh & Yadav, 2025). The head of femur receives blood supply through the fovea for ligament of head of femur (FCF), making its anatomical characteristics relevant to avascular necrosis. The FCF also plays a key role in hip arthroscopy, surgical planning, radiological assessment, and morphometric evaluation of the proximal femur (Roy *et al*., 2024; Singh & Yadav, 2025). Although previous studies have highlighted the vascular contributions of the ligamentum head of femur and head of femur (Migliorini *et al*., 2024; Singh & Yadav, 2025), data on sex-specific variations in FCF morphology and its association with femoral anatomy remain limited. This study investigates sex-based differences in the morphometric and morphological features of the FCF, focusing on its position, dimensions, classification, and correlation with proximal femoral parameters.

MATERIAL AND METHOD

Seventy-two adult dry femora (34 right, 38 left) of known sex (38 male, 34 female) without deformities were analyzed at Hitit University's Anatomy Department. Morphometric and morphological measurements of the fovea for ligament of head of femur (FCF) and proximal femur were performed following established protocols (Roy *et al*., 2024).

Digital images (mediolateral, craniocaudal, and anteroposterior) were obtained using a tripod-mounted Canon EOS 800D camera. ImageJ (v1.53, NIH, Bethesda, MD) was used for all image-based analyses, calibrated with a reference scale bar. FCF depth was measured with a digital caliper. Head of femur measurements included vertical (FHD-V) and anteroposterior (FHD-AP) diameters, head area (FHA) (Fig. 1), and neck-shaft angle (FIA). The center of the head of femur was identified via best-fit circle; anatomical and neck axes were determined based on femoral landmarks (Wu, 2017; Pastor-Pons *et al*., 2020). The FIA was calculated from anteroposterior images as the angle between the neck and shaft axes (Fig. 2). FCF measurements included longitudinal (LL-FCF) and transverse (TL-FCF) diameters, area (A-FCF), depth (D-FCF), and localization. Foramina number (FN) was counted visually and categorized as central or peripheral. FCF shapes were classified as oval, round, triangular, or piriform using Perumal's foveal index (FI = TL-FCF / LL-FCF × 100) (Perumal *et al*., 2017) (Fig. 3). The head of femur was divided into quadrants on mediolateral images, and FCF location was classified into six positional types (Fig. 4). Sex was determined by an anthropologist using long bone robustness and linea aspera morphology (White & Folkens, 2005). Each measurement was repeated three times, and 10% were reassessed by a second observer to ensure inter- and intra-observer reliability (Pastor-Pons *et al*., 2020).

Statistical analysis

Study data were analyzed using SPSS (version 25.0; SPSS, Chicago, IL, USA). The percentages of FCF localization and shape types, as well as foramina locations, were determined. Sex differences were assessed using Student's t-test, categorical variables with Pearson's chi-square test, and correlations between parameters with Pearson's correlation test. If the correlation coefficient's (r) absolute value fell between 0.2 and 0.4, it was considered weak correlation; if it fell between 0.4 and 0.6, it was considered moderate correlation. The threshold for statistical significance was set at $p<0.05$.

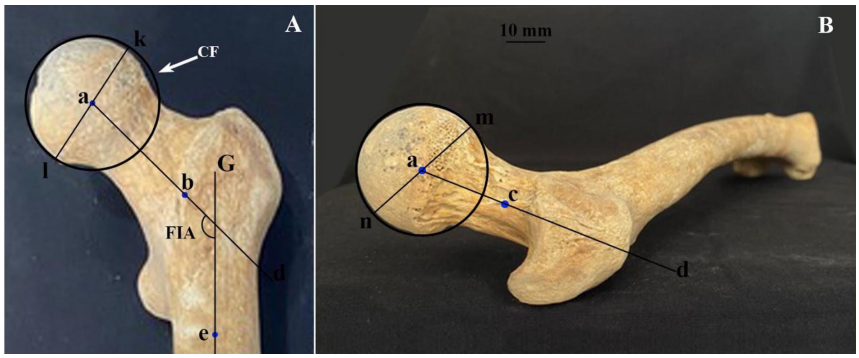

Fig. 1A. Anteroposterior image, B: craniocaudal image, CF: head of femur, a: head of femur center, b: the midpoint of the intertrochanteric line c: the midpoint of the neck of femur, ad: the neck of femur axis, e: the midpoint of the proximal femoral diaphysis, G: the femoral anatomical shaft axis, FIA: the femoral inclination angle, kl: vertical diameter of the head of femur (FHD-V), mn: anteroposterior diameter of the head of femur (FHD-AP).

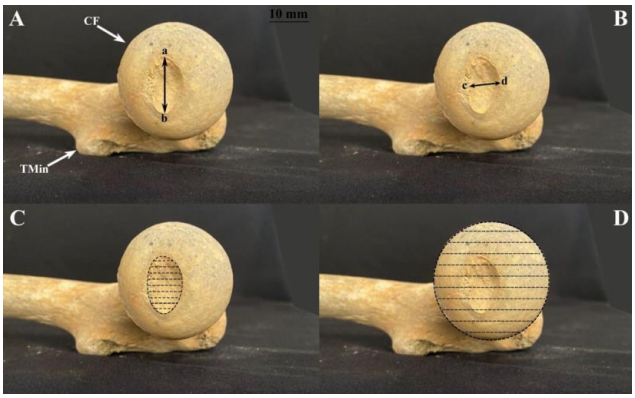

Fig. 2. Mediolateral view of the femur. A, a-b, Longitudinal length of the fovea for ligament of head of femur; B, c-d, transverse length of the fovea for ligament of head of femur, C, surface area of the FCF, D, surface area of the femoral head, CF: head of femur, TMin: Lesser trochanter.

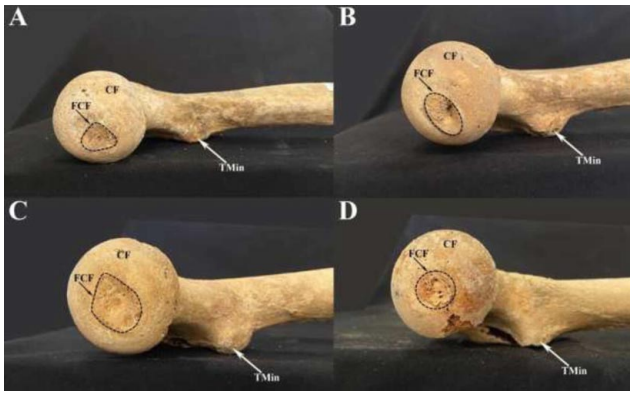

Fig. 3. The morphological shape types of the fovea for ligament of head of femur, A: triangular type, B: oval type, C: piriform type, D: round (or circular) type, CF: head of femur, FCF: fovea for ligament of head of femur, TMin: Lesser trochanter.

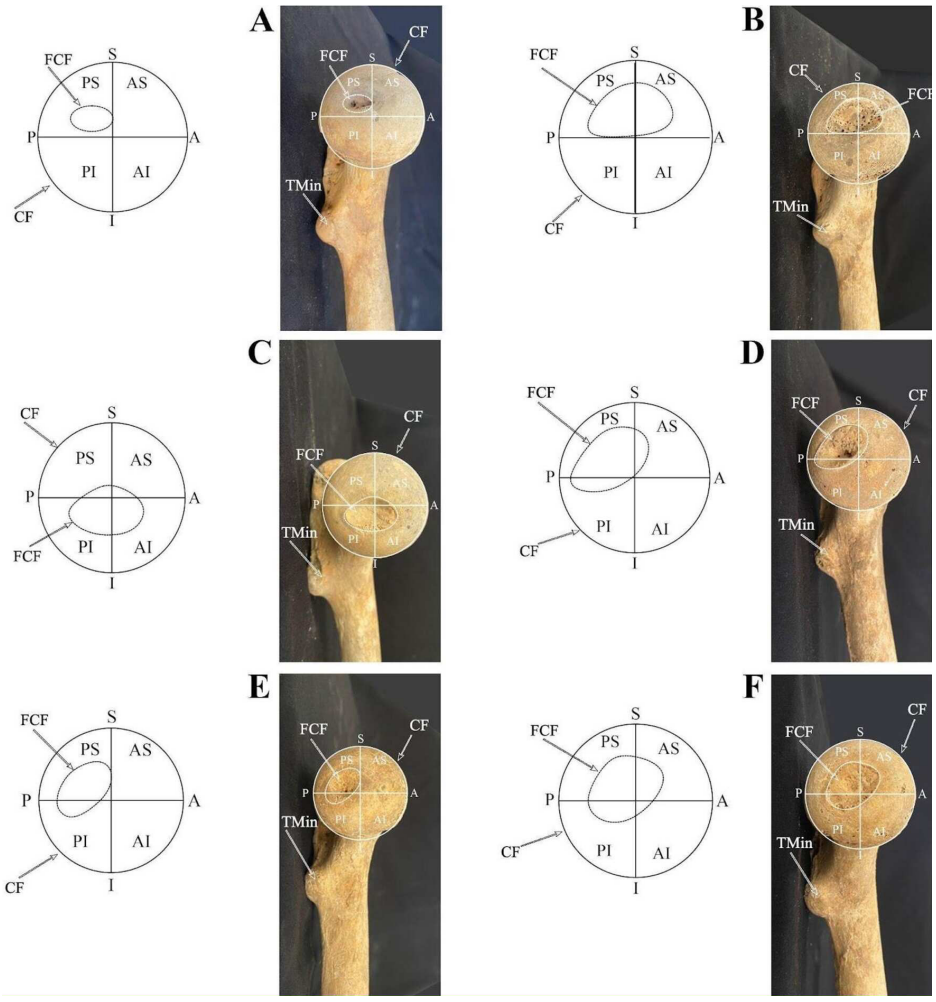

Fig. 4. The localization types of the FCF on mediolateral view of head of femur, A: Type 1, B: Type 2, D: Type 3, C: Type 4, E: Type 5, F: Type 6 CF: head of femur (HF), FCF: fovea capitis femoris, TMin: Lesser trochanter (LC), A: anterior, P: posterior, S: superior, I: inferior, AS: anterosuperior compartment, AI: anteroinferior compartment, PS: posterosuperior compartment, PI: posteroinferior compartment.

RESULTS

A total of 72 dry femurs were examined, comprising 34 females (47.2%) and 38 males (52.8%). The right bones of the limbs made up thirty-four of them. All femurs (n=72) have mean measurement values of 1.53±0.68, 1.09±0.45, 4.66±0.55, 3.82±0.40, 2,78±1.29, 13.14±2.84, 1.21±0.58, 13.11±12.31, 124.17±15.50, and 8.77±6.80 for LL-FCF, TL-FCF, FHD-V, FHD-AP, D-FCF, FHA, A-FCF, FHA/A-FCF, FIA, and FN, respectively. Table I displayed the bone measurement results and standard deviations (SD). With the exception of FHD-V and FHA, all parameters were comparable between the sexes ($p>0.05$). Males had higher FHD-V and FHA levels ($p<0.05$). Despite the fact that females had higher mean values for LL-FCF, TL-FCF, A-FCF, and foramina number, there was no significant difference between the sexes ($p>0.05$). Additionally, both sides' measured parameter values were comparable ($p>0.05$). At 5.6%, the FCF was only in the posteroinferior quadrant.

Based on the morphological features of the fovea for ligament of head of femur, the following morphological categories were identified: oval, circular, triangular, and piriform. The majority of the foramina (51.4%) were located in the central region. Table II shows that 6.9% of the head of femurs lack foramina.

The percentage distribution of the FCF shape types, foramina localization, and foramina localization did not significantly differ between the male and female sexes (Chi-

Table I. Morphometric measurements of femurs according to the sex.

Parameters	Female (Mean±SD)	Male (Mean±SD)	All individuals (Mean±SD)	T	*p*
LL-FCF (mm)	16.4±9	14.3±3.9	1,53±0,68	1.331	0.207
TL-FCF (mm)	11.3±5.3	10.5±3.6	1,09±0,45	0.712	0.488
FHD-V (mm)	43.8±4.8	49.1±4.9	4,66±0,55	-4.561	**0.001***
FHD-AP (mm)	36.9±3.2	39.4±4.3	3,82±0,40	-2.767	0.007
D-FCF (mm)	25.6±12.9	29.8±12.8	2,78±1,29	-1.376	0.173
FHA (mm^2)	1162±249	1450±243	13,14±2,84	-4.939	**0.001***
A-FCF (mm^2)	122±59	120±59	1,21±0,58	0.158	0.875
FHA/A-FCF	10.67±7.54	15.3±15.16	13,11±12,31	-1.609	0.112
FIA (º)	122.78±20.56	125.41±8.98	124,17±15,50	-0.717	0.476
FN	9.23±7.16	8.36±6.54	8,77±6,80	0.537	0.593

LL-FCF: Longitudinal length of fovea for ligament of head of femur, TL-FCF: Transverse length of fovea for ligament of head of femur, FHD-V: Femoral head vertical diameter, FHD-AP: Antero-posterior diameter of femoral head, D-FCF: Depth of fovea for ligament of head of femur, FHA: Femoral head area, A-FCF: Area of fovea capitis femoris, FIA: Neck-shaft angle, FN: Foramina number, *$p<0.05$ is statistically significant, Independent sample t-test

Table II. The number of cases and percentage distribution of the shape types of the FCF in terms of sexes.

	Fovea shape type			
	Oval	**Round/Circular**	**Triangular**	**Piriform**
Female	19	6	2	7
Male	25	1	6	6
Total n (%)	44 (61.1)	7 (9.7)	8 (11.1)	13 (18.1)
	Foramina localization			
	None	**Central**		**Peripheral**
Female	2	17		15
Male	3	20		15
Total n (%)	5 (6.9)	37 (51.4)		30 (41.7)
	Localization of fovea			
	Type 1	**Type 2**	**Type 3**	**Type 4**	**Type 5**	**Type 6**
Female	6	10	6	3	7	2
Male	12	10	6	1	5	4
Total n (%)	18 (25)	20 (27.8)	12 (16.7)	4 (5.6)	12 (16.7)	6 (8.3)

1: Centered at the posterosuperior of the head of femur; 2: Mainly centered at the posterosuperior of head of femur, additionally located inside the margins of the anterosuperior quadrant. 3: Mainly centered at the posterosuperior of the head of femur and additionally located inside the margins of all quadrants except the anteroinferior, 4: Mainly centered at the posteroinferior of the head of femur and additionally at all quadrants, 5: Mainly centered at the posterosuperior and located inside the margins of the posteroinferior of the head of femur, 6: Mainly centered at posterosuperior and additionally located at all quadrants, n: number of cases.

square (x^2): 6.264, 0.222, and 3.789, respectively, p>0.05). A-FCF and FN had a modest association (r=.359, p=0.001), while A-FCF and FHA had a moderate correlation (r=.457, p=0.001). Furthermore, as seen in Table III, all of the femur morphometric data by side were comparable (p>0.05).

The percentage distribution of the FCF shape types, foramina localization, and foramina localization did not significantly differ between the male and female sexes (Chi-square (x^2): 6.264, 0.222, and 3.789, respectively, p>0.05). A-FCF and FN had a modest association (r=.359, p=0.001), while A-FCF and FHA had a moderate correlation (r=.457, p=0.001). Furthermore, as seen in Table III, all of the femur morphometric data by side were comparable (p>0.05).

Table III. Morphometric measurements of femurs according to the side.

Parameters	Right (Mean±SD)	Left (Mean±SD)	t	*p*
LL-FCF (mm)	1.37±0.32	1.68±0.87	-1.941	0.056
TL-FCF (mm)	1.08±0.35	1.10±0.52	-0.165	0.869
FHD-V (mm)	4.76±0.54	4.57±0.54	1.511	0.135
FHD-AP (mm)	3.78±0.44	3.86±0.36	-0.790	0.432
D-FCF (mm)	2.60±1.16	2.94±1.39	-1.135	0.260
FHA (mm^2)	12.96±2.39	13.29±3.21	-0.487	0.628
A-FCF (mm^2)	1.10±0.51	1.31±0.63	-1.573	0.120
FHA/A-FCF	14.35±14.62	12±9.87	0.807	0.422
FIA (º)	121.77±20.59	126.31±8.55	-1.247	0.217
FN	9.17±6.99	8.42±6.71	0.467	0.642

LL-FCF: Longitudinal length of fovea for ligament of head of femur, TL-FCF: Transverse length offovea for ligament of head of femur, FHD-V: Head of femur vertical diameter, FHD-AP: Antero-posterior diameter of head of femur, D-FCF: Depth fovea for ligament of head of femur, FHA: Femoral head area, A-FCF: Area of fovea for ligament of head of femur, FIA: Neck-shaft angle, FN: Foramina number, *p<0.05 is statistically significant, Independent sample t-test.

DISCUSSION

In the present study, which investigated the localization of FCF on the head of femur, shape types, and bone morphometric properties by sex, most of the evaluated parameters were found to be similar between males and females. The FCF's location was found to be primarily focused posterosuperiorly to the head of femur. The majority of the four distinct forms of FCF that were found were oval in shape.

The relationship between proximal femur characteristics and different clinical situations, sex, ethnicity, and hip joint laterality has been the subject of numerous investigations (Maalman *et al*., 2023; Vlachos *et al*., 2023). Furthermore, anthropological sex assessment also uses proximal femur characteristics and FCF, particularly in situations where the pelvis is not available. Although FCF and proximal femur points are landmarks, little is known about how these metrics relate to one another by sex (Roy *et al*., 2024).

While previous studies reported five types of foveal localization (Cerezal *et al*., 2010; Perumal *et al*., 2017; Gölpınar, 2022), our analysis identified six distinct types. Consistent with earlier findings, the fovea for ligament of head of femur was generally located posterior to the head of femur, with only 5.6% observed in the posteroinferior quadrant—a lower rate compared to prior reports. In our study, the center was most frequently posterosuperior, occasionally extending into the anterosuperior quadrant. In contrast, Yarar *et al*. (2020) and Gölpınar (2022) found the center predominantly in the posteroinferior quadrant. Our results also support previous findings that the FCF is most commonly oval in shape (Cerezal *et al*., 2010; Gölpınar, 2022; Singh & Yadav, 2025). Perumal *et al*. (2017) identified oval as the dominant form but also noted circular and triangular variants. Similarly, both Yarar *et al*. (2020) and Gölpınar (2022) described four FCF shape types, including the piriform form, with oval being the most frequent.

Previous imaging studies using CT or MRI have measured the transverse diameter (TL-FCF) of the FCF in axial and coronal sections (Bensler *et al*., 2018; Ceynowa *et al*., 2019). Bensler *et al*. (2018), reported a wider FCF in asymptomatic males, differing from our findings. Similarly, Bertsatos *et al*. (2018) and Ceynowa *et al*. (2019) observed greater FCF width in males. In contrast, our study found no significant sex-based difference in TL-FCF. These discrepancies may stem from the use of fresh cadavers or living subjects in prior research, where ligamentous and

cartilaginous structures remain intact. In our dry bone analysis, the mean longitudinal length of FCF was 15.35 ± 6.88 mm, closely aligning with values reported by Yarar *et al*. (2020) (15.25 ± 2.86 mm) and Gupta *et al*. (2022) (15.94 ± 3.37 mm). The mean TL-FCF in our study (10.92 ± 4.51 mm) was slightly lower than those reported by Yarar *et al*. (2020) (12.00 ± 2.17 mm) and Gupta *et al*. (2022) (11.38 ± 2.35mm).

Consistent with Perumal *et al*. (2017), our study found a greater concentration of vascular foramina in the central region of the fovea for ligament of head of femur than in the periphery. However, unlike Perumal's findings, we observed no sex-based differences in the number or distribution of these foramina. A strong positive correlation was identified between the number of foramina, the size of the FCF, and the head of femur area—larger head of femurs were associated with a larger fovea and more vascular foramina. Although males exhibited a larger head of femur area, this did not translate into a higher foramina count compared to females.

Previous studies have suggested that a greater number of foramina may be protective against avascular necrosis (AVN) (Zhao *et al*., 2021). Our findings and those of Lai *et al*. (2020) indicate no significant sex-based difference in foramina count or AVN incidence. This supports the idea that AVN risk may not be sex-dependent, given its association with foramina number. Additionally, Philippon *et al*. (2014) and Late & Keche (2022) proposed that congenital absence of the ligamentum of head of femur could explain the lack of vascular foramina in certain individuals.

Without considering sex, Late & Keche (2022) measured the vertical length of the head of femur on dry bones and discovered no difference between the left and right bones. In the same way, our investigation found no variation between the vertical lengths of the left and right bones. Nonetheless, men's right and left bones were noticeably longer vertically than women's. A-FCF and FHA were assessed jointly in our study. To the best of our knowledge, only a small number of research have assessed and contrasted these two criteria (Perumal *et al*., 2017; Bertsatos *et al*., 2018; Yarar *et al*., 2020). Males had a bigger A-FCF than females, according to the Bertsatos *et al*. (2018) study, the only one currently in existence that did not compare the data by sex. We found in our study that there was no sex-based variation in A-FCF size.

Changes in the FCF's morphometric structure and location within the hip joint have been shown to have clinical significance. For instance, it has been observed that the FCF is located at a higher localization level in the head of femur in patients with hip dysplasia (Perumal *et al*., 2017). The FCF localization can be used to establish the head of femur's rotational location during the fixation procedure for femoral neck fractures (Singh & Yadav, 2025). The position of the fracture with respect to the FCF actually determines the kind of injury (kind I or Type II) in the "Pipkin classification" of femoral injuries (Sarkar *et al*., 2024). Additionally, the "femoral tunnel drilling technique" is employed in reconstructive surgery for the ligament of head of femur. Using this technique, the core of the FCF is traversed by the channel formed by opening the femoral neck (Bertsatos *et al*., 2018). One crucial element that has a big impact on the clinical results following total hip replacement is the hip rotation center (HRC) (Nieschk *et al*., 2023). In summary, accurate FCF localization is critical for clinical assessment and surgical planning. Surgeons may benefit from knowing how it relates to the head of femur center (HRC) when doing surgeries. However, there may be differences between the location of HRCs on dry bones and medical imaging. Comparative research using 3D imaging methods and dry specimens may help us better grasp the HRC–FCF relationship.

Regardless of sex, Late & Keche (2022) did not find any discernible variation in the femoral inclination angle between the right and left dry femur. Our study's results are consistent with those of Late & Keche (2022) who found no discernible change in the femoral inclination angle between the left and right femur bones, nor across sexes. There was no discernible sex difference in the neck-shaft angle in another investigation that used computed tomography to investigate the lower limbs (Ceynowa *et al*., 2019). The femoral neck-shaft angle did not significantly differ between males and females in our study.

CONCLUSION

This study analyzed FCF bone morphology in 72 femurs by sex. FHD-V and FHA values were greater in men, but there were no discernible sex or side differences in other parameters. In contrast to earlier research, the majority of FCFs were found in the posterosuperior quadrant. Most foramina were concentrated in for fovea for ligament of head of femur forms, which included oval, circular, triangular, and piriform shapes; FCF had no foramina. Differences in shape, foramina location, and sex were negligible. There was a mild association between A-FCF and FN and a moderate link between A-FCF and FHA. These discoveries provide important new information for anthropological and medicinal applications.

TEKMEN, E.; SEVER, S.N.; CIRAK, M.T.; GOLPINAR, M.; CANBEYLI, I.D. & TURHAN, B. Perspectivas morfométricas y morfológicas basadas en el sexo de la cabeza ósea del fémur y de fóvea de la cabeza ósea femoral. *Int. J. Morphol., 44(1)*:276-282, 2026.

RESUMEN: Este estudio investigó los parámetros morfométricos y morfológicos basados en el sexo, fóvea de la cabeza ósea (FCF) y la cabeza ósea del fémur. Se obtuvieron mediciones de 72 fémures secos mediante calibradores y el software ImageJ (versión 1.53q) en imágenes digitales. Los resultados mostraron que, excepto el área de la cabeza del fémur (FHA) y el diámetro vertical de la cabeza ósea del fémur (FHD-V) ($p > 0,05$), la mayoría de los parámetros fueron similares entre ambos sexos. Los hombres mostraron valores significativamente más altos de FHD-V y FHA ($p < 0,05$). Por el contrario, las mujeres presentaron valores medios más altos para el área del FCF (A-FCF), el número de forámenes y las longitudes longitudinal (LL-FCF) y transversal (TL-FCF) del FCF, pero estas diferencias no fueron estadísticamente significativas ($p > 0,05$). En general, los hallazgos indican que, si bien la mayoría de los parámetros no difirieron significativamente entre sexos, los hombres presentaron mayores diámetros verticales y áreas de la cabeza del fémur, mientras que las mujeres tendieron a mostrar valores más altos, aunque no significativos, en los parámetros relacionados con el FCF. Estos resultados proporcionan información valiosa sobre las variaciones anatómicas del FCF y la cabeza del fémur, destacando sutiles diferencias de sexo con potencial relevancia clínica y anatómica.

PALABRAS CLAVE: Cabeza femoral; Articulación coxal; Fovea para ligamento de la cabeza del fémur; Ligamento de la cabeza del fémur

.

REFERENCES

Bensler, S.; Agten, C. A.; Pfirrmann, C. W. & Sutter, R. Osseous spurs at the fovea capitis femoris—a frequent finding in asymptomatic volunteers. *Skeletal Radiol., 47(1)*:69-77, 2018.

Bertsatos, A.; Chovalopoulou, M.-E.; Giannaki, K. & Valakos, E. Morphological variation of the femoral head fovea capitis. *Eur. J. Anat., 22(5)*:397-402, 2018.

Cerezal, L.; Kassarjian, A.; Canga, A.; Dobado, M. C.; Montero, J. A.; Llopis, E.; Rolón, A. & Pérez-Carro, L. Anatomy, biomechanics, imaging, and management of ligamentum teres injuries. *Radiographics, 30(6)*:1637-51, 2010.

Ceynowa, M.; Roc?awski, M.; Pankowski, R. & Mazurek, T. The position and morphometry of the fovea capitis femoris in computed tomography of the hip. *Surg. Radiol. Anat., 41(1)*:101-7, 2019.

Gölpınar, M. Morphometric and morphological evaluation of the fovea capitis femoris. *Med. Rec., 4(3)*:400-4, 2022.

Gupta, M.; Devadas, D.; Sahni, C.; Nayak, A.; Tiwari, P. K. & Mishra, A. Morphometric analysis of the proximal femur with its clinical correlation in Eastern Uttar Pradesh region. *Cureus, 14(9)*:e28780, 2022.

Lai, S. W.; Lin, C. L. & Liao, K. F. Evaluating the association between avascular necrosis of femoral head and oral corticosteroids use in Taiwan. *Medicine (Baltimore), 99(3)*:e18585, 2020.

Late, S. V. & Keche, H. Morphometric study of proximal end of the fully ossified human femur: a cross-sectional study. *Cureus, 14(9)*:e29188, 2022.

Maalman, R. S. E.; Korpisah, J. K.; Ampong, K.; Darko, N. D.; Ennin, I. E.; Kpordzih, E. E.; Kumi, M. B.; Ali, M. A. & Adatara, P. Sex estimation using proximal femoral parameters of adult population in the Volta region of Ghana. *Forensic Sci. Int. Rep., 7*:100323, 2023.

Migliorini, F.; Cocconi, F.; Bardazzi, T.; Masoni, V.; Gardino, V.; Pipino, G. & Maffulli, N. The ligamentum teres and its role in hip arthroscopy for femoroacetabular impingement: a systematic review. *J. Orthop. Traumatol., 25(1)*:68, 2024.

Nieschk, C.; Abelmann-Brockmann, J.; Lisitano, L.; Fenwick, A.; Röttinger, H.; Ecker, M.; Mayr, E. & Röttinger, T. Clinical effects of different center of rotation reconstructions in total hip arthroplasty after femoral neck fractures: a cohort study including a follow-up analysis on patient's mobility and daily living ability. *J. Orthop. Traumatol., 24(1)*:58, 2023.

Pastor-Pons, I.; Lucha-López, M. O.; Barrau-Lalmolda, M.; Rodes-Pastor, I.; Rodríguez-Fernández, Á. L.; Hidalgo-García, C. & Tricás-Moreno, J. M. Interrater and intrarater reliability of cranial anthropometric measurements in infants with positional plagiocephaly. *Children (Basel), 7(12)*:306, 2020.

Perumal, V.; Woodley, S. J. & Nicholson, H. D. The morphology and morphometry of the fovea capitis femoris. *Surg. Radiol. Anat., 39(7)*:791-8, 2017.

Philippon, M. J.; Rasmussen, M. T.; Turnbull, T. L.; Trindade, C. A.; Hamming, M. G.; Ellman, M. B.; Harris, M.; LaPrade, R. F. & Wijdicks, C. A. Structural properties of the native ligamentum teres. *Orthop. J. Sports Med., 2(12)*:2325967114561962, 2014.

Rajive, A. V. & Pillay, M. A study of variations in the origin of obturator artery and its clinical significance. *J. Clin. Diagn. Res., 9(8)*:AC12, 2015.

Roy, T.; Basu, R. & Baisakhi, D. Morphological and morphometric variations of fovea capitis femoris: a cross-sectional study from Kolkata, West Bengal, India. *Int. J. Anat. Radiol. Surg., Sep, 13(5)*:AO14-AO18, 2024.

Sarkar, R.; Sarkar, S. & Sarkar, S. Management and outcome of Pipkin type I and type II femoral head fractures by Ganz surgical dislocation of the hip. *Cureus, 16(8)*:e67707, 2024.

Singh, R. & Yadav, N. Morphometry and morphology of the fovea capitis of the femoral head and its associated implications. *Cureus, 17(3)*:e79992, 2025.

Sun, G.; Fu, W.; Li, Q. & Yin, Y. Arthroscopic treatment of deep gluteal syndrome and the application value of high-frequency ultrasound. *BMC Musculoskelet. Disord., 24(1)*:742, 2023.

Vlachos, C.; Ampadiotaki, M. M.; Papagrigorakis, E.; Galanis, A.; Zachariou, D.; Vavourakis, M.; Rodis, G.; Vasiliadis, E.; Kontogeorgakos, V. A. & Pneumaticos, S. Distinctive geometrical traits of proximal femur fractures—original article and review of literature. *Medicina (Kaunas), 59(12)*:2131, 2023.

White, T. D. & Folkens, P. A. *The Human Bone Manual.* Burlington, Elsevier Academic Press, 2005.

Wu, C. C. Is clinical measurement of anatomic axis of the femur adequate? A radiographic verification. *Acta Orthop., 88(4)*:407-10, 2017.

Yarar, B.; Malas, M. A. & Çizmeci, G. The morphometry, localization, and shape types of the fovea capitis femoris, and their relationship with the femoral head parameters. *Surg. Radiol. Anat., 42(10)*:1243-54, 2020.

Zhao, K.; Zhang, F.; Quan, K.; Zhu, B.; Li, G. & Mei, J. Insufficient blood supply of fovea capitis femoris, a risk factor of femoral head osteonecrosis. *J. Orthop. Surg. Res., 16(1)*:414, 2021.

Corresponding author:
Begumhan Turhan
Baskent University
Faculty of Medicine
Department of Anatomy
Ankara
TURKEY

E-mail: begumhanturhan@baskent.edu.tr

Orcid ID:0000-0003-0842-2059