Failure rates for 4762 revision total hip arthroplasties in the Norwegian Arthroplasty Register

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We present the results for 4762 revision total hip arthroplasties with no previous infection in the hip, which were reported to the Norwegian Arthroplasty Register between 1987 and 2003. The ten-year failure rate for revised prostheses was 26% (95% CI 25 to 26). Cox regression analyses were undertaken separately for acetabular and femoral revision components. Cemented revision components without allograft was the reference category. For acetabular components, we found a significantly reduced risk of failure for uncemented revisions both with (relative risk (RR) = 0.66; 95% CI 0.43 to 0.99) and without (RR = 0.37; 95% CI 0.22 to 0.61) allograft. For femoral components, we found a significantly reduced risk of failure for uncemented revisions, both with (RR = 0.27; 95% CI 0.16 to 0.46) and without (RR = 0.22; 95% CI 0.11 to 0.46) unimpacted allograft. This reduced risk of failure also applied to cemented revision components with allograft (RR = 0.53; 95% CI 0.33 to 0.84) and with impaction bone grafting (RR = 0.34; 95% CI 0.19 to 0.62). Revision prostheses have generally inferior results when compared with primary prostheses. Recementation without allograft, and uncemented revision with bone impaction, were associated with worse results than the other revision techniques which we studied.

Within ten years, 11% of all primary prostheses in the Norwegian Arthroplasty Register failed. The treatment of patients with a revised prosthesis is a challenge to the orthopaedic surgeon. Documentation of the results for revision prostheses is sparse, although some studies have been undertaken.1-10 There are also studies from the Swedish National Hip Arthroplasty Register with results from a large number of revision hip prostheses.11-14 In terms of both function and survival the results of revision surgery have been regarded as inferior to primary total hip arthroplasty (THA).15 Different techniques have been described on how to approach revision hip arthroplasty. Traditionally, recementation of both the acetabulum and the femur have been common.13,14 In the 1990s, impaction cancellous allografting and cementing was introduced for both components.16-18 Uncemented, porous-coated acetabular revision and uncemented, extensively-coated femoral stem revision have become popular during the last decade and are associated with good results.19-22 There is, however, no consensus on the best method for revision.23

The aim of our study was to describe the results of hip revision operations using data from the Norwegian Arthroplasty Register.

Patients and Methods
The Norwegian Arthroplasty Register has collected information on prosthetic hip operations since September 1987. In this study, we selected revision operations which had been reported to the Register, and where the corresponding primary total hip replacement operation was also identified in the register. The number of primary operations was 78 534. There were reports on 5137 revisions, 375 of which were due to infections and were excluded from further analyses. Thus 4762 revision prostheses (4538 patients) remained for further analyses.

Linking the sequential operations and date of death, obtained from Statistics Norway (www.ssb.no/english), was undertaken by using the personal identification number for Norwegian citizens. The end of the study was set to 1 March 2003.

The analyses for the revision operations were undertaken separately for both acetabular and femoral components. A revision operation was defined as an operation which demanded removal or exchange of a component. For example, an acetabular or femoral component, which had been inserted at a revision operation was followed until the next operation on the same hip. A change of
Table I. Number of operations, infections, and the cumulative ten-year risk for a subsequent operation following THA

<table>
<thead>
<tr>
<th>Operation</th>
<th>Total Number of Operations</th>
<th>Revised Prostheses</th>
<th>Revision due to Infection</th>
<th>Percentage Revised at ten years</th>
<th>95% CI</th>
<th>Operations without previous infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Primary</td>
<td>78534</td>
<td>5137</td>
<td>375</td>
<td>11.4</td>
<td>11.3 to 11.4</td>
<td>78534</td>
</tr>
<tr>
<td>2nd Revision</td>
<td>5137</td>
<td>774</td>
<td>163</td>
<td>27.9</td>
<td>27.1 to 28.7</td>
<td>4762</td>
</tr>
<tr>
<td>3rd Re-revision</td>
<td>774</td>
<td>158</td>
<td>36</td>
<td>40.5</td>
<td>35.2 to 46.3</td>
<td>522</td>
</tr>
</tbody>
</table>

Table II. Revision of acetabular components following THA. Number of revisions, re-revisions, Cox regression analyses adjusted for age at revision and gender, and selected characteristics for the different methods of fixation and bone graft were used to calculate relative risks (RR)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Revisions</th>
<th>Re-revisions</th>
<th>Median follow-up yrs</th>
<th>Primary Charnley (%)</th>
<th>Revision Charnley (%)</th>
<th>Primary OA (%)</th>
<th>Men (%)</th>
<th>Primary uncremented (%)</th>
<th>Age in yrs at revision operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RR</td>
<td>95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cemented*</td>
<td>No bone graft</td>
<td>1108</td>
<td>82</td>
<td>1</td>
<td>-</td>
<td>4.1</td>
<td>58</td>
<td>48</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Allograft</td>
<td>301</td>
<td>14</td>
<td>0.60</td>
<td>0.34 to 1.06</td>
<td>3.6</td>
<td>30</td>
<td>27</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Impaction bone graft</td>
<td>259</td>
<td>12</td>
<td>0.70</td>
<td>0.38 to 1.30</td>
<td>3.0</td>
<td>32</td>
<td>35</td>
<td>61</td>
</tr>
<tr>
<td>Uncemented</td>
<td>No bone graft</td>
<td>542</td>
<td>20</td>
<td>0.37</td>
<td>0.22 to 0.61</td>
<td>3.8</td>
<td>27</td>
<td>62</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Allograft</td>
<td>487</td>
<td>33</td>
<td>0.66</td>
<td>0.43 to 0.99</td>
<td>4.7</td>
<td>19</td>
<td>52</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Impaction bone graft</td>
<td>54</td>
<td>4</td>
<td>1.03</td>
<td>0.38 to 2.83</td>
<td>3.3</td>
<td>24</td>
<td>57</td>
<td>52</td>
</tr>
</tbody>
</table>

* antibiotic-containing cement

Results

Of the 4762 revision operations, 1812 (38%) were undertaken on men and 2950 (62%) on women. The mean age at the time of revision was 68.5 years (SD = 12.0) for men and 69.0 years (SD = 11.7) for women. At the corresponding primary operation the mean age was 63.6 years (SD = 12.5) for men and 63.8 years (SD = 12.2) for women.

Of the entire 78534 primary operations, 23603 (30%) were undertaken on men and 54931 (70%) were undertaken on women, with mean ages 67.5 years (SD = 11.6) and 70.1 years (SD = 10.6), respectively. The median follow-up for revision operations was 4.3 years and for re-revisions, without previous infections, it was 3.2 years. For primary operations the median follow-up was 5.6 years.

The probability of requiring revision surgery within ten years for all the primary operations, reported to the Norwegian Arthroplasty Register (Table I) was 11.4% (95% CI 11.3 to 11.4). For a revision operation, with no infection, the ten-year risk of failure was 25.6% (95% CI 24.8 to 26.4).

There were 2751 (58%) acetabular components revised in the 4762 revision operations (Table II). For these acetabular components the Kaplan-Meier curves for the different categories of revision show the differences clearly (Fig. 1).

In the Cox regression analysis for the acetabular revision components, adjusted for gender and age, we found a significantly reduced risk of re-revision for uncremented revi-
Survival curves for the acetabular revision prostheses, categorised by both bone transplantation and fixation techniques: a) cemented without allograft; b) cemented with allograft; c) cemented with impaction bone grafting; d) uncemented without allograft; e) uncemented with allograft; and f) uncemented with impaction bone grafting.
sion components with \( \text{RR} = 0.66; \text{95\% CI} \ 0.43 \) to 0.99) and without \( \text{RR} = 0.37; \text{95\% CI} \ 0.22 \) to 0.61) bone grafting.

Of the 4762 revision operations, 2860 (60\%) femoral components were revised (Table III). For these, the Kaplan-Meier curves for the different categories of revision (Fig. 2) showed their best results in the categories other than procedures carried out with cemented revision components without bone grafting (Fig. 2). This finding was confirmed by the Cox regression analysis, adjusted for gender and age, where all categories, except the uncemented revision components with impaction bone grafting had significantly better results than the reference category of cemented revision components without the use of bone allograft (Table III).

**Discussion**

In our study, we have shown that revision THAs have a higher risk of failure than primary prostheses. Re-revision operations had an even greater risk of failure. There was a trend towards revision techniques, with recemented prostheses without the use of bone allograft, being related to an increased risk of failure.

We have not been able to find any large, comparative study in the literature on revision techniques. Nearly 50\% of the revisions in Norway were by recementation without the use of allograft or impaction grafting techniques. The results of direct recementation were inferior to both impaction bone grafting with cementation and to uncemented revision of the acetabular and femoral components. The mean follow-up is relatively short, so acetabular revision, because of wear and osteolysis might appear in due course, as has been seen in primary operations after eight to ten years.\(^{26}\) The use of larger implants on the acetabular side might create fewer wear problems for revisions than for primary operations, where the surgeons tend to use smaller acetabular cups. The results of cemented polyethylene cups and cemented femoral components for primary hip arthroplasty have been good at ten to 12 years’ follow-up.\(^{26,27}\) We cannot explain the inferior results of recemented revision without the use of allograft.

Few studies have assessed the results for revision THAs.\(^{1-10,13,14}\) There may be several reasons for this. The number of revision prostheses is much lower than the number of primary prostheses. Furthermore, there may be a greater difference in revision techniques, patients, and prostheses, which make comparison of the different categories problematic. There may, therefore, be more confounding factors than for studies of primary prostheses. These factors may be difficult to standardise in large studies, for example osteolysis or characteristics of the primary operation.

Due to an uneven distribution of prognostic factors, particularly for bone loss, comparisons in our study may be inappropriate. We have a large data source on revision prostheses, but no data on bone loss or osteolysis. One might anticipate that patients who receive allograft or impaction bone grafting probably have more bone loss and should have a poorer prognosis for their revision prostheses than in patients who do not receive bone grafting. However, we found better results for those categories that included the use of allograft or impaction bone grafting. Furthermore, patients who received an uncemented revision prosthesis and no allograft probably had little bone loss and should have had a good outcome for their revision prostheses. This corresponded to our findings.

We decided to exclude revision operations undertaken because of infection. This was because operations due to infections can cause specific problems, such as a higher risk of future infection, which is not necessarily related to the revision technique itself. Furthermore, most revisions for infection have dedicated treatment at revision surgery, such as first undertaking an excision arthroplasty followed by subsequent prosthetic insertion. To have included these operations might have caused problems with our analysis and interpretation of the results.

Further studies are clearly needed. These must include detailed information on bone loss and osteolysis. In addition, studies into recurring operations should be considered. The statistical analysis of operations is not straightforward as the same individual and hip are observed several times.\(^{25,26}\) Revision operations will remain a crucial and

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**Table III.** Revision of femoral components following THA. Number of revisions, re-revisions, Cox regression analyses adjusted for age at revision and gender, and selected characteristics for the different methods of fixation and bone graft were used to calculate relative risks (RR)

<table>
<thead>
<tr>
<th>Method</th>
<th>No bone graft</th>
<th>Allograft</th>
<th>Impaction bone graft</th>
<th>No bone graft</th>
<th>Allograft</th>
<th>Impaction bone graft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revisions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cemented*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No bone graft</td>
<td>1243</td>
<td>144</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allograft</td>
<td>326</td>
<td>20</td>
<td>0.53</td>
<td>0.33 to 0.84</td>
<td>5.3</td>
<td>80</td>
</tr>
<tr>
<td>Impaction bone graft</td>
<td>442</td>
<td>12</td>
<td>0.34</td>
<td>0.19 to 0.62</td>
<td>3.4</td>
<td>82</td>
</tr>
<tr>
<td>Uncemented Allograft</td>
<td>478</td>
<td>16</td>
<td>0.22</td>
<td>0.11 to 0.46</td>
<td>3.7</td>
<td>47</td>
</tr>
<tr>
<td>Impaction bone graft</td>
<td>89</td>
<td>4</td>
<td>0.51</td>
<td>0.19 to 1.38</td>
<td>3.8</td>
<td>67</td>
</tr>
</tbody>
</table>

* antibiotic-containing cement
Survival curves for the femoral revision prostheses, categorised by both bone grafting and fixation techniques: a) cemented without allograft; b) cemented with allograft; c) cemented with impaction bone grafting; d) uncemented without allograft; e) uncemented with allograft; f) uncemented with impaction bone grafting.
important treatment for failed primary prostheses although their long-term results are harder to document than the results of primary prostheses.

We thus conclude that revision prostheses have generally worse results than primary prostheses. Recementation without the use of allograft, and un cemented revision with impaction bone grafting, were associated with inferior results when compared with other revision techniques. Uncemented revision prostheses without impaction bone grafting showed promising results.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References