MECHANICAL LOOSENING OF THE STEM IN CHARNLEY ARTHROPLASTIES
IDENTIFICATION OF THE “AT RISK” FACTORS

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A retrospective review of 72 cases of Charnley low friction arthroplasty revised for stem loosening, has identified a number of “at risk” factors. These were: previous hip surgery and, in radiographs taken at one year, demarcation of the distal cement and fracture of the cement near the tip of the stem. Separation of the back of the stem from the cement, as an isolated feature, was not considered significant. Endostal caviation of the femoral shaft, rare in the first year, indicated loosening of some duration. Patients whose radiographs show the “at risk” changes, should be followed-up indefinitely in order to plan timely revision and avoid gross loss of the femoral bone stock.

Loosening of the stem in cemented total hip arthroplasty is recognised as a major problem. It often causes symptoms and is relatively easily recognised on serial radiographs. However, the large number of operations performed makes it almost impossible to follow-up all patients indefinitely.

If radiographic signs indicating a high risk of stem loosening could be identified, then follow-up of a selected group of patients could be rationalised. To identify the radiographic signs of such “at risk” cases, as well as to study the changing pattern of revisions for stem loosening after Charnley low friction arthroplasty (LFA), a retrospective study has been undertaken of all cases revised for mechanical loosening of the stem. The one-year radiographs of the revised group were compared with those of the clinically successful cases with the longest follow-up (15–21 years, Wroblewski 1986). The time interval between the arthroplasty and the revision as well as the changing incidence of revisions for loosening were also noted.

MATERIALS AND METHODS

Between November 1962, when Charnley low friction arthroplasties became routine, and December 1984, 19,161 have been performed in our unit. During this 22-year period 1 085 are known to have been revised for various reasons; this included 72 which were revised for mechanical loosening of the stem. The records and serial radiographs of these were studied. The radiographs taken about one year after operation were carefully compared with those taken soon after the operation. The following were recorded:

Appearance unchanged. Rounding off, or loss of cortical definition of the medial femoral neck was accepted as indicating no significant change.

Separation of the lateral side of the stem from the cement. This indicates a “slip” or tilting of the stem within the cement mantle (Fig. 1).

Demarcation of the tip of the cement. This is almost certainly due to lack of stem support and movement of the stem-cement complex within the medullary canal; it becomes more obvious if associated with condensation of cancellous bone around the distal cement (Fig. 2).

Fracture of the cement near the tip of the stem. When an end-weight bearing stem slips within the cement mantle, fracture of the distal end of the cement occurs. The proximal, curved portion of the stem is likely to break the continuity of the medial cement (Fig. 3).

Endostal caviation. Scalloping of the endosteal surface of the cortex is the result of alteration of pressure and volume within the cavity containing the implant (Fig. 3).

The position of the stem (varus, valgus or neutral), previous hip surgery, and the patients’ weight were also recorded.

RESULTS

Of the 72 cases revised 47 were men and 25 women. Their average age at surgery was 58 years (range 22 to 75 years). The average time to revision was 7.7 years (range 1 to 17 years).

The original hip pathology is shown in Table I and
Incidence of revision for stem loosening in relation to postoperative follow-up.

Yearly incidence of revision for stem loosening in relation to the evolution of the Charnley low friction arthroplasty from November 1962 to December 1986.
Table I. The original hip pathology

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number</th>
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<tbody>
<tr>
<td>Osteoarthritis</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>48</td>
</tr>
<tr>
<td>Secondary</td>
<td>18</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Idiopathic protrusio</td>
<td>2</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>1</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
</tr>
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Table II. Previous operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Number</th>
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<tbody>
<tr>
<td>Intertrochanteric osteotomy</td>
<td>11</td>
</tr>
<tr>
<td>Fracture fixation</td>
<td>3</td>
</tr>
<tr>
<td>Total hip arthroplasty</td>
<td>3</td>
</tr>
<tr>
<td>Femoral head replacement</td>
<td>3</td>
</tr>
<tr>
<td>Cup arthroplasty</td>
<td>1</td>
</tr>
<tr>
<td>Fusion</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
</tr>
</tbody>
</table>

Table III. The radiographic appearances at one year of 72 cases revised for stem loosening compared with those of 116 clinically successful cases followed up for 15-21 years

<table>
<thead>
<tr>
<th>Radiographic appearances at one year</th>
<th>72 revisions for stem loosening</th>
<th>116 successful cases</th>
<th>Statistical significance of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
</tr>
<tr>
<td>Unchanged</td>
<td>12</td>
<td>16.7</td>
<td>70</td>
</tr>
<tr>
<td>Separation of stem from cement</td>
<td>19</td>
<td>26.4</td>
<td>31</td>
</tr>
<tr>
<td>Demarcation at tip of cement</td>
<td>43</td>
<td>59.7</td>
<td>21</td>
</tr>
<tr>
<td>Fracture tip of cement</td>
<td>12</td>
<td>16.7</td>
<td>4</td>
</tr>
<tr>
<td>Endosteal cavitation</td>
<td>1</td>
<td>1.4</td>
<td>0</td>
</tr>
<tr>
<td>Stem position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>varus</td>
<td>7</td>
<td>9.7</td>
<td>16</td>
</tr>
<tr>
<td>valgus</td>
<td>42</td>
<td>58.3</td>
<td>19</td>
</tr>
<tr>
<td>neutral</td>
<td>23</td>
<td>31.9</td>
<td>81</td>
</tr>
<tr>
<td>Previous surgery</td>
<td>22</td>
<td>30.6</td>
<td>5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>69</td>
<td>66</td>
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Table IV. Radiographic appearances before revision for stem loosening

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Per cent</th>
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</thead>
<tbody>
<tr>
<td>Separation of stem from cement</td>
<td>33</td>
<td>45.8</td>
</tr>
<tr>
<td>Demarcation tip of cement</td>
<td>38</td>
<td>52.8</td>
</tr>
<tr>
<td>Fracture tip of cement</td>
<td>22</td>
<td>30.6</td>
</tr>
<tr>
<td>Fracture other part of cement</td>
<td>6</td>
<td>8.3</td>
</tr>
<tr>
<td>Endosteal cavitation</td>
<td>25</td>
<td>34.7</td>
</tr>
<tr>
<td>Fracture femur</td>
<td>2</td>
<td>0.3</td>
</tr>
</tbody>
</table>
any previous hip surgery in Table II. Table III shows the 
radiographic appearances at one year compared with 
those of clinically successful cases which had been 
followed up for 15 to 21 years; the statistical significance 
also is shown. Table IV lists the radiographic appear-
ances immediately before the revision for stem 
loosening.

Figure 4 shows that the rate of revision for stem 
loosening was greatest in the ninth postoperative year 
and then, with one exception, gradually declined. 
Revision for stem loosening as part of the evolution 
of the Charnley LFA (Fig. 5) has shown that in the first six 
years (1962/63 to 1968) of the technique and during a 
time when some 2 500 LFAs were performed, there were 
no revisions for stem loosening. The numbers gradually 
increased to peak in 1985. Only now are the benefits of 
improved stem design and surgical technique becoming 
apparent.

**DISCUSSION**

This review has identified certain “at risk” factors. 
Careful assessment of the one-year radiograph will, in 
most cases, indicate the likelihood of future revision 
being needed. Apart from patients who have had 
previous hip surgery, the main “at risk” features are 
cement demarcation or fracture, and endosteal cavita-
tion; once stem subsidence has occurred these changes 
may become progressive, with fractures of other parts of 
the cement and more endosteal cavitation (Fig. 4). These 
changes are rare in the first year but increase with time 
and are related to the duration of the loosening. This 
is clearly shown when Tables III and IV are compared; 
endosteal cavitation was present in only one case at one 
year, but increased to 25 cases by the time of revision. 
One important consequence of loosening of the stem or 
stem-cement complex is that it acts as a stress riser and 
may lead to fracture of the femoral shaft.

A valgus position of the stem, often regarded as 
desirable, featured prominently in the group of revised 
cases and was associated with early demarcation of the 
distal femoral cement in 42% of them; the ideal position 
of the stem is neutral. The quality of cement fixation is 
 Improved. 

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desirable, featured prominently in the group of revised 
cases and was associated with early demarcation of the 
distal femoral cement in 42% of them; the ideal position 
of the stem is neutral. The quality of cement fixation is 
improved by the use of an intramedullary bone block, 
which reduces the incidence of those radiological 
appearances indicating stem loosening (Wroblewski and 
Van der Rijt 1984).

This present study of stem loosening has not only 
Identified the “at risk” factors, but has also highlighted 
the increasing incidence with longer follow-up. The peak 
incidence in the ninth postoperative year and the twenty-
third year of the Charnley LFA technique warns against 
drawing conclusions from a short follow-up. It should 
be emphasised that the study was exclusively of Charnley’s 
low friction arthroplasty, but there is no reason why the 
same criteria should not apply to other cemented total 
hip arthroplasties - provided, of course, that the cement 
is radio-opaque.

No benefits in any form have been received or will be received from a 
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