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EDITORIAL

## Offset restoration in total hip arthroplasty: Important: A current review

Anil Thomas Oommen

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### Abstract

Normal vertical and horizontal offset is essential for hip biomechanics, muscle functioning and gait pattern. Total hip arthroplasty (THA) should aim to restore normal offset with implantation of femoral and acetabular components. This would be possible with proper preoperative planning, templating and ensuring implant options are available for offset restoration. Templating is essential for understanding the vertical and horizontal offset change, especially in hip arthritis presenting late with significant limb length discrepancy at THA. Planning should include appropriate soft tissue releases and the use of ideal implants to achieve restoration of horizontal and vertical offset. Under correction of horizontal offset at THA for fracture neck of femur could result in abductor fatigue, limp and increased wear. Restoration of horizontal offset is imperative at THA for a fractured neck of the femur to achieve optimal abductor function. Horizontal offset is necessary for optimal abductor muscle tension and function. Revision THA for acetabular bone loss would require hip center restoration with the acetabular and femoral offset correction to achieve limb length correction and abductor length. The inability to achieve vertical and horizontal offset correction could lead to dislocation or signs of abductor fatigue. Careful vertical and horizontal femur offset restoration is required for normal hip biomechanics, decreased wear and increased longevity.

Key Words: Offset; Vertical; Horizontal; Total hip arthroplasty; Templating; Restoration

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**Core Tip:** Total hip arthroplasty (THA) requires careful attention to achieve restoration of both the vertical and horizontal offset. The vertical offset is critical to establish the correct limb length; inadequate restoration of vertical offset results in limb length discrepancy and poor clinical outcomes. The horizontal offset plays a role in obtaining optimal abductor tension and function, allowing for normal gait. Failure to achieve normal horizontal offset leads to sub-optimal abductor function, fatigue, limp, increased wear, and possible THA instability. Pre-operative templating and intra-operative execution of this plan allow for offset restoration, appropriate soft-tissue releases, and suitable implant selection, which ultimately results in hip center restoration and recreation of normal hip biomechanics.

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### INTRODUCTION

Total hip arthroplasty (THA) aims to restore biomechanics and function as close as possible to the native hip[1]. This can be accurately achieved by restoring the acetabular inclination, version and, more importantly, the center of rotation (COR). The correct COR allows for the establishment of the acetabular, femoral, and global offset. Acetabular offset is measured from the COR to the true floor of the acetabulum or to the center of the pelvis. Femoral offset is defined as the distance from the COR to the center of the femoral canal. In this horizontal plane, the combination of acetabular and femoral offset is defined as a global offset.

Once the COR has been established, both horizontal and vertical offset restoration is required for the recreation of native hip biomechanics (Figures 1 and 2)[1–5]. The acetabular, femoral, and global offsets are ideally templated preoperatively, assessed intra-operatively, and critiqued post-operatively to ensure ideal correction. Adequate horizontal offset is necessary for optimal functioning of the abductors (Figure 3); a decrease in horizontal offset could lead to abductor fatigue and a persistent Trendelenberg gait. Hip function significantly improves with proper restoration of horizontal offset[1]. Improper restoration of vertical offset can result in limb length discrepancy, resulting in an unhappy patient.

### TEMPLATING

Planning for THA includes pre-operative templating, which must be corroborated with the intra-operative findings. The size of the femoral and acetabular components and the offset requirements are assessed to enable restoration of normal hip biomechanics, leg length and hip center restoration.

Two-dimensional templating can be done routinely in almost all centers, while 3D-templating requires technologyassisted THA. Three-dimensional templating could prove to be more precise. However, 2D templating provides reliable information for intra-operative assessment[6–8].

### PRIMARY THA, COMPLEX PRIMARY THA

Templating provides valuable information regarding the position of the COR and femoral offset, as well as the proposed sizing and position of the acetabular and femoral components. The various trial offset options can restore the horizontal offset before the femoral component is implanted (Figures 3 and 4). Pre-operative planning should be done with specific attention to restoring the COR and matching options to restore the horizontal and vertical offset (Figure 2B).

Acetabular true floor identification is important intra-operatively to ensure appropriate reaming, medialization, and COR restoration. The appropriate medialization with the restoration of the femoral offset would be ideal for restoring the hip global offset, outcome and function[1]. Reduction in global offset could lead to impingement, instability and increased risk of dislocation[1].

Patient-specific restoration is possible with proper templating and pre-operative planning[6,7,9,10]. Individual hip biomechanics can be restored with information gleaned from proper pre-operative templating. Trial implants can be used to ascertain the ideal options before final component implantation. An increase in neck length would achieve correction of both the horizontal and vertical offset, resulting in increased offset and soft-tissue irritation (*e.g.* trochanteric bursitis) and an undesired limb length discrepancy. A high offset stem would only change the horizontal offset without affecting the limb length (Figures 5 and 6). Functional joint scores have been reported as better with minimal increase in the acetabular and global offset[7]. Under correction or increase in offset can be avoided by careful pre-operative templating and intra-operative execution (Figure 2B).

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Figure 1 X-ray both hips anteroposterior for preoperative planning. A: Offset assessment. a: Acetabular offset; b: Femoral offset/ horizontal offset; a + b: Combined offset; c: Global offset; B: Limb length discrepancy measurement-inter-teardrop line, line-the center of lesser trochanter-the difference between 2 lengths a1, a2; b: Denotes the vertical offset.



Figure 2 Offset-horizontal needs careful assessment. A: Horizontal offset represented by a; B: Neck trial options available including short neck, standard offset, and high offset-for Corail-Depuy, Johnson and Johnson, United States.



Figure 3 Templating for total hip arthroplasty requires preoperative and intraoperative assessment. A: Preoperative templating to ascertain acetabular size and center of rotation; B: Femur templating provides optimal size and horizontal offset; C: Intra-operative templating with trial reduction provides information regarding offset correction. Trial reduction with offset options available would prevent under-correction or increase in offset.

### FRACTURE NECK OF FEMUR

THA for fracture neck of femur in an older individual can provide excellent functional outcomes with proper restoration of the horizontal offset. Recent evidence suggests that incorrect offset restoration could impair function and outcome in these situations. The risk of inaccurate restoration seems to be higher in surgeons without regular experience in hip arthroplasty[11]. THA for a fractured neck of the femur should be done with appropriate pre-operative planning and



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Figure 4 Horizontal offset needs careful assessment. A: A 51-year-old lady with a painful right hip, normal left hip shows a short neck and reduced horizontal offset; B: Total hip arthroplasty done with reduced neck length–short neck to match the normal offset -left hip. Horizontal and vertical offset restored.



Figure 5 Increased horizontal offset needs to be identified preoperatively. A: Preoperative right hip arthritis with neck length matching high offset option; B: Both pre-operative and intraoperative templating are required to restore offset. High offset total hip arthroplasty establishes horizontal and vertical offset; C: Preoperative left hip arthritis with neck shaft angle 120 degrees and neck length matching high offset option; D: High offset total hip arthroplasty establishes both

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#### horizontal and vertical offset



Figure 6 Horizontal and vertical offset need restoration. A: A 41-year-old lady with left hip childhood arthritis sequelae; B: Total hip arthroplasty left hip with appropriate soft tissue release and modular stem achieved both horizontal and vertical offset restoration.



Figure 7 Restoration of horizontal offset and optimal abductor function. A: Fracture neck of femur planned for total hip arthroplasty; B: Templating on the normal left hip shows a high offset requirement; C: High offset stem implanted with horizontal and vertical offset restoration and good functional outcome.

templating to restore the length and offset (Figure 7).

### **REVISION THA**

The restoration of horizontal offset is necessary in hips with proximal migration along with acetabular defects requiring reconstruction. Hip COR with the establishment of the horizontal and vertical offset is critical as horizontal offset plays a significant role in abductor function (Figures 8 and 9).

Indication for revision THA could be inadequate restoration of offset with well-fixed femoral and acetabular components. Use of the bio ball adapter to restore the offset in revision THA has been reported with good one-year results[12].

Recent data suggest that establishing the horizontal and vertical offset improves function and longevity and postpones the need for revision. Satisfaction was much lower in individuals with inadequate restoration of offset and length.

### DISCUSSION

Offset restoration with particular attention to horizontal and vertical offset is needed to recreate native hip biomechanics.



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Figure 8 Hip center and horizontal center restoration. A and B: 18-year post-operative bipolar arthroplasty with right hip pain due to acetabular erosion. Proximal migration, shortening, and loss of horizontal offset: C and D: 2-year follow-up of right hip conservative revision -acetabular component implantation with impaction bone grafting. Horizontal and vertical offsets were restored with a good functional outcome.



Figure 9 Inadequate vertical and horizontal offset. A: A 29-year-old lady six years post total hip arthroplasty with pain and limp due to inadequate horizontal and vertical offset restoration; B: 1-year post-revision total hip arthroplasty with horizontal and vertical offset restoration.

A minimal increase in horizontal offset up to 5 mm restores hip biomechanics, function with favorable long-term outcomes, while decreased offset can prove detrimental[1]. Inadequate restoration of both horizontal and vertical offset could lead to dislocation, which would require revision to establish normal length and offset (Figure 10). Failure to restore offset would result in a reduced range of motion and functional outcome[13]. Femoral stems are available with a short neck and standard and high offset options. Offset options are essential in offset restoration as seen in various studies[1,3,5,7,14,15]. Using high-offset stems has increased stability and reduced dislocation rates in hip arthroplasty [16]. Modular necks have also been considered for offset adjustment and restoration at THA. Modularity, especially at the neck, should be avoided, and using modular necks for THA offset restoration has shown poor results, especially in obese patients<sup>[17]</sup>.

Restoration of offset should be individual based with appropriate preoperative and intraoperative templating and assessment to achieve normal function and good outcome with longevity. Under correction and overcorrection should be avoided[9,13].

### CONCLUSION

Offset restoration at THA requires careful preoperative and intraoperative templating to avoid under-correction. The trial neck options should be available after preoperative templating. An increase in offset can be avoided with intraoperative templating and trial reduction before final implantation.



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Figure 10 Failure to restore vertical and horizontal offset resulted in dislocation. A and B: Acetabular reconstruction and total hip arthroplasty with failure to establish horizontal and vertical offset resulted in dislocation 3 months postop; C and D: Revision total hip arthroplasty with femoral shortening, soft tissue release and modular components achieved horizontal and vertical offset restoration with good radiological and functional outcome at 4-year follow-up.

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