Comparison of offset in Birmingham hip resurfacing and hybrid total hip arthroplasty

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Hip resurfacing is being performed more frequently in the United Kingdom. The possible benefits include more accurate restoration of leg length, femoral offset and femoral anteverision than occurs after total hip arthroplasty (THA).

We compared anteroposterior radiographs from 26 patients who had undergone hybrid THA (uncemented cup/cemented stem), with 28 who had undergone Birmingham Hip Resurfacing arthroplasty (BHR). We measured the femoral offset, femoral length, acetabular offset and acetabular height with reference to the normal contralateral hip. The data were analysed by paired t-tests.

There was a significant reduction in femoral offset (p = 0.0004) and increase in length (p = 0.001) in the BHR group. In the THA group, there was a significant reduction in acetabular offset (p = 0.0003), but femoral offset and overall hip length were restored accurately. We conclude that hip resurfacing does not restore hip mechanics as accurately as THA.

Metal-on-metal hip resurfacing is being performed with increasing frequency in the UK. We feel that it improves mobility because of the ‘natural feel’ of the arthroplasty and recommend it for younger, more active patients.1

The differences between resurfacing and conventional total hip arthroplasty (THA), which include a larger size of femoral head, preservation of femoral bone stock and more anatomical restoration of leg length and femoral offset2,3 may account for the improved dynamics.

Our aim in this study was to compare the restoration of hip mechanics after resurfacing and hybrid THA.

Patients and Methods

Between March 2001 and December 2002, 46 patients received metal-on-metal resurfacing and 47 hybrid THA all carried out by a single surgeon (JPH). The implants used were the Birmingham Hip Resurfacing arthroplasty (BHR; Midland Medical Technology, Stoke Prior, Bromsgrove, UK; Fig. 1) or the cemented Exeter stem (Stryker, Howmedica, Newbury, Berkshire, UK) with a 28 mm head and an uncemented acetabular component which was either ABG II (Stryker, Howmedica) or Trilogy (Zimmer, Warsaw, Indiana) (Fig. 2).

A posterior approach was used with release of the insertion of gluteus maximus and circumferential capsulotomy. Radiographs were templated before surgery in all patients. The surgeon had been performing BHRs for two years before the study and was experienced in both procedures. BHR was used in patients who were younger and more active than those having THA.

Measurements were taken from standardised post-operative anteroposterior radiographs of the pelvis centred on the symphysis pubis, with the patient lying supine and the great toes touching to maintain consistent femoral rotation.

The post-operative radiograph of the operated hip was compared with the contralateral hip, in order to eliminate the changes in the hip biomechanics from pre-operative morbidity in the operated hip. Since all measurements were taken from the same radiograph the magnification was assumed to be constant. At this stage 39 patients were excluded because the radiographs were inadequate in 25 and the contralateral hip was abnormal in 14. This left 28 in the BHR group, and 26 in the THA group. The mean age of the BHR group was 50 years (39 to 58) and of the THA group 62 years (45 to 82). The gender distribution was comparable in both groups.

The effect of component placement on offset and limb length was assessed by the techniques described by Nunn et al4 and Jolles, Zangger and Leyvraz.5 These provide a guide to the mechanics of the hip in two planes at right
angles to each other (vertical and horizontal). Anteversion was not measured. Four standard measurements were made on each radiograph (Fig. 3):

1) Femoral offset. The anatomical femoral axis (FA) was marked together with the centre of rotation of the femoral head determined by templating. The femoral offset represents the perpendicular distance from the femoral axis to the centre of rotation (line B; Fig. 3a).

2) Femoral length. This is the distance in the line of the anatomical femoral axis from the tip of the greater trochanter to the line perpendicular to the femoral head (line C; Fig. 3a).

3) Cup offset. This is the distance from the medial border of the teardrop (line A) to the centre of rotation of the acetabulum which corresponds to the centre of rotation of the femoral head, parallel to Hilgenreiner’s line (HR) (line D; Fig. 3b).

4) Cup height. This is the distance in the vertical plane from the centre of rotation of the acetabulum to a line drawn between the base of the teardrops, parallel to Hilgenreiner’s line (line E; Fig. 3b).

**Statistical analysis.** Total offset was defined as the sum of the femoral and acetabular offsets. Hip length was defined as the femoral length minus the cup height.

The operated and control measurements were compared using a paired t-test. BHR and hybrid THA were compared by a ratio of the post-operative measurements divided by the control measurements using an unpaired t-test.

Although a large number of studies have used similar techniques we assessed the reproducibility of our own measurements. Intra-observer variation was determined from ten randomly selected sets of radiographs measured initially and after several weeks by two of the authors (JML, DC). Interobserver variability was determined using the same ten radiographs, assessed independently and analysed by the Pearson correlation coefficient. Scores between 0.61 and 0.80 represented good and those greater than 0.81 excellent correlation.

**Results**

Inter- and intra-observer variability was excellent in all measurements except femoral offset which was good (Table I).

Details of the results are given in Table II. In the BHR group, the femoral offset was significantly reduced \( (p = 0.0004) \), and the femoral \( (p = 0.001) \) and hip \( (p = 0.0003) \) length increased. In the THA group, cup offset was reduced \( (p = 0.0003) \) and the femur lengthened \( (p = 0.006) \) but with a higher cup placement \( (p = 0.0001) \), resulting in more anatomical hip length. In both groups the total offset was reduced \( (p = 0.045) \).

The ratio of post-operative and control measurements showed greater femoral offset \( (p = 0.002) \), and a trend...
towards increased hip length ($p = 0.057$) in the BHR group. Figures 4 and 5 show box-and-whisker plots for femoral and acetabular offset giving the median, upper and lower quartiles and the confidence interval around the median.

The control measurements for the BHR and THA groups were very similar confirming the reproducibility of the measurements and suggesting comparable mechanics of the hip before the onset of disease.

The absolute differences in the post-operative and control measurements were small. The greatest change was in femoral offset which was reduced in the BHR group by a mean of 4.5 mm.

**Discussion**

With encouraging results$^9$ and increasing use of hip resurfacing, there is a need for better understanding of the key differences between it and conventional THA. This may have implications for future modifications of design of the components and the surgical technique of resurfacing arthroplasty.

Reproduction of hip mechanics after resurfacing are not as good as has been suggested.$^{2,3}$ There are a number of variations in the surgical technique which could produce the changes which we have demonstrated. The amount of bone resected from the femoral head can be altered and this affects the offset and length of the femur. Varus alignment of the femoral component increases femoral offset and the tension on the femoral neck increasing the risk of fracture.$^{10}$ The femoral component should therefore be placed in either neutral or valgus alignment, and this reduces femoral offset.

There is greater versatility with a cemented femoral stem including a trial implantation to ensure accurate offset and leg length. In our series this gave better overall hip length in the THA group (Table II).

Subjectively, patients had greater levels of activity after BHR than after THA as has been suggested by Amstutz et al.$^{11}$ they are discharged sooner and report an excellent 'natural feel' of the hip.

We have not been able to assess this improvement subjectively and since the BHR group was pre-selected for higher functional demand we anticipate difficulties in validating any assessment. We do not believe that the difference in offset affects function. Although the reduced offset should be detrimental to normal function, the difference, is likely to

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**Table I. Reproducibility of measurements**

<table>
<thead>
<tr>
<th></th>
<th>Femoral offset</th>
<th>Cup offset</th>
<th>Femoral length</th>
<th>Cup height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-observer error</td>
<td>0.97</td>
<td>0.99</td>
<td>0.99</td>
<td>0.96</td>
</tr>
<tr>
<td>Inter-observer error</td>
<td>0.77</td>
<td>0.91</td>
<td>0.96</td>
<td>0.86</td>
</tr>
</tbody>
</table>

**Table II. Analysis of the measured parameters (mm) in both groups**

<table>
<thead>
<tr>
<th></th>
<th>Resurfacing</th>
<th>Total hip arthroplasty</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-operative</td>
<td>Post-operative</td>
<td>p value</td>
</tr>
<tr>
<td>Femoral offset</td>
<td>49.4</td>
<td>44.9</td>
<td>0.0004</td>
</tr>
<tr>
<td>Cup offset</td>
<td>40.7</td>
<td>42.8</td>
<td>0.02</td>
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<tr>
<td>Femoral length</td>
<td>3.7</td>
<td>6.8</td>
<td>0.001</td>
</tr>
<tr>
<td>Cup height</td>
<td>17.3</td>
<td>16.8</td>
<td>0.57</td>
</tr>
<tr>
<td>Total offset</td>
<td>90.1</td>
<td>87.6</td>
<td>0.045</td>
</tr>
<tr>
<td>Hip length</td>
<td>6.4</td>
<td>10.0</td>
<td>0.003</td>
</tr>
</tbody>
</table>
be clinically insignificant. Our findings indicate that resurfacing does not produce more accurate restoration of leg length or offset.

The advantages of BHR over THA are more likely to result from increased range of movement because of the larger femoral head and enhanced stability. Preservation of femoral bone stock may also be beneficial. While we anticipate that there will be more studies on the outcome of hip resurfacing, further research is necessary to measure objectively femoral anteversion and the range of hip movement.

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References


