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PROXIMAL FEMORAL BONE MORPHOLOGICAL MEASUREMENT IN HUMAN ADULT DRY FEMUR

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ABSTRACT

Abstract: -

This study aims to contribute to the existing knowledge about the morphometry of the femur's proximal end and its variations across different populations. This may have implications for Hip joint pathology diagnosis (both congenital and acquired) and Prosthesis development for hip replacement. Furthermore, surgeons, clinicians, implant manufacturers, and researchers will find the study's findings valuable as a convenient resource for the Indian population. A multitude of characteristics and parameters have been utilized to qualitatively and quantitatively characterize the morphology of the proximal femur. The right FEMORAL HEAD LENGTH SUPERIORLY (FHLS) measures 35.11 mm, whereas the left FHLS measures 34.61 mm. FEMORAL HEAD LENGTH INFERIORLY (FHLI) measures 25.83 mm and 25.51 mm, respectively. There is a statistically significant side difference. The Intertrochanteric length value of 63.52 mm on the right side and 62.52 mm on the left

I Introduction:

In bygone eras, arthritic hip surgery was fraught with difficulty, with severe complications and failures. "The surgery of the century" is now regarded as hip arthroplasty.[1]People with problems related to the anatomy and function of the musculoskeletal system were historically referred to as "cripples" due to

the lack of knowledge about this kind of ailment. Surgical treatment of hip injuries often necessitates the use of appropriate surgical techniques and implants, necessitating ongoing study and innovation. The path to contemporary arthroplasty was laid by Chicagoan John Benjamin Murphy at the turn of the twentieth century. Murphy investigated the disease's anatomy and progression and gave it the label "malum coxae senilis." A rubber prosthesis was used by French surgeon Pierre Delbet in 1919 to replace the femoral head in the first effort at restoring joint surfaces. In 1927, Ernest W. Hey-Groves, a physician from Britain, used ivory, but in 1948, the Judet brothers used acrylic prostheses. Various developmental and acquired disorders can affect the morphometry of the femoral head, such as

Hip Dysplasia. It is thought that dysplastic hips result from axial pressure on an acetabulum that is not properly aligned. This may cause the labrum to partially detach or the acetabular rim to fatigue fracture.

Femoroacetabular Impingement Because of morphologic changes in the proximal femur or acetabulum caused by mild childhood developmental abnormalities.

Perthes Disease: One such disorder is Perthes disease, characterized by a congruent hip joint, often causing distress among pre-adults and young adults affected by the condition.

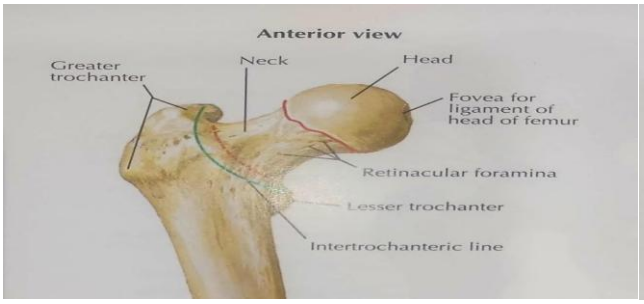
The Femoral Head Osteonecrosis: Osteotomies prevent subluxation and shear stresses on the femoral head by repositioning it in the acetabulum after osteonecrosis.

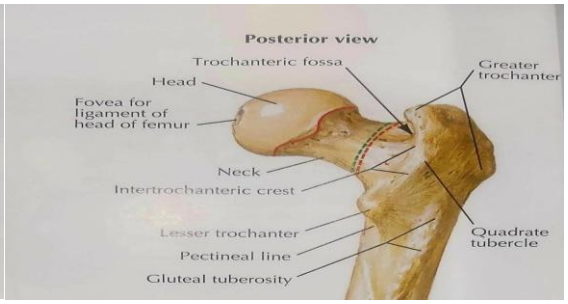
Acetabular Retroversion: Acetabular retroversion, a hip disorder, was first diagnosed in 1999 by Reynolds and colleagues. It occurs in 17% of dysplasia cases and is associated with osteoarthritis.

Intrauterine and Childhood Development: The proximal femur is an intricate formation that develops throughout the prenatal period of an infant's growth. Outgrowth of limb buds from ectodermal layer of ventrolateral wall's starts the process at 4 weeks.[11]Synovial joints, bones, cartilage, muscles, and tendons all originate in the mesodermal layer under the epidermis.[12]

Blood Supply of Femoral Head: The three separate artery systems that feed the circulation of blood to the femora near end are the foveal, capsular (retinacular), and intraosseous. The foveal blood supply, via the ligamentum teres, provides limited blood flow to the femoral head.

Proximal Femoral Geometry The typical angle according to Dr Paley, the angle b/w greater trochanter and center of femoral head is $90^0 \pm 5^0$, is known as the ―Lateral Proximal Femoral Angle‖ (LPFA) and $84^0 \pm 5^0$ on mechanical or anatomical axis is known as ―Medial Proximal Femoral Angle‖ (MPFA). The neck anatomic axis, also known as the ―Medial Neck-Shaft Angle‖ (MNSA), is another point of reference; it measures $130° \pm 10°$.[16] (Paley et al.,1994)





Anterior Aspect of Proximal End of Femur **Posterior Aspect of Proximal End of Femur**

The Extracapsular basi cervical area is described as the femoral neck-intertrochanteric junction. Where the Greater & Lesser trochanter of femur meet defines the intertrochanteric zone[18]Bone morphology is significantly impacted by racial/ethnic background, gender, lifestyle choices, and environmental variables.

II Material & Methods:

The investigation utilizes human cadaveric specimens consisting of dry femur bones. Cross-sectional observational study in the Department of Anatomy, Gajra Raja Medical College, Gwalior (M.P.) over a period of one year, wherein 100 human adult dry femora (50 Right and
50 left side bones) were studied.

SAMPLE SIZE CALCULATION: From the study of **GEETHANJALI (2019)**, using the estimated parameter.

$r=1, S_1=2.46$, $S_2=2.95$, $N_1=50$, $N_2=50$

$\mu 1$(NTD Mean for Right Femur) =2.46 $\mu 2$ (NTD Mean for Left Femur) =2.95n= 50 for the right femur and 50 for the left femur

Inclusion Criteria: Human adult dry femur specimens available for study in the Department of Anatomy, Gajra Raja Medical College, Gwalior (M.P.), and Specimens without evidence of pathological conditions affecting the proximal femur.

Exclusion Criteria: Specimens showing signs of trauma or post-mortem damage or structural abnormalities that could compromise accurate morphological measurement.

Instruments used

1. **Vernier Callipers-** This instrument is used to measure the length or breadth of tiny objects with more accuracy compared to a standard centimeter scale.
2. **Goniometer**

Quantitative Parameter used: Femoral head Vertical Diameter (FHVD), Femoral Head Transverse Diameter (FHTD), Femoral Neck Vertical Diameter (FNVD), Femoral Head Length Superiorly (FHLS), Intertrochanteric Length (IL), Neck Shaft Angle (NSA)

Qualitative Features: The subsequent characteristics are examined in relation to the proximal end of the femur: Femoral head: shape of femoral head, Fovea centralis: location of fovea centralis,

Femoral neck: appearance of anterior surface, Greater trochanter: shape and location, Lesser trochanter: location and shape., Intertrochanteric line: shape and location, Intertrochanteric crest: shape and location, luteal tuberosity: shape and location

RESULTS:

A Goniometer and Vernier Callipers were used to quantify certain quantitative dimensional parameters of 100 femur bones obtained from the Department of Anatomy, G.R. Medical College, Gwalior (M.P.). The bones were divided evenly between the right and left sides, with 50 bones on each side, and a comparison was made between the two sides. The attributes of femora from both right and left sides were documented and organised into a table. The mean and std deviation were then computed. To enable a direct comparison, a student t-test with two tails was employed. For every analysis, a significance level of 5% ($P<0.05$) was employed.

1. Comparative Analysis of FHVD of both sides (Mean and SD in mm)

	FHVD	
	Right	**Left**
N	50	50
Mean	38.65	38.97
Std. Deviation	2.3305	2.2732
t	117.271	121.221
df	49	49
P Value	0.000	0.000
Inference	Significant	

2. Comparative Analysis of FHTD both sides (Mean and SD in mm)

	FHTD	
	Right	**Left**
N	50	50
Mean	36.32	35.82
Std. Deviation	2.6434	2.6434
t	97.157	95.82
df	49	49
p value	0.000	0.000
Inference	Significant	

3. Comparative Analysis of FNVD of both sides (Mean and SD in mm)

	FNTD	
	Right	**Left**
N	50	50
Mean	27.06	27.06
Std. Deviation	2.9445	2.9445
t	64.984	62.583
df	49	49
p Value	0.000	0.000
Inference	Significant	

4. Comparative Analysis FHLS of both sides (Mean and SD in mm)

	FHLS	
	Right	**Left**
N	50	50
Mean	35.11	34.61
Std. Deviation	2.8451	2.8451
t	87.26	86.017
df	49	49
Sig. (2-tailed)	0.000	0.000
Inference	Significant	

5. Comparative Analysis of FHLI of both sides (Mean and SD in mm)

	FHLI	
	Right	**Left**
N	50	50
Mean	25.83	25.51
Std. Deviation	2.3378	2.417
t	78.126	74.632
df	49	49
p Value	0.000	0.000
Inference	Significant	

Femoral Parameters were noted as:

Measurement		N	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Inference
FHVD	Right	50	38.65	2.3305	117.271	49	0.000	Significant Difference
	Left	50	38.97	2.2732	121.221	49		
FHTD	Right	50	36.32	2.6434	97.157	49	0.000	Significant Difference
	Left	50	35.82	2.6434	95.82	49		
FNVD	Right	50	27.92	3.0828	64.04	49	0.000	Significant Difference
	Left	50	26.92	3.0828	61.747	49		
FNTD	Right	50	27.06	2.9445	64.984	49	0.000	Significant Difference
	Left	50	26.06	2.9445	62.583	49		
FHLS	Right	50	35.11	2.8451	87.26	49	0.000	Significant Difference
	Left	50	34.61	2.8451	86.017	49		
FHLI	Right	50	25.83	2.3378	78.126	49	0.000	Significant Difference
	Left	50	25.51	2.417	74.632	49		

Discussion

The Femur is the most extended and most robust bone in the human body. This Bone is composed of a central part (shaft) and two extremities, one closer to the centre (proximal) and the other farther out (distal). A variety of conditions, including inflammation, degeneration, tumours, and injuries, can affect the femur as a result of its distinctive anatomical configuration, physiological location, and functional function. A comprehensive comprehension of the femur's anatomical composition and dimensions is imperative in order to devise and execute surgical strategies for femoral disorders. A hip arthroplasty's efficacy is contingent upon proper joint component insertion, precise prosthesis selection, and adequate sizing.[60] The long-term success of Total Hip Replacement surgery depends on the alignment of the prosthetic limb with surgically excised portion of the Hip. There is a vast amount of proof that can be found in many research papers that demonstrate the differences in the femoral head size among different races. The heredity which plays the considerable role in determining morphology of femora is an idea that affects individuals of different races uniquely. [75] An implant that is not properly adjusted or designed may lead to limited movements, undone surgical gestures, and needs of an additional surgery such as a fracture that occurs during the operation.

1.Comparing the (FHVD) with the findings reported in existing international literature (in mm)

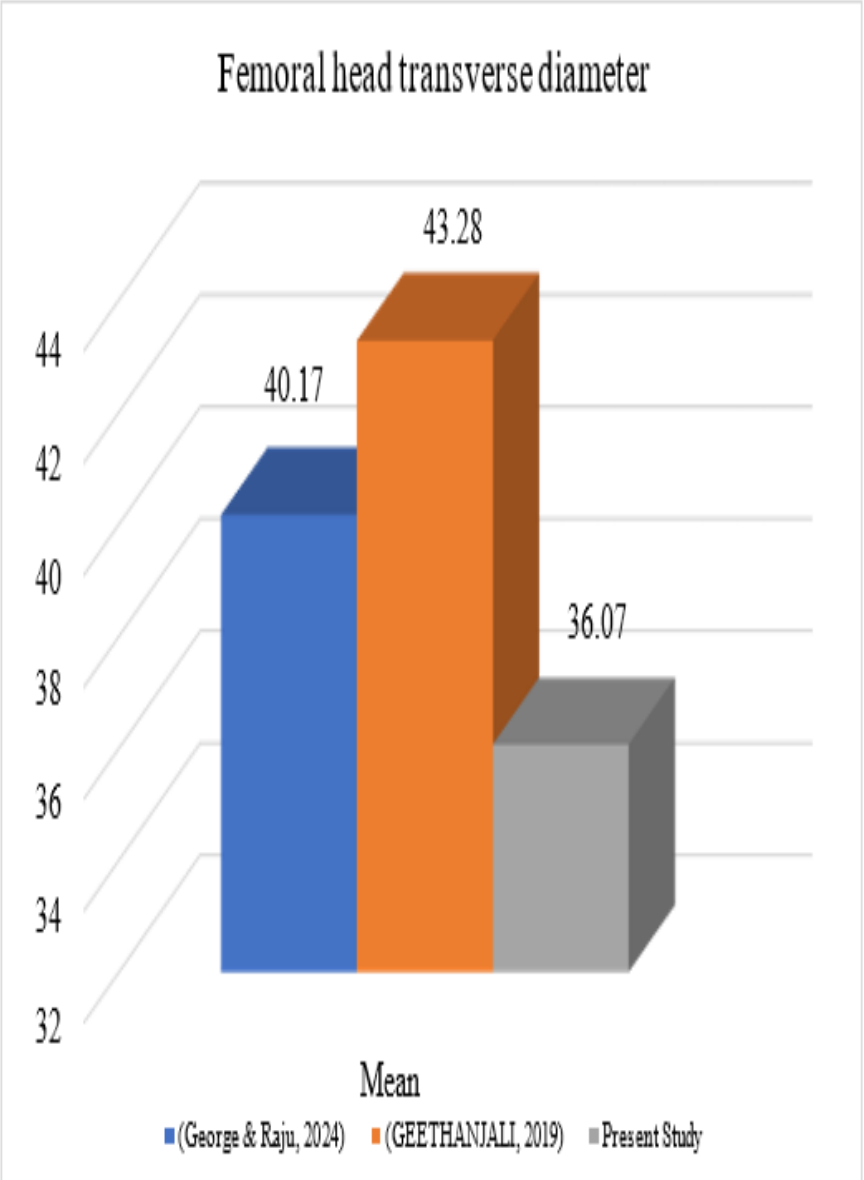
Author and Year	Ethnic Demography	Mean
Babacan and Deniz (2022)[79]	Turkey	45.46
Özandaç et al., (2015)[80]	Turkey	44.2
Tokpınar et al. (2020)[42]	Turkey	43.29
Lakati and Orth (2017)[81]	Kenya	42.6
Dewo et al. (2016)[67]	Indonesia	45.35
Branco de Sousa et al. (2010)[46]	Brazil	31.1
Iyem et al., (2014)[82]	Turkey	48.1
Umer et al., (2010)[83]	Pakistan	50.1
Caetano, Serafim and Padoveze, (2007)[34]	Brazil	41.95
Jamali et al., (2013)[36]	USA	46.47
Young et al., (2013)[37]	USA	52.05
Tang, Yeoh and Tan, (2017)[66]	China	43.88
Tang, Yeoh and Tan, (2017)[66]	Malay	42.92
Present Study	**India (Central)**	**38.81**

2. Comparing the FHVD with the findings reported in existing Indian literature (in mm)

Author and Year	Ethnic Demography	Mean
Ghosh et al. (2020)[41]	India (East)	38.31
George and Raju, (2024)[84]	India (South)	39.61
Gupta et al. (2022)[85]	India (North)	41.59
Verma et al., (2017)[86]	India (North)	42.32
Geethanjali, (2019)[53]	India (South)	41.9
Murlimanju et al. (2012)[49]	India (South)	41.5
Present Study	**India (Central)**	**38.81**

Comparing the mean FHTD with research published in literature (in mm)

Author and Year	Ethnic Demography	Mean
George and Raju, (2024)[84]	India (South)	40.17
Geethanjali, (2019)[53]	India (South)	43.28
Present Study	**India (Central)**	**36.07**

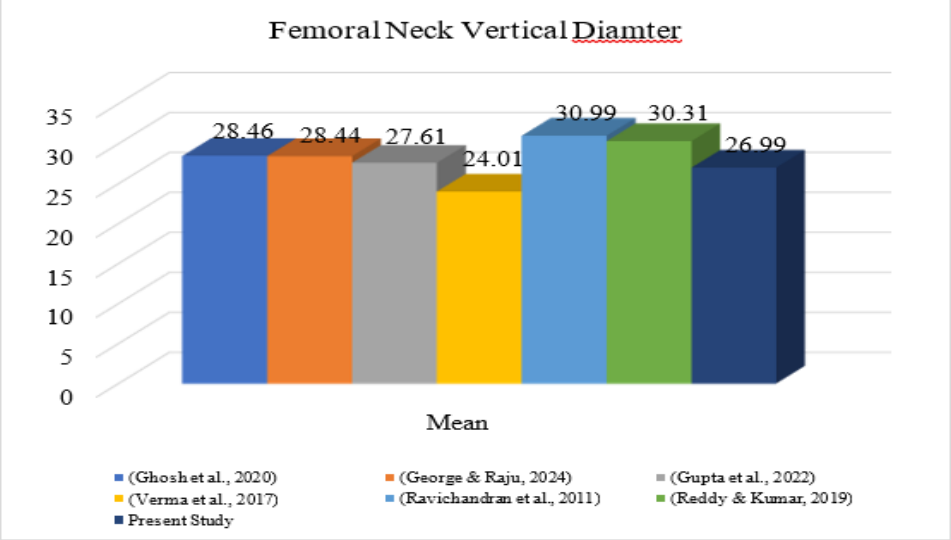


3. Examining the Present Study's mean FNVD in Light of Previous Research

Author and Year	Ethnic Demography	Mean
Özandaç et al., (2015)[80]	Turkey	30.4
Mukhia et al., (2019)[87]	Nepal	29.4
Tokpınar et al., (2020)[42]	Turkey	30.93
Lakati and Orth, (2017)[81]	Kenya	29.36
Iyem *et al.* (2014)[82]	Turkey	35.4
Caetano, Serafim and Padoveze, (2007)[34]	Brazil	28.75
Tang, Yeoh and Tan, (2017)[66]	China	34.39
Tang, Yeoh and Tan, (2017)[66]	Malay	33.46
Present Study	**India (Central)**	**26.99**

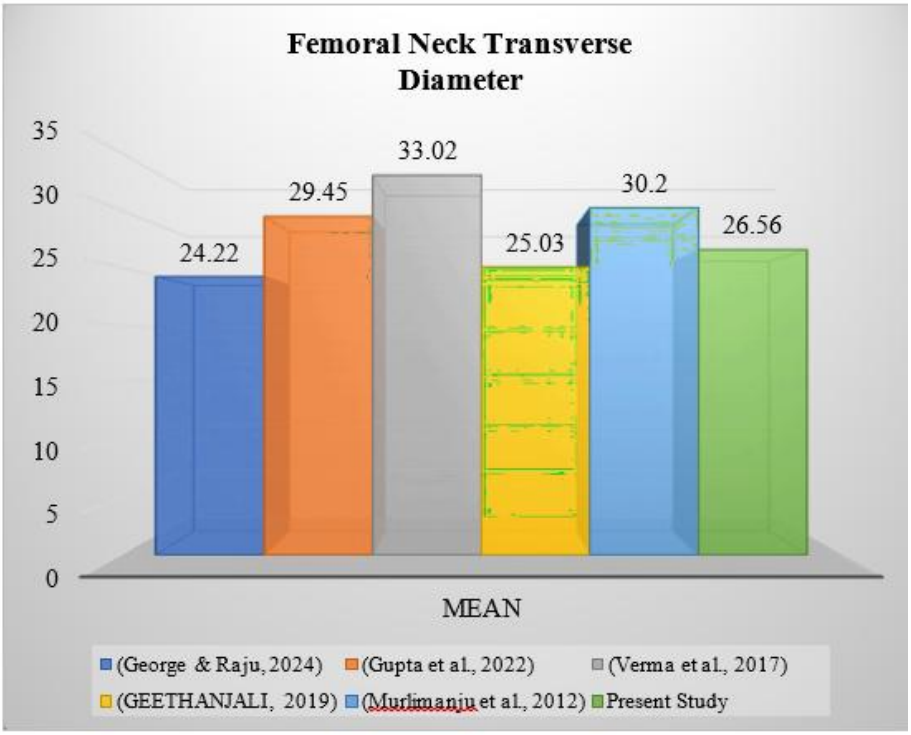
Examining the Present Study's mean FNVDin Light of Previous Research in India

Author and Year	Ethnic Demography	Mean
Ghosh et al., (2020)[41]	India (East)	28.46
George and Raju, (2024)[84]	India (South)	28.44
Gupta et al., (2022)[85]	India (North)	27.61
Verma et al., (2017)[86]	India (North)	24.01
Ravichandran et al., (2011)[88]	India (South)	30.99
Reddy and Kumar, (2019)[89]	India (South)	30.31
Present Study	**India (Central)**	**26.99**



4. Examining the Current Study's Mean FNTD in Relation to Published Literature in India

Author and Year	Ethnic Demography	Mean
George and Raju, (2024)[84]	India (South)	24.22
Gupta et al., (2022)[85]	India (North)	29.45
Verma et al., (2017)[86]	India (North)	33.02
GEETHANJALI, (2019)[53]	India (South)	25.03
Murlimanju et al., (2012)[49]	India (South)	30.2
Present Study	**India (Central)**	**26.56**

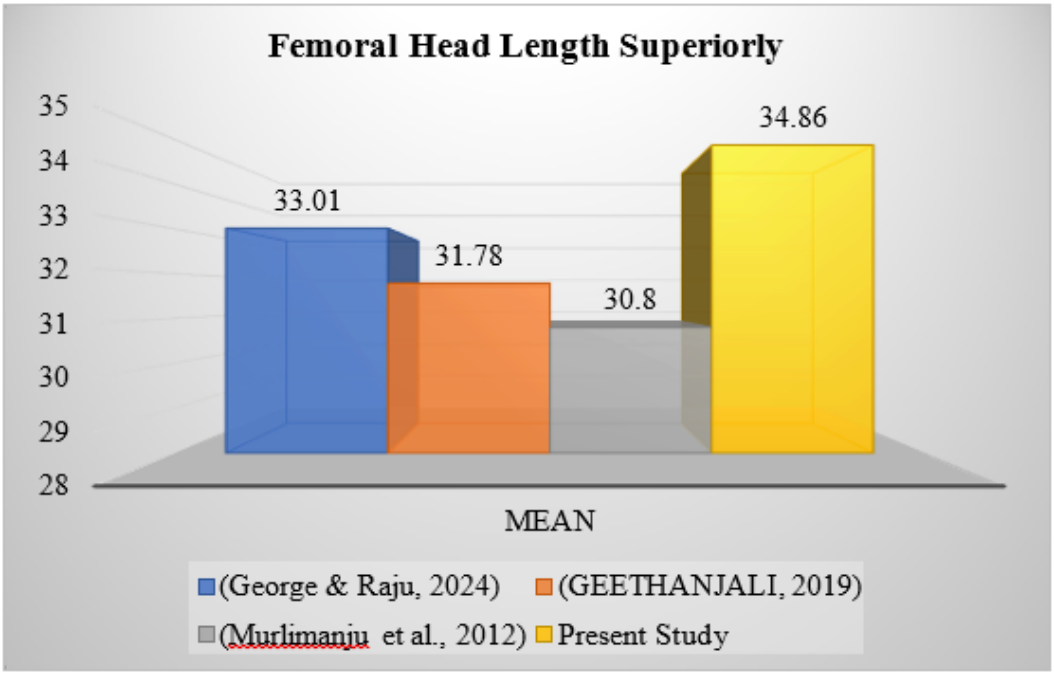


5. Comparison of Current Study Mean Neck Length to Published Literature

Author and Year	Ethnic Demography	Mean
Özandaç et al., (2015)[80]	Turkey	22.25
Mukhia et al., (2019)[87]	Nepal	41.2
Tokpınar et al., (2020)[42]	Turkey	26.01
Oyebiyi et al., (2021)[90]	Nigeria	22.9
Branco de Sousa et al., (2010)[46]	Brazil	30.1
Iyem et al., (2014)[82]	Turkey	30.8
Present Study	**India (Central)**	**25.76**

6.Comparing Mean FHLS in Current Study with Published Literature

Author and Year	Ethnic Demography	Mean
George and Raju, (2024)[84]	India (South)	33.01
Geethanjali, (2019)[53]	India (South)	31.78
Murlimanju et al., (2012)[49]	India (South)	30.8
Present Study	**India (Central)**	**34.86**



7.Comparing Mean FHLI in Current Study with Published Literature

Author and Year	Ethnic Demography	Mean
George and Raju, (2024)[84]	India (South)	23.88
Geethanjali,(2019)[53]	India (South)	22.8
Murlimanju et al., (2012)[49]	India (South)	21.2
Present study	**India (Central)**	**25.67**

SUMMARY AND CONCLUSION:

This study aims to contribute to the existing knowledge about the morphometry of the femur's proximal end and its variations across different populations. This may have implications for:

- Hip joint pathology diagnosis (both congenital and acquired).

- Prosthesis development for hip replacement.
- Allowing the prediction of prognosis based on the measurement and mechanical properties of the pelvic girdle, and enabling early and suitable rehabilitation to minimize the likelihood of problems.
- Furthermore, surgeons, clinicians, implant manufacturers, and researchers will find the study's findings valuable as a convenient resource for the Indian population.

Quantitative measurements were made, and the resulting data was obtained. -

- The FHVD is measured to be 38.65 mm on right and 38.97 mm on the left. When comparing the two sides, a significant side difference is seen.
- The results show that the FHTD is 35.82 mm on left side and 36.32 mm on the right. There is a noticeable side difference.
- Right and left, the FNVD measures 27.92 mm and 26.92 mm, respectively. There is a noticeable side difference.
- The mean left and right dimensions of the FNTD are 27.06 mm. displaying a statistically no significant difference.
- The right FHLS measures 35.11 mm, whereas the left FHLS measures 34.61 mm. There is a statistical side difference.
- Right and left, the FHLI measures 25.83 mm and 25.51 mm, respectively. There is a statistically significant side difference.
- Both left and right sides of the FNLS measure 25.45 mm and 25.93 mm, respectively. There is a noticeable side difference.
- On the right side, the FNLI is 25.34 mm, and on the left side, it's 26.34m. A distinction between sides is apparent.
- The Intertrochanteric length value of 63.52 mm on the right side and 62.52 mm on the left. There is a statistical disparity between the two sides.
- The mean neck shaft angle of the right side is 132.62 degrees, whereas that of the left femora is 130.5 degrees. There is a statistical disparity between the two sides.

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