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Original Research Article.

Radiographic Analysis of the Proximal Femoral Anatomy at a Tertiary Care Centre

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ABSTRACT

Background: To analyse the proximal femoral anatomy by radiographic evaluation.

Materials & Methods: A retrospective analysis was conducted on conventional hip radiographs, involving a study cohort comprising 50 women and 50 men. The results were analysed using SPSS software.

Results: The mean values of femoral head diameter and lateral femoral offset in females were significantly smaller than the corresponding values in males. There is a statistically significant difference of femoral head diameter mean values between genders (P = 0.001).

Conclusion: The high diversity in the morphology of the proximal femur and the specificity of proximal femoral anatomy are evident from the observations.

Keywords: Femur, Anatomy, Head Diameter.

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INTRODUCTION

Presently in the developing countries like India the frequencies of total hip replacement (THR) have been increased to a great extent. The morphological features of the proximal femur, relied on radiographs or computed tomography, are used in preoperative planning prior to total hip arthroplasty because it is vital to match the dimension of the implant with those of the femur. Otherwise, inappropriate sized or incorrectly placed prosthesis might cause aseptic loosening and improper load distribution causing huge discomfort to the patient thus ultimately affecting long term success of the operation.[1,2]

Most of the standard prostheses available in the market are manufactured based on the data available from the Western population. Mainly three parameters femoral head diameter, horizontal offset and neck shaft angle are considered for the manufacture of the prosthesis. Many studies evaluating proximal femoral geometry based on dry bone, radiographs or computed tomography, showed substantial variations in these parameters among populations of different geographic regions.[3,4]

The femoral head and the acetabulum of the hip bone grow independently but in such a way that they develop congruently. This mechanism is influenced by forces that act externally in these areas. The most important of these are body weight and muscle tension forces, which need to have magnitudes and directions for appropriate interactions. Any change to the compression forces or any joint incongruence will lead to deformities. The pressure, arching and shearing stresses to which the femur is subjected are important in relation to fracture production and also development of various pathological processes.[5,6]

Radiographic studies have suggested that the hip axis and the femoral neck are becoming longer. These changes may increase the risk of fractures through the increased length of the lever arm. Other non-geometric factors that might predispose toward femoral fractures have been widely debated in the literature and these include: advanced age, female sex, osteoporosis, genetic factors (such as Colia1 Sp1 polymorphism), smoking, alcohol abuse, previous fractures and low estrogen levels. Thus, new analyses on how the geometric pattern might influence pathological conditions of the femur are pertinent.[7,8]

Population-based studies have shown that, over time, there has been an increase in the length of the femoral neck and a decrease in the width of the neck in the female population and have correlated these changes with an increase in the risk of fractures. This may have contributed toward the one-third increase in the incidence of hip fractures.[9,10]

Hence, this study was conducted to analyse the proximal femoral anatomy by radiographic evaluation.

MATERIALS & METHODS

A retrospective analysis was conducted on conventional hip radiographs, involving a study cohort comprising 50 women and 50 men. The assessed proximal femoral geometric parameters included femoral head diameter, femoral neck length, neck-shaft angle, angle of femoral neck anteversion, and lateral femoral offset. A comparison of the obtained results was carried out between the male and female subjects. The results were analysed using SPSS software.

Table 1: Radiographic assessments of geometric parameters in the proximal femur

Parameters	Mean
Femoral head diameter/mm	39.52
Neck length/mm	44.15
Shaft angle/°	128.81
Angle of femoral neck anteversion/ °	17.26
Lateral femoral offset/mm	52.63

Table 2: Comparison of the proximal femoral parameters between genders

Parameters	Females	Males	P value
Femoral head diameter/mm	38.82	41.46	0.001
Neck length/mm	44.12	44.42	0.5
Shaft angle/⁰	128.42	128.05	0.5
Angle of femoral neck anteversion/⁰	17.62	17.15	0.5
Lateral femoral offset/mm	50.13	53.20	0.01

RESULTS

The mean values of femoral head diameter and lateral femoral offset in females were significantly smaller than the corresponding values in males. There is a statistically significant difference of femoral head diameter mean values between genders (P = 0.001). However, there was no statistically significant difference in the mean values of other femoral geometric parameters between the two genders. The mean value of lateral femoral offset among females was 50.13 mm and 53.20 mm among males, which was statistically significant difference (P = 0.01).

DISCUSSION

Bone geometry of the proximal femur has been studied as a potential risk factor, and has been positively associated in the prediction of fracture risk.[11] However, most hip fracture studies do not distinguish the predisposition between the two main types of fracture (femoral neck and transtrochanteric), which in clinical practice would be fundamental, since the surgical approach of choice can be different due to the high rate of hip arthroplasty indication in femoral neck fractures, which in turn has financial repercussions and affects patient recovery in the postoperative period. Hence, this study was conducted to analyse the proximal femoral anatomy by radiographic evaluation.

In the present study, the mean values of femoral head diameter and lateral femoral offset in females were significantly smaller than the corresponding values in males. There is a statistically significant difference of femoral head diameter mean values between genders (P = 0.001).

In the present study, however, there was no statistically significant difference in the mean values of other femoral geometric parameters between the two genders. The mean value of lateral femoral offset among females was 50.13 mm and 53.20 mm among males, which was statistically significant difference (P = 0.01). Another study by Roy S et al, measure the important parameters of upper end of femur in elderly Eastern Indian population which will help the prosthetist to manufacture ideal implant for the local population. This will also help the orthopaedic surgeons while positioning the implants during total hip replacement (THR) procedure in this population. Measurements were made on both sides, left and right from anterior-posterior radiograph of 102 subject (>50yrs, 42 male and 60 females) using AGFA software. Three parameters femoral head diameter (FHD), neck-shaft angle (NSA) and horizontal off-set (HO) were measured. Gender- wise no significant differences were found in NSA and FHD, but HO was significantly lower in female than that of male (p<.05). The values on both sides didn't differ significantly. Improved knowledge of the morphology of the proximal femora will assist the surgeon in restoring the geometry of the proximal femur during total hip arthroplasty and the data could be used as a guideline to design a more suitable implant for Eastern Indian population.[12] De Farias et al, analyzed five hundred anteroposterior radiographs of the pelvis of skeletally mature patients (250 of each sex) who did not present any osteoarthrosis, fractures or tumoral or infectious lesions. The length and width of the femoral neck, length of the femoral axis, neck-shaft angle and femoral offset were measured. The following means were observed: 36.54 mm for the length of the femoral neck; 37.48 mm for the width of the femoral neck; 108.42 mm for the length of the femoral axis; 130.47° for the neck-shaft angle; and 44.4 mm for the femoral offset. The mean values for the main measurements on the proximal femur in Brazilians differed from those of previous studies. It could also be shown that there was a statistically significant mean difference between men and women for all the variables, both on the left and on the right side, and that the men had greater means than the women.[13] Unnanuntana et al.[14] analyzed proximal femoral morphology in American Caucasians,

and the diameter of the femoral head in his study was 52.09 ± 4.4 mm, significantly larger than in the Croatian population. With regard to FNSA, varying ranges have been described as reference ranges. Boese et al. reported the value ranging from 98 to 160° in the healthy population.[15]

Higher values for the width of the femoral neck in the Brazilian population were found here, in comparison with the study by Mourão and Vasconcellos,[16] whose values were 26.7 mm (±3.1) for the right side and 26.3 mm (±3.3) for the left side. Neither of the Brazilian studies found any significant differences between the sides. O'Neill et al.[17] observed that there was a positive correlation between the length and width of the femoral neck and found measurements of 36.6 mm and 39.1 mm for the widths in 1950 and 1990, respectively. Using similar methodology, Reid et al.[18] found mean values for the width of the femoral neck of 38.1 mm from radiographs performed on women in 1950 and 38.6 mm in 1990. They therefore concluded that the width of the femoral neck had increased over the course of time. In the radiographic study by Cheng et al.,[19] the mean values found for the length of the femoral neck for both sexes were 35.1 mm for the left side and 35.5 mm for the right side. Femoral horizontal offset restoration is also essential to improve function and longevity of hip arthroplasty.

Charnley[20] considered it to be a factor under the control of the surgeon at the time of hip replacement surgery, the more lateral position of the femur with greater horizontal offset was said to increase the range of motion and decrease the incidence of impingement of the femoral head on the pelvis thus decrease the post-operative complications. Though CT scan is more accurate, the plain radiography is definitely the most cost effective and convenient method for offset measurement in the developing countries like India.[21] Canto et al.[22] analyzed 126 radiographs of the coxofemoral joint, of which 42 had no fracture, 42 had transtrochanteric fracture and 42 had femoral neck fractures. In their series, the authors observed: significant correlation comparing the acetabular tear-drop distance and the great trochanter distance in the groups of patients with fractures; significant correlation between the increase of the cervicodiaphyseal angle and the incidence of proximal femoral fracture; significant correlation between the acetabular tear-drop distance and the incidence of femoral neck and transtrochanteric fractures. There was no significance between the axial length of the hip and the incidence of proximal femoral fracture. The author emphasizes that he did not find any explanation for valgism of femoral neck being considered a risk factor, since the greater the values of varism, the greater the lever arm between the abductor muscles and the center of rotation of the hip and, therefore, the more vulnerable the patient to the occurrence of fractures. This finding was also corroborated by other studies.[23] Other authors, however, did not encounter such an association.[24]

CONCLUSION

The high diversity in the morphology of the proximal femur and the specificity of proximal femoral anatomy are evident from the observations.

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