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ANTHROPOMETRIC MEASUREMENT OF DRY FEMORAL OF ADULT POPULATION FOR CLINICAL APPLICATION – A DESCRIPTIVE STUDY

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ABSTRACT **Introduction:** Anthropometric measurements of the femur have shown variation amongst different population groups. The variation in these measurements poses a challenge for an implant and prosthesis design. **Aim:** The present study evaluated the possible variation in measuring femoral length, femoral neck length, neck, anteversion, shaft angle, and femoral notch values in a dry femoral adult population. **Methods:** This descriptive study was conducted at Mahatma Gandhi medical college and research institute Pondicherry. The study was done on 50 cadaveric specimens. The femur length, head diameter, neck shaft angle, anteversion, neck length, notch depth, and notch width was measured with the help of standard techniques, and represented statistically **Results:** The mean femur length was 43.13 cm, the mean head diameter was 42.68 mm, the mean neck shaft angle was 127.8 mm, the mean anteversion was 11.92 mm, the mean neck length was 38.30 mm, the mean notch depth was 29.45 mm, and the mean femur notch width was 21.25 mm. **Conclusion:** This study further proves requirement of region-specific prosthetic design and need of further large scale studies for different ethnicities to prevent mismatch of implants

KEYWORDS : Dry femoral, Anthropometric, Neck shaft angle, Anteversion, Femur notch, Head diameter

INTRODUCTION

The human femur underwent a considerable functional change during the evolution of upright bipedalism. One of the most common locations for orthopaedic surgical treatments is the proximal femur.[1] These operations aim to restore normal anatomy of the limb. Implants for femoral fracture healing, reconstruction, and replacement have typically been designed with the anthropometry of the Western population in mind, which is distinct from that of other ethnic groups.[1-2] Due to the vast anatomical differences across populations, commercially available prostheses may not be the optimal fit for all individuals. The femur's osteology is essential for designing a correctly sized total hip replacement (THR) and, Total knee replacement in particular for cementless application.

Since habits, physique, and genetic makeup vary greatly amongst ethnic groups, the anthropometric proportions in Westerners may differ substantially from those of other ethnic groups. The clinical relevance of anthropometric femur is to facilitates pre-operative planning for arthroplasty, fracture fixation, and biomechanics.

The shape of the femur is a crucial design factor for complete hip replacement implants. Complications such as micromotion, stress shielding, and loosening have been linked to mismatch of implant size due to regional variations of size. Anthropometry differs across ethnicities due to changes in physique, applied force, lifestyle, and distribution. Another concern such as faster implant life degradation, compromising the long-term and short-term outcomes of the procedure.

The present study evaluated the possible variation in measuring femoral length, femoral neck length, neck, anteversion, shaft angle, and femoral notch values in a dry femoral adult population.

METHODOLOGY

This descriptive study was conducted at Mahatma Gandhi medical college and research institute Pondicherry.

Inclusion Criteria

Fifty dry adults femoral of unidentified age and sex, skeletally mature bones, and intact and undamaged specimens from the Department of Anatomy MGMCRI were included.

Exclusion Criteria

Immature bones, bones with abnormal pathology or damaged specimens were excluded.

The neck shaft angle is the degree of angulation between the axis of the femoral shaft and the neck. With the vernier calliper centre of the femoral shaft was noted 2cm below the vastus ridge, in correspondence to the shaft axis. A line drawn through the axis of femoral neck (midpoint identified using vernier calliper). intersecting the axis of femoral shaft reveals the neck shaft angle(Figure1-2).

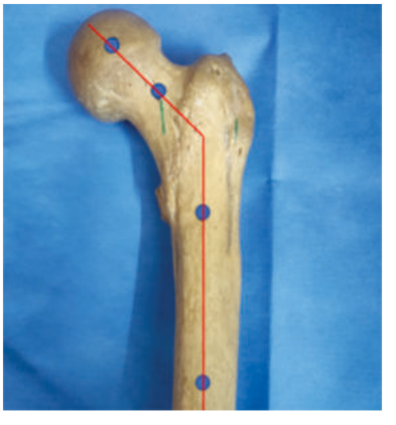

Figure 1: Neck Axis And Femoral Axis

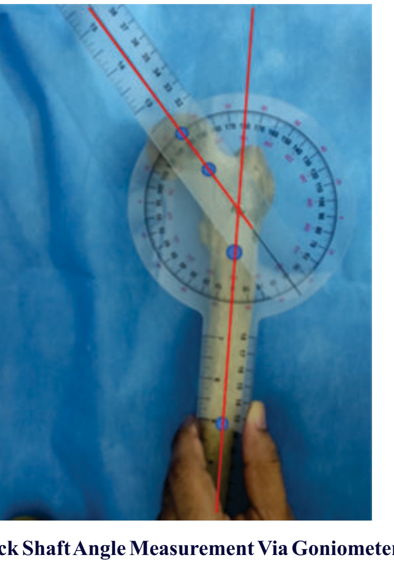

Figure 2: Neck Shaft Angle Measurement Via Goniometer

Femur anteversion measured using the Kingsley-Olmsted technique. The bone was positioned on a table with both the condyles flush with the surface and a goniometer's horizontal arm was secured to the table's edge and vertical arm was held along the axis of the femur's head The anteversion was determined via femur dead and neck deviation relative to the horizontal surface(Figure 3).

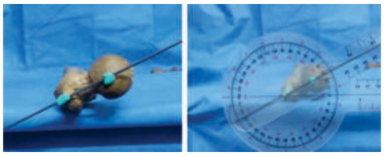

Figure 3: Femoral Anteversion Measured Via Goniometer

Osteometric Board was used to measure femoral length, bone adjusted along the horizontal axis to get the maximum length possible, with both the distal and proximal ends in contact with their corresponding board regions(Figure 4).

Figure 4: Femur Length Measured Via Osteometric Board

The Vernier calliper measured the vertical distance from the inferior portion of the femoral head's base to the lower end of the intertrochanteric line (FNL) (Figure 5).

Figure 5: Femur Neck Length Measured Via Vernier Calliper

The notch depth was identified as the maximum height of the intercondylar notch. The maximum distance between the inner margins of both condyles was taken as the notch width as per guidelines given by Anderson et al. (Figure 5-6).

Figure 5: Notch Width Measured Via Digital Vernier Calliper

Figure 6: Notch Depth Measured Via Digital Vernier Calliper

Data were presented as a minimum, maximum, median, percentile, mean and standard deviation.

RESULTS

Our study found the mean femur length to be 43.13 cm, which was comparable to previous studies (43.51 cm by Khaleel et al.) The 42.68 mm was recorded as the mean head diameter of the dry femur, also comparable to the 46.1 mm reported by Noble et al. and Rawal et al in their study. The mean neck shaft angle of the femur bone was 127.8 mm in the present study, which is considerably different from the study by Noble et al., the average angle of the neck shaft was found to be 124.7°, and Reddy et al. who found an average neck shaft angle of 136°. In the present study, the anteversion's mean value was 11.92°, which is considerably higher than the 10° in the study reported by Reddy et al. The mean neck length of the femur bone was found to be 38.30 mm which is considerably lower than the mean of 46.22mm reported by Mahaisavariya et al. The mean notch depth of the femur bone was reported as 29.45mm, which is comparable to the depth of 29.5mm proposed by Wada et al in a Japanese population. However, the mean femur notch width was 21.25 mm in our study which is considerably higher than as reported by Wada et al (17mm). (Table 1).

Table 1. Observation Of Parameter Measurements

	Mean	Std	Min-Max	Median	Percentile 25	Percentile 75
Femur length	43.13	2.95	38.00-48.00	43.55	40.40	45.62
Head diameter	42.68	2.31	38.00-46.50	43.60	40.30	44.20
Neck shaft angle	127.80	5.48	117.00-137.00	128.00	124.00	132.00
Anteversion	11.92	5.21	2.00-20.00	12.50	7.00	16.25
Femur neck length	38.30	2.90	31.40-42.70	39.35	36.12	40.77
Notch depth	29.45	2.67	24.80-34.80	30.20	26.36	31.30
Notch width	21.25	3.18	15.30-26.20	21.15	19.72	23.62

DISCUSSION

There are substantial differences in the femoral geometry of people from various geographic areas and ethnicities. Implants and prostheses for the femur in general are designed based on anthropometry of the western population, which varies from other ethnic groups.[2] Descriptive analysis of dry femoral measurements of adults at MGMCRI can aid in region specific design of implants

The femur length, was compared to the findings of previous investigations. Khaleel et al.[4] reported a mean femur length of 43.51 cm; the mean femur length of the current research was 43.13 cm, which is closer to this value.

The femoral head diameter was 42.68 mm, compared to the 46.1 mm reported by Noble et al.[5]. Exploration for a smaller implant size is warranted for better biomechanical outcome. This measurement is also clinically significant in determining the size of the acetabular cup.

The average neck-shaft angle in the present study was 127.8 degrees (ranging from 117 to 137 degrees). Noble et al. found a average of 124.7° (154.5°-105.7°.)[5] In contrast, Reddy et al.[6] found an average neck shaft angle of 136° (161°-120°.) This size variance must be taken into account for design of angled implants such as the dynamic hip screw, the dynamic condylar screw, and the blade plate. Precaution should be taken to choose implants with a smaller angle to prevent their superior cut through in the femoral neck.

The mean femoral anteversion angle was 11.92° compared to 10° in the study reported by Reddy et al.[6] The anteversion angle of the femur offers torsional stability of the hip, mismatch of which can cause instability following fixation.

Femur neck length was found to be 38.30 mm (42.7mm-31.4mm). IMahaisavariya et al., the average femur neck length was 46.22 mm ± 5.14, the variation in femur neck length was more in the later study.[7] Mismatch of which can cause varus and valgus angulation of hip joint Notch depth was observed as 29.45mm, (24.8mm-34.8mm). Wada et al. reported the mean notch depth as 29.5 mm, slightly higher than our study.[3] This parameter should be considered for knee joint replacement and ACL repair.

Our study evaluated the mean femur bone notch width as 21.25 mm and the median notch width as 21.15mm. In a study by Wada et al., it was reported to be 17 mm in their research, significantly less than reported in our study.[3] This parameter plays an important role in knee joint replacement surgeries and anterior cruciate ligament reconstruction; hence should be smaller for some people in case of replacement.

The morphometric analysis of the femur can be used as a guide in improving the design of commercially available femoral stems, particularly for regional populations. By comprehending the peculiar characteristic of the regional femur, better design of implants and prostheses with optimal fit and fill can be produced, which will prolong its lifetime and inhibit other complications such as micromotion, loosening, stress shielding, and fractures. The parameters for designing the femoral prosthesis and implants and the correlation coefficient among these variables in our study were relatively significant, proving that these parameters should be considered for the regional population.

Limitations

Our study was conducted on 50 dry Femur bones, a small sample size. Also the sex of the bones was not known. Desiccation of the samples during preservation could lead to an altered outcome in measurement when compared to a live specimen. The individual margin of error during measurements.

CONCLUSION

The prosthesis and implants used for femur are being designed based on international standards. These standards may not be suitable for certain population belonging to different races and ethnical groups. There is also considerable variation of geometry within populations. Hence in light of current evidence of variation in the geometry of femur these variations must be taken into account for design of region-specific prosthesis and implants, and a study on a large-scale population is required for further validation of region-specific prosthesis and implants.

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