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Original Article

Radiological Evaluation of the Proximal Femoral Geometric Parameters of Adult Bangladeshi Population

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Abstract

Background: *The present study is aimed to determine the value of proximal femoral parameters such as Femoral Neck Shaft Angle (FNSA) Femoral Neck Length (FNL) and Femoral Neck Width (FNW) of both sexes and also on both sides for the purpose of adequate planning, preparation and pre-operative selection of prosthetic implants and also stocking of prosthesis implants in hospitals located in developing countries like Bangladesh.*

Materials and methods: *It was a cross sectional observational study and was conducted by Department of Anatomy, Chittagong Medical College from July 2020 to June 2021 among 200 (119 male, 81 female) normal adult Bangladeshi population of Chattogram district. Normal participants, both male and female were recruited from Radiology Department of Chittagong Medical College Hospital (CMCH) as per enrolment criteria. After taking demographic data of all participants plain pelvic X-ray A/P view were taken and reported by an expert radiologist of CMCH. Only normal radiographs were included in the study. All measurements such as FNSA, FNL and FNW of femur were taken from both sides of the X-rays. Data were analyzed by SPSS version–25.*

Results: *In this study, mean FNSA, FNW and FNL were found larger in male than in female. The FNSA, FNW and FNL all were found higher in right side than the left and also statistically significant.*

Conclusion: *The result of the present study provides some baseline information about proximal femoral parameters of adult Bangladeshi population which will help to design the prosthesis for hip replacement.*

Key words: Femoral neck shaft angle; Femoral neck length; Femoral neck width.

INTRODUCTION

Hip fractures in particular are the main health risk that has a significant impact on quality of life.[1] Bone Mineral Density (BMD) is itself not the only component that affectsthe strength of bones,age related variables and geometrical features also play a major role on this entity.[2-5] There is dissimilarity in human bony configuration that determines the racial attribute of the populations. The structure of the bone and different bony measurements both anatomically and radiologically can guide the clinicians for the determination of fracture risk.[6] The risk of hip fractures can be predicted by many factors such as Body Mass Index (BMI) Bone Mineral Density (BMD) the direction and severity of fall, muscle strength, body habitus, morphometric parameters of femur such as Hip Axis Length (HAL) femoral Neck-Shaft Angle (NSA) Femoral Neck Length (FNL) Femoral Neck Width (FNW) history of family, geographical factoror lifestyle factors.[7-9] The femoral head acts as a brace and its biomechanical properties depend on the width and length of femoral

neck.[6] Femoral morphometric parameters has been related to mechanical length of proximal femur and these parameters are involved in the resistance of bone to impact, the highest being found in the races with a higher incidence of hip fracture.[3, 10-11]

Proximal hip surgeries including trauma and hip arthroplasty procedures have been increased extremely in the last ten years all over the world. Variations of proximal femoral parameters has been seen in different literature of different countries and all the orthopedic implants are designed according to the values of the literatures of concerned countries which may be different from Bangladeshi population.The implants which are used to treat the proximal femur fractures include the sliding hip screws, the proximal femoral nail, cannulated cancellous screws, angle blade plates and even hemi replacement with bipolar or unipolar prosthesis etc. Use of undersized or oversized femoral implants can leads to altered soft tissue tensioning and altered patella femoral stresses.[12] In case of improper selection of femur implant, there may be serious problems for the patients in long run.[13-14]

Majority of these implants come with different angular options and all orthopedic implants are manufactured considering the biomechanics and anthropological data and body morphology according to different countries of the world. Keeping the above background and knowledge in mind, the present study was designed to evaluate proximal femoral parameters of adult Bangladeshi population radiologically and analyzed the data statistically to find out any significant difference of these parameters within the study population which will help orthopedic surgeons in future of choosing implants for prosthesis.

MATERIALS AND METHODS

A cross sectional observational study was conducted at the Department of Anatomy, Chittagong Medical College from July 2020 to June 2021 among 200 (119 male, 81 female) normal adult Bangladeshi residents of Chattogram district. Normal participants, both male and female were recruited from Radiology Department of Chittagong Medical College Hospital (CMCH) as per enrolment requirements. After receiving approval from CMCH authority, patients who were present in the Radiology Department of CMCH were asked for their written consent and included in accordance with the enrolment criteria. Participants who were above the age of 20 years, had normal pelvic radiograph results as reported by radiologist, Bangladeshi by birth and were willingly to engage in the study were included. Subjects with any kind of asymmetry, congenital malformations, undergoing surgery, trauma or dislocation involving proximal femur and history of rheumatic bone disease, osteomyelitis, osteonecrosis, metabolic bone diseases such as osteoporosis, rickets, etc. as well as tribal people were excluded from the study. The age of the respondents ranged from 21-75 years. Plain pelvic radiographs, A/P view was obtained from patients who were giving informed written consent by using the standardized protocol that was 15-30 degrees of internal rotation of the hips in the supine position with a film-focus distance of 100 cm and the beam centered on the symphysis pubis.[15-16] Anthropometric measurements were performed bilaterally from normal radiograph and the measurements were done with the aid of view box, measuring scale and protractor.[16] Following measurements were recorded.

Femoral Neck-Shaft Angle (FNSA): The FNSA is the angle made by the intersection of the longitudinal axis of the femoral neck with that of longitudinal axis of femoral shaft. The longitudinal axis of the neck was obtained by joining two midpoints. One at the center of the head and another at the constricted part of neck region while the longitudinal axis of the shaft of the femur was drawn by joining the midpoints on the proximal shaft of the femur below the lesser trochanter. The angle formed by the intersection of the two axes.[15]

Femoral Neck Length (FNL): Femoral Neck Length (FNL) was measured by drawing a line in distance between the lateral margin of the femoral head and the superior base of the trochanteric region with the help of measuring steel plate.[17](Figure 1)

Femoral Neck Width (FNW) : Femoral Neck Width (FNW) was measured by drawing a line which is the midpoint distance between the superior cortex and the inferior cortex of the femoral neck with the help of measuring steel plate.[17](Figure 2)

After collection, all data were placed in a record sheet and then they were fed into SPSS (Statistical Package for Social Science) version 25 software for processing and analysis. The result considered significant if p value was <0.05 at 5% level of significance.

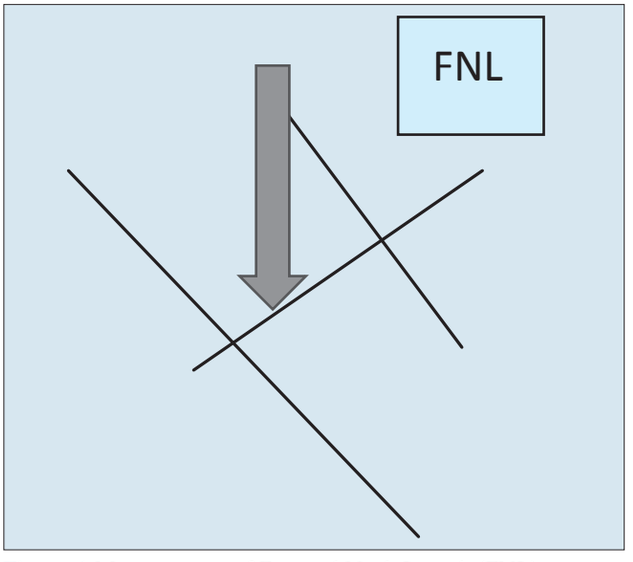

Figure 1 Measurement of Femoral Neck Length (FNL)

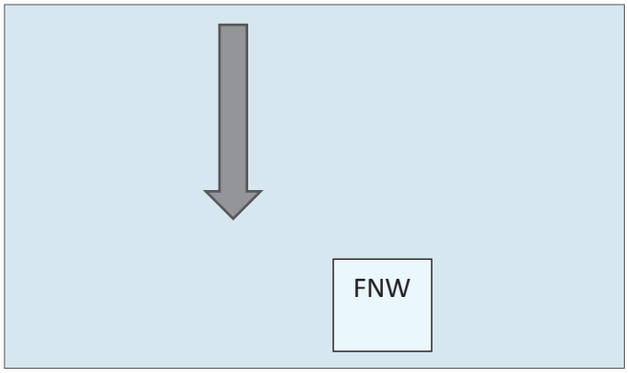

Figure 2 Measurement of Femoral Neck Width (FNW)

RESULTS

There were 119 (59%) male participants and 81 (41%) female participants in the present study (Figure 3).

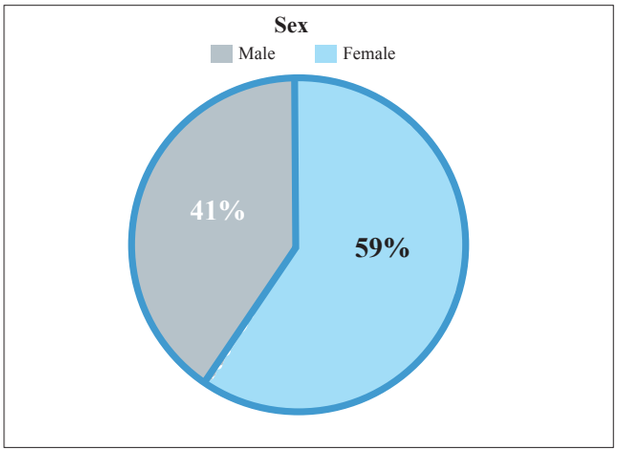

Figure 3 Sex distribution of the respondents (n=200)

Table I Mean FNSA, FNL, FNW between right and left side

Parameter	Right side	Left side	p-value
Mean FNSA	125.74°±3.15°	124.79°±3.08°	0.000
Mean FNW	31.82±3.89	30.43±3.74	0.000
Mean FNL	35.53±3.25	34.13±3.15	0.000

The mean neck shaft angle was 125.74° in right femur and 124.79° in left femur and it was highly statistically significant. The mean neck width was 31.82 mm in right femur and 30.43 in left femur which was also highly statistically significant. The mean neck length was 35.53 mm in right femur and 34.13 mm in left femur and the result was highly statistically significant.

Table II Mean FNSA, FNW, FNL in male and female

Parameter	Male (n=119)	Female (n=81)	p-value
Mean FNSA	125.61°±3.06°	124.76°±3.08°	0.055
Mean FNW	32.05±3.70	29.77±3.42	0.000
Mean FNL	34.89±2.77	34.73±3.62	0.728

The mean femoral neck-shaft angle in male was 125.61° and in female was124.76° which was statistically not significant. The mean femoral neck width was 32.05 mm in male and 29.77 mm in female which was statistically highly significant. The mean femoral neck length was 34.89 mm in male and 34.73 mm in female and the result was statistically not significant.

DISCUSSION

Similar result obtained in the study done by Pathak et al. Here 55 male (55%) and 45 female (45%) patients were included.[18] Iyidobi et al. in their study included 75 participants among them 30 males (40%) and 45 females (60%).[19] In the present study mean femoral neck-shaft angle was 125.74± 3.154 degree in right side and 124.79 ± 3.079 degree in left side. Mean femoral neck-shaft angle in right side found larger than left side and was highly statistically significant (p<0.000). Syed et al. conducted a study among Indian population and described that the mean NSA on the right side was 133.9±7.02 degree and left side was 131±7.11 degree and found statistically significant difference between right and left side (p=0.0040).[19] A similar study conducted by Oduntan et al. among Nigerian population. Here mean NSA on the right side was 131.28±6.56 degree and mean NSA on the left side was 130.22±5.18 degree. Here right sided NSA found larger than the left side and was statistically significant (p=0.001).[15] Another study was conducted by Kaur et al. and found that the mean neck shaft angle of the right side in the total population was 121.39 degree and left side it was 121.13 degree. The difference between right and left sided NSA of total population were found statistically significant (p=0.009).[20,21] A study done by Pathak et al. revealed that the mean NSA on the right side was 129.6±4.61 and left side was 129.1±4. 08. In their study there was no statistically significant (p>0.5) side difference between both side.[18] All these results have shown similarity with the present study. According to Gilligan et al. the mean NSA on the left side was 127.02 degree and right side was 125.71 degree. The finding revealed significantly higher (p<0.001) left sided NSA than right sided NSA which is dissimilar with our study.[22]

In this study, mean femoral neck-shaft angle in male was 125.61°±3.06°and in female was124.76°±3.08°. Here male femoral neck-shaft angle found larger in male than female but was statistically not significant (p<0.055). Elbuken et al. found that, the mean NSA of male was 129.63 degree and female was 129.142 degree and there was a significant difference of mean NSA between male than female (p<0.05).[23] Nissen et al.described that, the mean NSA of male respondents was 131 ± 5^0 and female respondents was 129 ± 5^0. Here mean NSA found larger in male than female and was statistically highly significant (p<0.001).[24] In another study by Lyidobi et al. male had a higher mean NSA of 131.43 degree compared to females who had a mean NSA of 130.78 degree although the difference was not statistically significant (p>0.05).[19] All these studies

have shown similarity with this present study. Another study conducted by Sinha et al. revealed that the mean neck shaft angle in male was 130.28º and in female was 131.42º. Neck shaft angle was slightly greater in female than in male but the result was statistically not significant which is dissimilar with this present study.[25]

In the present study, the mean neck length was 35.53±3.25 mm in case right femur and 34.13±3.15 mm in case of left femur. Here right femoral neck length is larger than left which was highly statistically significant (p<0.000). Acar and Unal conducted a retrospective study among Turkish population. Here mean femoral neck length in right femur was 35.85±4.89 mm and left femur was 34.28±4.74 mm which was not statistically significant (p=0.009).[17] The study have shown similarity with the present study. Syed et al. carried out a cross sectional observational study in Department of Anatomy at Dr. Shankarrao Chavon Govt. Medical College, Nanded, Maharashtra. Here mean neck length of right femur was 35.80±4.54 and left femur was 37.53±5.03 mm. Here left femoral neck length found larger than right which was statistically significant (p<0.0118).[20] This result is dissimilar with the present study.

In the present study, the mean femoral neck length was 34.89±2.77 mm in male and 34.73±3.62 mm in female. Here male femoral neck length found larger than female which is statistically highly significant (p=0.728). In a study of syed et al. mean neck length of male femur was 37.61 mm and female femur was 34.75 mm which was statistically highly significant (p<0.0001).[20] Acar and Unal found that neck length of male femur was 35.96±4.27 mm and female femur was 33.17±4.78 mm which was statistically significant (p<0.001).[17] Nagarathnamma described that mean neck length in the male right femur was 30.0±3.3 mm, while on the left side was 29.9±3.5 mm. In the female mean of right femoral the neck length was 28.3±4.2 mm while in the female left femur the neck length was 27.5±3.1 mm. Here male femoral neck length found larger than female on both sides but was not statistically significant (p>0.05).[26] All the results have shown similarity with the present study.

In this present study, the mean neck width was 31.82±3.89 mm in right femur and 30.43±3.74 in left femur. Here right femoral neck width found larger than the left and it was statistically significant (p<0.000). Syed et al. showed that mean neck width of right femur was 30.13±3.88 mm and left femur was 29.85±3.92 mm which was not statistically significant (p>0.05).[20] Acar and Unal found that mean femoral neck width on the right femur was 38.47±4.96 mm and left femur was 37.93±4.82 but statistically not significant (p=0.11).[17] All these studies have shown similarity with the present study. Sultan et al. described that mean neck width was 31.81 mm in right femur and 32.26 mm in left femur (Left>right) which was statistically significant (p<0.005) and dissimilar with the present study.[27]

In this present study, the mean femoral neck width was 32.05±3.70 mm in male and 29.77±3.42 mm in female. Here male femoral neck width was larger in male than female and was statistically highly significant (p<0.000). Syed et al. described that the mean neck width of male femur was 31.54 mm and female femur was 27.20 mm which was highly statistically significant (p<0.0001).[20] Acar and Unal found that mean femoral neck width of male femur was 41.9±3.23 mm and female femur was 34.48±3.15 and was statistically significant (p=0.001).[17] Nissen et al conducted a cross sectional observational study and found that mean neck width of male was 3.8±0.3 cm and female was 3.3±0.3 cm. and was highly statistically significant (p<0.01).[24] All these studies have shown similarity with this present study.

CONCLUSION

The result of the present study provides some baseline information about proximal femoral parameters of adult Bangladeshi population which will help the orthopedic surgeons and biomechanical engineers to design implant and restore the normal anatomy of the proximal part of femur which is generally fractured.

RECOMMENDATIONS

Multicenter grounded study with larger sample size all over Bangladesh can be performed which make the study completly representative among Bangladeshi population. In this study tribal population were excluded. So, further studies can be undertaken to observe any significant difference of proximal femoral parameters between tribal and normal Bangladeshi adult.

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DISCLOSURE

All the authors declared no competing interest.

REFERENCES

1. Gregory JS, Stewart A, Undrill PE, Reid DM, Aspden RM. A method for assessment of the shape of the proximal femur and its relationship to osteoporotic hip fracture. Osteoporosis int. 2004; 15: 5-11.
2. Karasik D, Dupuis J, Cuppies LA. Bivarient linkage study of proximal hip geometry and body size indices: the Framingham study. Calcif tissue int. 2007; 81: 162-173.
3. Faulkner KG, Cummings SR, Black D, Palermo L, Gluer CC, Genant HK. Simple measurement of femoral geometry predicts hip fracture. J Bone Miner Res. 1993; 8(10):1211-1217.
4. Faulker KG, Wacker WK, Barden HS. Femur strength index predicts hip fracture independent of bone density and hip axis length. Osteoporosis int. 2006: 17: 593-599.
5. Yoshikawa T, Turner CH, Peacock M. Geometric structure of the femoral neck measured using dual energy x-ray absorptiometry. J Bone Miner Res. 1994; 9: 1053-1064.
6. Cheng XG, Lowest G, Boonen S, Nicholson PHF, Brys P, Nigs J et al. Assesment of the strength of proximal femur in vitro: relationship to femoral bone mineral density and femoral geometry. Bone.1997; 20:213-218.
7. Gluer CC, Cummings SR, Pressman A, L J, Gluer K, Faulkner KG, Grampp S, Genant HK. Prediction of hip fractures from pelvic radiographs: The study of osteoporotic fractures. The study of osteoporotic fractures research group.J Bone Miner Res. 1994; 9: 671-677.
8. Gnudi S, Ripamonti C, Gualtieri G, Malavolta N. Geometry of proximal femur in the prediction of hip fracture in osteoporotic women. Br J Radiol.1999; 72:729-733.
9. Greendale GA, Young JT, Huang MH, Bucur A, Wang Y, Seeman T. Hip axis length in mid-life Japanese and Caucasion US. Residents: no evidence for an ethnic difference.Osteoporos int. 2003; 14:320-325.
10. Karlsson KM, Sernbo I, Obrant KJ, Redlund JI, Johnell O. Femoral neck geometry and radiographic signs of osteoporosis as predictors of hip fracture. Bone.1996; 18: 327-330.
11. Pinilla TP, Boardman KC, Bouxsein ML, Myers ER, Hayes WC. Impact direction froma fall influences the failure load of the proximal femur as much as age related bone loss. Calcf Tissue int. 1996; 58: 231-235.
12. Hitt K, Shurman JR, Greene K, Mcarthy J, Moskal J , Hoeman T et al. Anthropometric measurements of the human knee: correlation to the sizing of current knee arthroplasty system. JBJS. 2003; 85(4):115-122.
13. Kay RM, Jaki KA, Skaggs DL. The effect of femoral rotation on the projected femoral neck-shaft angle.J PediatrOrthop. 2000; 20(6):736-809.
14. Mcgrory BJ, Morrey BF, Cahalan TD, An KN, Cabanela, ME. Effect of femoral offset on range of motion and abductor muscle strength after total hip arthroplasty. Bone & Joint Journal.1995; 77(6): 865-909.
15. Oduntan T, Cole A, Akinmokun IO, Soyebi OK, Oguchi EO. Femoral neck shaft angle: A radiological anthropometric study. Nigerian post graduate medical journal. 2016. 23(1):17-20.
16. Bhattacharya S, Chakraborty P, Mukherjee A. Correlation between neck shaft angle of femur with age and anthropometry: A radiological study. Ijbamr. 2014. 3:100-107.
17. Acar N, Unal MA. Radiological evaluation of the proximal femoral geometric features in the Turkish population. Med J SDU/SDO Tip FakDerg. 2017; 10:12-34.
18. Pathak SK, Maheshwari P, Ughareja PG, DM, Gour SK. Evaluation of femoral neck shaft angle on plain radiographs and its clinical implications. Int J Res Orthop. 2016; 2(4): 383-386.
19. Lyidobi EC, Obande BO, Eyichukwu GO, Nwadinigwe CU, Ekwunife RT, Ede O. Assesment of the femoral neck-shaft angles of adults in Nigeria.Asian Journal of Orthopaedic Research. 2020; 3(3):1-7.
20. Syed IS, Joshi DS, Diwan CV. Proximal femoral geometry in cadaveric femora and its clinical relevance. IJAPB. 2017; 4(7): 2994-3440.
21. Kaur P, Mathew S, George U. A study of neck shaft angle in the North–West indian population on radiograph. Int J Basic Appl Med Sci. 2013;3:9-15.
22. Gilligan I, Chandraphak S, Mahakkanukrauh P. Femoral neck-shaft angle in humans: Variation relating to climate, clothing, lifestyle, sex, age and side. J Anat. 2013; 223(2):133-151.
23. Elbuken F, Baykara M, Ozturk C. Standarization of femoral neck-shaft angle and measurement of age, gender and BMI related changes in the femoral neck using DXA. Singapore Med. J. 2012; 53(9):587-590.
24. Nissen N, Hauge EM, Abrahamsen B, Jensen JNE, Mosekilde L, Brixen K. Geometry of the proximal femur in relation to age and sex: A cross sectional study in healthy adult Danes. ActaRadiol. 2005;46(5):514-518.
25. Sinha RR, Kumar B, Kumar S, Ratnesh R, Akhtar MJ, Fatima N. 2017, Study of neck shaft angle of femur in population of Bihar. Int. Journal of Research in Medical Sciences. 2017; 5(11):4819-4821.
26. Nagarathnamma B. Measurement of femoral neck-shaft angle in cadaveric femora.International journal of current research. 2017; 9(12): 62462-62467.
27. Sultan SI, Joshi DS, Diwan CV. Proximal femoral geometry and its clinical relevance in Indians -A radiological study. Indian Journal of Clinical Anatomy and Physiology. 2018; 5(1):107-111.