A Comparison between 2D and 3D Digital Templating for Resurfacing Hip Arthroplasty

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INTRODUCTION:
Proper component size selection in hip resurfacing is important to reduce the risk of femoral neck notching and to obtain greater ROM without impingement. Recently, computer assisted templating system such as 2D digital templating and CT-based 3D templating has been developed to improve the accuracy of templating. However, there have been few reports regarding the accuracy of templating for hip resurfacing.

PURPOSE:
The purpose of this study was to assess and compare the accuracy of 2D digital templating and 3D-CT based templating for hip arthroplasty.

METHODS:
The subjects are consecutive 56 patients with 66 hips who underwent hip resurfacing arthroplasty using Adept hip system (Finsbury, UK). The mean age at surgery was 49 years (range, 24 to 73). The patients had anteroposterior radiographs of bilateral hip joints with a 1-inch ball marker for size calibration and 3D-CT scan preoperatively.

2D digital templating was performed using digital radiograph templating software (CasePlan, Stryker). After correcting the magnification using the marker, the stem-shaft angle was set in slightly valgus so that the femoral stem axis aligned to the femoral medial cortex. The femoral component size to fit the head neck junction was selected. And then the cup size 6 mm larger than the femoral component was selected.

3D-CT based templating was performed using our developed digital software which can show multiple planar reconstructed images through any orthogonal planes. Oblique coronal and sagittal planes of the femoral neck were reconstructed through the femoral neck axis. The stem-shaft angle was set in valgus so that the femoral stem axis aligned to the femoral medial cortex on the oblique coronal plane. The anteverision of the femoral component was set to be parallelized to the femoral neck axis on the oblique sagittal plane. The femoral component size to fit the head neck junction was selected on these 2 orthogonal planes. Then multiple radial planes through the femoral stem were reconstructed in every 15 degrees of increment for the fine tuning of the plan. When more than 1mm of femoral neck notching was detected, the femoral component was translated on the radial plane to avoid notching. The cup 6 mm larger than the femoral component was selected. When it is possible to increase the cup size, both the cup and the femoral component were changed to 1 size larger ones.

We calculated the percentage of agreement between the planned component size and actual implanted one. To investigate the effect of femoral head deformity on the accuracy of both templating, the femoral head deformity index was assessed by dividing the width of the femoral head by its height. The height of the femoral head was measured from the head neck junction (Fig 4). The patients were divided into two groups based on the deformity index; the cases with the deformity index of less than 1.5 were grouped into the minimal deformity group, the cases with the deformity index of 1.5 or more were grouped into the deformity group.

RESULTS:
The percentage of agreement for the acetabular and femoral component size was 74% (49 of 66 hips) in the 2D digital templating and 95% (63 of 66 hips) in the 3D-CT based templating (p<0.05, Chi square test) (Fig 5).

Thirty eight of 66 hips were classified into the minimal deformity group, 28 of 66 hips were classified into the deformity group. In the minimal deformity group, the agreement of size selection for acetabular and femoral components were 92% (35 of 38 hips) in the 2D digital templating and 100% (38 of 38 hips) in the 3D-CT based templating (Fig 6).

In the deformity group, the agreement of size selection for acetabular and femoral components were 50% (14 of 28 hips) in the 2D digital templating, 89% (25 of 28 hips) in the 3D-CT based templating (p<0.05, Chi square test) (Fig 7).

DISCUSSION AND CONCLUSION:
The accuracy of component size selection in 2D analogue preoperative templating for hip resurfacing has been reported to be 47% for the acetabular component, 54% for the femoral component. In our study, the accuracy of 2D digital templating was 74% for acetabular and femoral components. This indicated that the size calibration of 2D digital templating improved the accuracy of component size selection.

However, in the 2D digital templating, the accuracy of component size selection in the deformed femoral heads (50%) was lower than that in the minimal deformed femoral heads (92%) in both acetabular and femoral components. This indicated that it was difficult to assess the femoral component size to fit the head neck junction in the deformed femoral head using 2D digital templating. The accuracy of 2D templating was significantly influenced by the femoral head deformity. We considered that this was a limitation of 2D digital templating for hip resurfacing. The deformity index was useful to assess the degree of femoral head deformity and to predict the utility of 2D templating for each case.

This study showed that 3D-CT based preoperative planning for hip resurfacing was accurate regardless of the grade of femoral head deformity. We highly recommended using the 3D-CT based templating for hip resurfacing in the deformed hips.

In conclusion, the accuracy of 2D digital templating for hip resurfacing was comparable to the CT-based 3D templating in the minimal deformed hips. In the deformed hips, the 2D digital templating was less accurate than the CT-based 3D templating.

SIGNIFICANCE:
3D-CT based preoperative planning for hip resurfacing was accurate compared to 2D digital templating, especially for deformed femoral head with the deformity index 1.5 or more.

REFERENCE: