Original Article

Access this article online

Quick Response Code:

Website: www.joas.org.in

DOI: 10.4103/JOASP.JOASP_23_22

# Effect of body mass index on the conventional method of templating in uncemented total hip arthroplasty: A prospective study

**Akshay Sharma, Kamparsh Thakur[1], Manish Prasad[1], Varun Vig[1]**

## Abstract

**BACKGROUND:** Preoperative templating is an important step in total hip arthroplasty (THA). Results of traditional as well as digital method of templating are well established in various studies. Very few studies have evaluated the effect of body mass index (BMI) and gender on templating. Our study was undertaken to evaluate the effect of BMI and gender in accurate size estimation in uncemented THA components by conventional method of templating.

**MATERIALS AND METHODS:** Preoperative radiographs were templated for 60 patients who underwent primary uncemented THA. BMI and gender of patients were noted during preoperative evaluation. Patients were grouped as per gender and divided into three groups as per BMI (underweight <18.5, normal 18.5-24.9, overweight >25). The estimated preoperative template size was compared with the actual implant size used. P-value of <0.05 was considered to be significant.

**RESULTS:** Acetabular component was exactly templated in 63.33% and femoral component in 76.6% cases. Gender and BMI had no statistical difference in component size prediction. Post-operative analysis of THA performed showed statistically significant association between high BMI and limb length discrepancy and restoration of femoral offset.

**CONCLUSION:** In our study, we found that femoral component is more accurately predicted. No statistically significant effect of gender and BMI was seen in accuracy of conventional method of templating in implant size estimation. However, BMI is found to affect limb length assessment during surgery and restoration of femoral offset.

**Keywords:**

BMI, gender, templating, total hip arthroplasty

*Department of Orthopaedics, Military Hospital, Jaipur, Rajasthan, [1]Department of Orthopaedics, Armed Forces Medical College, Pune, Maharashtra, India*

**Address for correspondence:** Dr. Kamparsh Thakur, Department of Orthopaedics, Golden Jubilee Block, Armed Forces Medical College, Wanowarie, Pune, Maharashtra, India. E-mail: drkamparsh@gmail.com

**Received:** 13 September 2022
**Accepted in revised form:** 14 November 2022
**Published:** 22 February 2023

## Introduction

Total hip arthroplasty (THA) is one of the most satisfying and effective surgeries performed in orthopedics. Results of THA are very successful in patients with hip arthritis complaining of persistent pain and disability.[1] Preoperative templating encompasses anticipation of type of implants to be used, size and position, determining offset, calculation of limb length inequality and any potential intra-op problem, using preoperative radiographs to restore biomechanical forces around the hip.[2-4] Periprosthetic fractures as a result of overestimation of implant size as well as component loosening due to underestimation of implant size can be prevented by accurate implant size selection.[5] Obesity prevalence is increasing in our society due to modern lifestyle.[6] It has been proposed that the thickness of subcutaneous fat may obscure bony landmarks which deteriorate optimal implant positioning and prolong operative time. The effect of body mass index (BMI) on THA functional outcome, quality of life, and



**How to cite this article:** Sharma A, Thakur K, Prasad M, Vig V. Effect of body mass index on the conventional method of templating in uncemented total hip arthroplasty: A prospective study. J Orthop Spine 2022;10:69-72.

complication rate has been investigated in many clinical studies.[7] Studies have evaluated the effect of BMI in results and functional outcome of THA. However, few studies have assessed the effect of BMI in templating.[8] With increasing prevalence of obesity, the effect of BMI on preoperative templating is becoming important for consideration. Studies have shown gender-specific variation in various pelvic parameters.[9] The effect of gender in templating results are not known. The hypothesis of our study was that BMI and gender have no effect on templating in THA.

## Material and Methods

Patients undergoing primary uncemented hip arthroplasty were included in the study. Patients who underwent cemented or hybrid THA or patients with fixed rotational deformity were excluded from the study.

Patient parameters including BMI were documented and recorded.

Well centered and exposed radiographs were taken pre-operatively.[10,11] As compared with normal anteroposterior (AP) view of pelvis, the AP view was taken with centering on the pubic symphysis. For templating purposes, a wider radiograph was taken with the proximal extent up to antero-superior iliac spine (ASIS) and distal extending to mid shaft of femur. To calculate the offset of the hip accurately on radiographs, the anteversion of hip was also considered. By internally rotating both lower limbs, femoral neck was brought parallel to the film, so that the full length of neck was seen, and offset was calculated properly. To determine the rotation on radiograph the lesser trochanter was assessed. In normal resting position of limb with 15°–20° external rotation, lesser trochanter is more prominent and usually measures more than 5 mm from femoral cortex. However, in 15°–20° of internal rotation, the value lies between 2–5 mm and will not be seen or less than 2 mm in case of excessive internal rotation. All the X-rays were obtained with 100 cm of distance from the tube to the X-ray plate. We controlled magnification by taking a standard object, metallic femoral head of 36 mm in between both thighs near pubis in plane of greater trochanter. Once X-rays were found to be of acceptable magnification and well centered, anatomical and mechanical landmarks were marked on X-ray, as described by Scherlink *et al*.[11] Templated size of acetabular and femoral component, limb length difference, and femoral offset were documented.

### Procedure of acetabulum templating

Well positioned and centered anteroposterior pelvis and lateral X-rays of hip were taken. Landmarks marked on acetabular side were superolateral corner of acetabulum, illioischial line, and teardrop. Inter-teardrop line was drawn first. The inclination of acetabular component was decided by drawing a line 45° to inter-teardrop line at the teardrop. The acetabular component was chosen so that its distal and medial-most parts lie just lateral to teardrop with inferior margin at obturator foramen. The acetabulum component was chosen, not crossing the illioischial line with adequate preservation of subchondral bone. While assessing lateral coverage, large osteophytes were not considered and the component with adequate lateral coverage was chosen. The component that fulfilled all the above criteria and causing minimum loss of subchondral bone was chosen and its center was marked on the X-ray. The templated acetabulum component was recorded.

### Procedure of femoral templating

After acetabular templating, the center of acetabulum component was marked and used as the new center of rotation of hip. The axis of femoral shaft was drawn on AP and lateral X-ray. The femoral component was chosen which perfectly fit the proximal femur, axis aligned with femoral shaft axis, and consideration was given for minimal loss of medullary canal. The center of femoral stem was marked and adjusted for limb length in relation to acetabular center of rotation.

All patients were operated using posterolateral approach. The intraoperatively-used component was recorded. Postoperative radiographs were analyzed for restoration of horizontal offset, acetabular component inclination, and limb length discrepancy.

### Statistical analysis

Descriptive statistics (frequency and percentages) were calculated for sample demographic characteristics of the study participants. Chi-square analysis was done to find out the association of BMI with various preoperative predictions and surgical outcomes among study participants. A value of $P < 0.05$ was taken as statistically significant.

## Results

There were 60 participants in this study with mean age of 55.95 (±9.82) years. The sample comprised of 36 male and 24 female patients. The cases were further divided into three groups based on their BMI as underweight, normal, and overweight. Other demographic features of the study participants are shown in Table 1.

The association of BMI [Table 2] and gender [Table 3] with various preoperative predictions and surgical outcomes were explored but no significant association was found.

Postoperative association of BMI and restoration of offset, limb length discrepancy were also explored

**Table 1: Demographic parameters of study participants**

| | Study population Total (*N* = 60) *n* (%) |
|---|---|
| Age group (years) | |
| 30–45 | 9 (15.0) |
| 45–60 | 32 (53.3) |
| 60–75 | 19 (31.7) |
| Gender | |
| Male | 36 (60.0) |
| Female | 24 (40.0) |
| BMI classification | |
| Underweight | 2 (3.3) |
| Normal | 42 (70.0) |
| Overweight | 16 (26.7) |

BMI = body mass index

**Table 2: Association of BMI with various preoperative predictions among study participants**

| Characteristics | BMI | | | *P*-Value |
|---|---|---|---|---|
| | Underweight | Normal | Overweight | |
| Accurate acetabular prediction | | | | |
| Yes | 1 | 29 | 8 | 0.374 |
| No | 1 | 13 | 8 | |
| Accurate femoral prediction | | | | |
| Yes | 1 | 23 | 12 | 0.356 |
| No | 1 | 19 | 4 | |

BMI = body mass index

**Table 3: Association of gender with various preoperative predictions among study participants**

| Templating | Accurate | Not accurate | *P*-Value |
|---|---|---|---|
| Acetabular component | | | |
| Male | 24 | 12 | 0.43 |
| Female | 14 | 10 | |
| Femoral component | | | |
| Male | 22 | 14 | 0.285 |
| Female | 13 | 11 | |

**Table 4: Association of BMI with postoperative limb length discrepancy and horizontal offset variation among BMI groups in study participants**

| Characteristics | BMI | | *P*-Value |
|---|---|---|---|
| | Underweight and normal | Overweight | |
| Limb length difference | | | |
| Up to 9 mm | 43 | 11 | 0.009 |
| Outliers | 1 | 5 | |
| Horizontal restoration of offset | | | |
| Exactly | 43 | 10 | 0.001 |
| Outliers | 1 | 6 | |

BMI = body mass index

[Table 4] and significant association between high BMI and poor restoration of horizontal offset and limb length was found.

Postoperative radiographs were evaluated to assess inclination and anteversion of acetabulum template in 45° ± 10° and 15° ± 10°. All patients were found to have acetabular inclination in safe range with average of 43.33° ± 0.429° and anteversion of 18°.

## Discussion

The goal of a successful THA is to achieve a painless and functional hip replacement. Accurate templating in various studies has shown increased precision during surgery, decreased operative time, reduced revision rates, and reduced overall complication rate.[2,12] Presently, with the advent of new software and 3D templating, more accurate prediction of component and potential intraoperative problems can be anticipated. However, one of the limiting factors in the use of advance templating methods is the affordability of expensive software. Hence, the traditional method of templating still finds its place in the setting where affordability of these software is an issue due to financial constraints.

In our study, we found more accurate prediction of femoral component as compared with acetabular components. We successfully templated 76.6% femoral components, whereas our accuracy of prediction for acetabular component was 63.3%. Results from our study are comparable with results obtained by other authors. The study conducted by Eggli *et al.*[3] of 100 THA performed reported predicting more than 90% of the components size accurately. In the study conducted by Untana *et al.*[2] in 2009, exact size was estimated in 42.2% of acetabular components and 68.8% of femoral components on templating preoperative radiographs in patients undergoing uncemented THA. Eggli *et al.*[3] suggested that decrease in accuracy in prediction was due to the peculiar feature of acetabular component. He attributed this decrease in prediction mainly to the variation in the intraoperative component used. The intraoperative component varied as it was difficult to control the pelvic fixation during surgery and with change in position the acetabulum component varied.

A few studies have postulated the effects of BMI on preoperative templating. The study conducted by Holzer *et al.*[12] showed poor size estimation in patients with higher BMI as compared with patients with normal BMI. The decrease in prediction of femoral component in patients with high BMI is due to improper positioning of radio-opaque reference objects while performing X-rays and consequently resulting in magnification errors.[12] However, results published by Sershon *et al.* found no significant effect of BMI on results of THA templating. In our study, there were 2 underweight, 42 normal weight, and 16 overweight patients. In our study, we were unable to find any statistically significant effect of BMI on prediction of hip arthroplasty components.

While assessing the effect of gender in templating, Sershon *et al*.[8] and Holzer *et al*.[12] found no gender-specific differences in prediction of size. Similarly, we had comparable results when gender was in consideration.

Restoration of femoral offset, placement of acetabulum in safe zone, and limb length discrepancy in acceptable limits are goals of successful arthroplasty. Horizontal offset is measured by distance from center of head to femoral axis. Al-Amiry, *et al*.[13] in their study showed significant impact of BMI on offset restoration. They ascribed the mechanical difficulty in restoring the offset to the increased adipose tissue and lack of a reliable method of intraoperative assessment of offset restoration. Our study also showed more higher offset variation in the high BMI group of patients. Our offset variation was 37.5% in the overweight group which was found to be statistically significant.

Limb length discrepancy is one of the common complications after THA. Currently, most studies accept less than 10 mm of variation. Intraoperative measurement of limb length in lateral position is done by palpating bony landmarks—patella and heel level and assessing soft tissue tension. Palpation of these landmarks is obscured by drapes and more so difficult in the presence of increased adipose tissue. Our study had 10% of patients who had variation in limb length vis-a-vis 15% in the study by Al-Amiry, *et al*.[13] Most of our limb length difference was found in the high BMI group, similar to the study by Al-Amiry, *et al*.[13] Statistically analyzing variation of limb length in all BMI groups showed *P*-value of 0.01 which is significant.

It has been recommended to place acetabular component in safe zone by Lewinnek.[14] In their study, to reduce the risk of postoperative dislocation, it was recommended to place a cup in 45° ± 10° of inclination and 15° ± 10° of anteversion. In our study, we were able to place all our cups in an acceptable range of inclination. Average inclination and anteversion obtained in our study were 43.33° and 18° respectively. Three of our components had excessive anteversion with no component in retroverted position.

Limitation of our study is in terms of small sample size. However, decrease in incidence of hip disease in the Indian population as compared with the western world explained this low number of hip arthroplasty performed. Presently, more sophisticated methods of templating are available; however, their high cost prevents their use.

## Conclusion

We rejected our null hypothesis as there was no statistically significant effect of BMI and gender on component size prediction on conventional radiographs in patients undergoing THA. However, the conventional method of templating resulted in an accurate prediction of 63.3% acetabulum and 76.6% of femoral component in our study. Our study showed significant association between high BMI and limb length discrepancy and poor restoration of femoral offset. Thus, conventional method of templating still is an effective method of estimating the component size.

### Financial support and sponsorship
Not applicable.

### Conflicts of interest
There are no conflicts of interest.

## References

1. Judge A, Arden NK, Kiran A, Price A, Javaid MK, Beard D, *et al*. Interpretation of patient-reported outcomes for hip and knee replacement surgery: Identification of thresholds associated with satisfaction with surgery. J Bone Joint Surg Br 2012;94:412-8.
2. Unnanuntana A, Wagner D, Goodman SB. The accuracy of preoperative templating in cementless total hip arthroplasty. J Arthroplasty 2009;24:180-6.
3. Eggli S, Pisan M, Müller ME. The value of preoperative planning for total hip arthroplasty. J Bone Joint Surg Br 1998;80:382-90.
4. Heinert G, Hendricks J, Loeffler MD. Digital templating in hip replacement with and without radiological markers. J Bone Joint Surg Br 2009;91:459-62.
5. Kim YH, Kim VE. Uncemented porous-coated anatomic total hip replacement. Results at six years in a consecutive series. J Bone Joint Surg 1993;75:6-13.
6. Arroyo-Johnson C, Mincey KD. Obesity epidemiology worldwide. Gastroenterol Clin North Am 2016;45:571-9.
7. Jeschke E, Citak M, Günster C, Halder AM, Heller KD, Malzahn J, *et al*. Obesity increases the risk of postoperative complications and revision rates following primary total hip arthroplasty: An analysis of 131,576 total hip arthroplasty cases. J Arthroplasty 2018;33:2287-2292.e1.
8. Sershon RA, Diaz A, Bohl DD, Levine BR. Effect of body mass index on digital templating for total hip arthroplasty. J Arthroplasty 2017;32:1024-6.
9. Atkinson HD, Bailey CA, Willis-Owen CA, Oakeshott RD. Bilateral hip arthroplasty: Is 1-week staging the optimum strategy? J Orthop Surg Res 2010;5:84.
10. González Della Valle A, Comba F, Taveras N, Salvati EA. The utility and precision of analogue and digital preoperative planning for total hip arthroplasty. Int Orthop 2008;32:289-94.
11. Scheerlinck T. Primary hip arthroplasty templating on standard radiographs. A stepwise approach. Acta Orthop Belg 2010;76:432-42.
12. Holzer LA, Scholler G, Wagner S, Friesenbichler J, Maurer-Ertl W, Leithner A. The accuracy of digital templating in uncemented total hip arthroplasty. Arch Orthop Trauma Surg 2019;139:263-8.
13. Al-Amiry B, Pantelakis G, Mahmood S, Kadum B, Brismar TB, Sayed-Noor AS. Does body mass index affect restoration of femoral offset, leg length and cup positioning after total hip arthroplasty? A prospective cohort study. BMC Musculoskelet Disord 2019;20:1-6.
14. Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman JR. Dislocations after total hip-replacement arthroplasties. J Bone Joint Surg Am 1978;60:217-20.