

## Original Research Article

# Femoral head diameters in Nepalese patients undergoing hemiarthroplasty

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## ABSTRACT

**Background:** Sizing of the femoral head is important for determining the appropriate size of implants to be used for a patient undergoing hip arthroplasty. The present study aimed to determine the mean diameter of femoral head in Nepalese population who underwent hemiarthroplasty in our department.

**Methods:** We retrospectively reviewed the medical records of patients who underwent hemiarthroplasty from December 2016 till December 2020. We included patients aged more than 50 years who underwent hemiarthroplasty. The diameter of the femoral head was measured intraoperatively using standard fully circular templates. For radiological measurements, X-ray of pelvis with hips anteroposterior view were included.

**Results:** A total of 600 femoral heads were evaluated, 400 of women and 200 of men. Of these cases, the femoral head diameter were evaluated based on x-ray pelvis in 500 cases and rest of the 100 cases were evaluated intraoperatively. The mean age of the patients in our sample was  $75.2 \pm 9.4$  (range 50–90) years. Overall, the mean femoral head diameter (with intact articular cartilage) was  $44.9 \pm 3.2$  (range 39–53 mm) mm. Among the male patients, mean femoral head diameter was  $47.7 \pm 2.8$  mm, which was found to be significantly higher than that of female patients, who had a mean femoral head diameter of  $43.7 \pm 2.4$  mm, p value  $< 0.05$ .

**Conclusions:** Further studies are needed in other geographical locations, so that reference values could be established for specific regions.

**Keywords:** Femoral head diameter, Radiological, Total hip arthroplasty, Pre-operative planning

## INTRODUCTION

Hemiarthroplasty is one of the most common and widely performed surgeries across the globe. The surgery aims to reduce pain, improve functionality and mobility and improve overall quality of life.<sup>1</sup> It is also considered as a highly successful and reproducible surgery, with minimal associated complications. A decade long study in a Singapore hospital found that more than two thirds of femoral neck fractures were treated with hemiarthroplasty.<sup>2</sup> In these cases, sizing of the femoral head is important as part of pre-operative planning. This helps the surgeon determine appropriate implant size

which is to be used for a patient undergoing the surgery.<sup>3</sup> However, the available data on the common sizes of implants used are based on studies of Western populations. Umer et al found that the proximal femur morphology of healthy population aged 20 to 50 years in Pakistan was significantly different from those in Western countries.<sup>4</sup> Lee et al found that among the Chinese, Malay and Indian races in Malaysia, the Chinese had significantly larger femoral head diameters compared to the other ethnicities.<sup>5</sup> Chin et al found that Asian women have having smaller distal femurs as compared to males.<sup>6</sup> There is very limited data which informs about the variation in the femoral head diameters among Nepalese population. Mukhia and

colleagues assessed the morphometric parameters of 75 adult cadaveric femurs.<sup>7</sup> However, the age group of the sample ranged from 30 to 60 years. Hip arthroplasties usually happen in people aged 50 years or more. The present study aimed to determine the mean diameter of femoral head in Nepalese population who underwent hemiarthroplasty in our department.

**METHODS**

*Study design and sampling*

In this study, we retrospectively reviewed the medical records of patients who underwent hemiarthroplasty from December 2016 till December 2020. The study was conducted in the Department of Orthopedics, Janki Medical College and teaching hospital, Janakpur, Nepal. We included patients aged more than 50 years who underwent hemiarthroplasty and visited our outpatient clinic for follow up. We excluded patients who had a history of previous arthroplasty, existing deformity of the contralateral hip, deformed femoral head secondary to avascular necrosis and advanced arthritis. The patients were explained the purpose of the study and an informed written consent was obtained. The study was approved by the institutional ethics committee.

*Measurement methods*

A standard posterior surgical approach to the hip was used in all patients. After capsulotomy of the hip, the femoral head was delivered out for measurement. The diameter of the femoral head was measured intraoperatively using standard fully circular templates, with the surgeons passing the femoral head through the circular template, progressing from smaller rings to larger ones which get easily fit into ring.<sup>8</sup> For radiological measurements, X-ray of pelvis with hips anteroposterior view were included. In order to validate this, the measurements are taken from greyscale images of the patient’s hip with those obtained from the above mentioned mechanical measurements; X-ray and computed tomography (CT) scan were performed on the 10 femur head samples. The X-ray image was used to analyse the size of the femur head using Image J software (National Institutes of Health, US). Using the measure function of the Image J software, virtual pointers are placed on the image in order to measure the pixel elements, which are translated using pre-set scaling that is applied to the images beforehand. While measuring size of head, we choose widest diameter of articulating head and subtracted 10% considering radiological magnification. After taking all the measurements the hemiarthroplasty operation completed by standard technique with fixed bipolar, modular bipolar, Austin-Moore prosthesis with cemented or uncemented.

*Data collection and data analysis*

Using a pre-designed semi-structured proforma, demographic information like age and gender were noted.

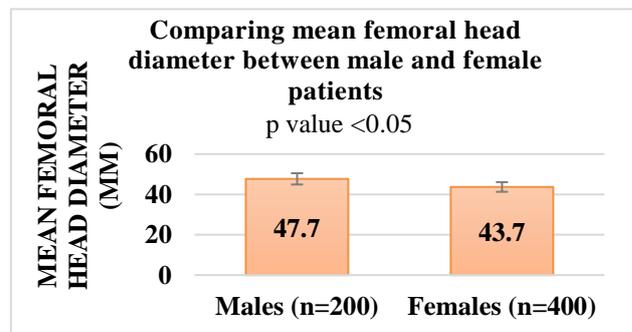
The diameter of femur head was noted for all patients. The data were compiled and analysed in statistical package for the social sciences (SPSS) version 23. Quantitative data were described as means and standard deviation and categorical data were described as frequency distribution. To compare mean femur head diameters of male and female patients’ student’s t test was used, with p value less than 0.05 as statistically significant.

**RESULTS**

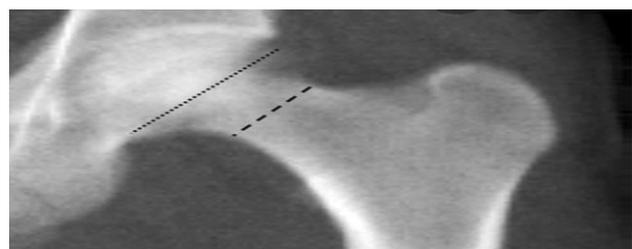
A total of 600 femoral heads were evaluated, 400 of women and 200 of men. Of these cases, the femoral head diameter were evaluated based on X-ray pelvis in 500 cases and rest of the 100 cases were evaluated intraoperatively. The mean age of the patients in our sample was 75.2±9.4 (range 50–90) years. Overall, the mean femoral head diameter (with intact articular cartilage) was 44.9±3.2 (range 39–53) mm. Among the male patients, mean femoral head diameter was 47.7±2.8 mm, which was found to be significantly higher than that of female patients, who had a mean femoral head diameter of 43.7±2.4 mm, p value <0.05.

**Table 1: Measurement method used in our sample of 600 cases.**

Parameters	Femoral head diameter measurement		
	X-ray	Intra-operatively	
Gender			
Male	166	34	200
Female	334	66	400
	500	100	



**Figure 1: Comparing mean femoral head diameter between male and female patients.**



**Figure 2: Radiological measurement showing widest diameter at head circumference.**



**Figure 3: Intraoperative measuring devices for measurement of femoral head diameter.**

## DISCUSSION

To the best of our knowledge, this is the first study which determined the mean diameters of femur head among Nepalese population who underwent hemiarthroplasty. We included only those who were aged 50 years or more. Of the 600 heads evaluated, 500 were measured on x-ray and the rest directly using a circular template intra-operatively. The diameter was reduced by 10% in the assessments done radiologically. The accuracy of either method is debatable. In a prospective study, Deb and Mallick measured the femoral neck length, between two fixed bony points, from the tip of greater trochanter (GT) to the center of the femoral head intra-operatively and again post-operatively, using the true size x-ray of the replaced femoral head.<sup>9</sup> In the same set of patients, all the measurements intra-operatively and radiologically were similar and the difference was not statistically significant. Athapatu et al performed a series of experimental measurements to investigate which method or mode of measurement is more reliable with measuring the diameter of the femur head.<sup>8</sup> In 10 samples, they measured the diameter of femur head using four methods; Vernier calliper, ring gauges, X-ray and CT scan and found no major difference between the results. It was observed that the results of the Vernier calliper and ring gauges show less variation in readings in comparison with X-ray and CT scan methods. Although the sizes of the femoral head and stem components of prosthetics may produce in intervals of 2 mm, the range of direct error within the methods themselves being less than 2 mm for most samples and this would make each method as viable a solution as the others. The ring gauge in conjunction with the use of the vacuum test is recommended as it negates any doubt concerning the fit of the implant and ensuring a good range of motion, and can be performed by a surgeon regardless of the expanse of their experience.<sup>10</sup>

As for intraoperative measurements, Ben lulu examined the absolute difference between the implanted cup outer diameter and diameter of the actual femoral head that was removed during surgery.<sup>11</sup> The authors found that the mean difference between the actual implanted cup diameter and the actual removed femoral head diameter was 3.2 mm. Ninety-two percent of the patients had a difference range

of 2–4 mm in favor of the actual implanted cup (implanted cup bigger). Furthermore, the authors found that the correlation between the actual implanted cup diameter and the actual removed femoral head diameter was very high ( $r=0.923$ ), indicating that this gap is consistent. Based on the results of the current study, the authors concluded that measuring the actual femoral head diameter during surgery, which is simple and quick, can serve as a real-time intraoperative monitoring tool for pre-operative planning.

In the present study, the mean femoral head diameter was  $44.9\pm 3.2$  (range 39–53 mm) mm. In the cadaveric study of 75 adults femurs, Mukhia et al reported mean diameter of femurs was  $13.05\pm 0.9$  cm. It was  $13.10\pm 0.88$  cm for right femurs and  $13\pm 0.92$  cm for left femurs.<sup>7</sup> A similar cadaveric study from India reported mean diameter of femoral head to be  $4.19\pm 0.19$  cm.<sup>12</sup> In a cross-sectional study, Riad et al aimed to measure the femoral head diameter radiologically and to find out male-female variation and relationship with the stature in Bangladeshi population.<sup>13</sup> They found that the overall femoral head diameter in Bengali Bangladeshi population was found 4.90 cm. Siwach et al in an anthropometric study on X-ray of dry femora demonstrated that the average femoral head diameter in Indian population was 4.35 cm, whereas Nobel et al on radiological osteometric measurements on dry femora in Caucasians demonstrated the average femoral head diameter was 4.61 cm.<sup>14,15</sup> In addition, we observed that among the male patients, mean femoral head diameter was  $47.7\pm 2.8$  mm, which was found to be significantly higher than that of female patients, who had a mean femoral head diameter of  $43.7\pm 2.4$  mm,  $p$  value  $<0.05$ . Riad et al found that the mean femoral head diameter of males were found significantly higher than the females ( $5.21\pm 0.26$  versus  $4.58\pm 0.21$  cm,  $p<0.05$ ). However, no significant difference was found between right and left femoral head diameter ( $4.9\pm 0.39$  versus  $4.89\pm 0.4$ ,  $p=0.841$ ) in their study. Similar observations were made by Lee et al, who found that men had a significantly larger mean femoral head diameter than women ( $47.7\pm 2.8$  mm versus  $43.7\pm 2.4$  mm;  $p<0.05$ ).<sup>5</sup>

It should be noted that the morphometry of femur depends on the ethnicity of the patients as well. Lee and colleagues reported that the mean femoral head diameter was largest in Chinese patients ( $45.2\pm 3.1$  mm), followed by Indian ( $44.4\pm 3.3$  mm) and Malay ( $44.2\pm 3.0$  mm) patients. The femoral head diameters in Chinese patients were significantly larger than those in Indian and Malay patients ( $p<0.05$ ). However, there was no statistically significant difference between the femoral head diameters in Indian and Malay patients ( $p>0.05$ ).

There are a few limitations of the present study. First, all patients were enrolled from the single centre. It could limit the generalizability of our results to whole of Nepal. Second, all X-ray and intra-operative measurements were not done by the same orthopedic surgeon over a period of four years. This could bring some subjectivity in our measurements.

## CONCLUSION

In our study, we found that the mean femoral head diameter was  $44.9 \pm 3.2$  mm. Male patients had significantly larger femoral head diameters as compared to female patients ( $47.7 \pm 2.8$  mm versus  $43.7 \pm 2.4$  mm, p value  $< 0.05$ ). This suggests that femoral head diameters are of value in sex differentiation. Further studies are needed in other geographical locations, so that reference values could be established for specific regions. This will help numerous surgeons in pre-operative planning of patients scheduled to undergo hip replacement surgeries.

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