SOCKET MIGRATION AFTER CHARNLEY ARTHROPLASTY
IN RHEUMATOID ARTHRITIS AND OSTEOARTHRITIS

A ROENTGEN STEREOPHOTOGRAMMETRIC STUDY

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Socket migration and rotation in the Charnley total hip replacement were evaluated by roentgen stereophotogrammetric analysis in 23 patients with rheumatoid arthritis and 23 patients with osteoarthritis. The two groups were matched with regard to age and sex. The follow-up time was two years.

In the rheumatoid patients socket migration was most prominent in the proximal direction and averaged 0.6 mm at 24 months as compared with 0.1 mm in the osteoarthritic group (p = 0.0003). Within the rheumatoid group a preoperative acetabular protrusion in five patients was associated with increased migration and rotation in all directions. The increased proximal migration in rheumatoid arthritis was consistent (p = 0.0009) even after the exclusion of the five protrusion cases.

In the rheumatoid patients there was a correlation between low body-weight and proximal migration, but there was no such correlation in the osteoarthritic group. Our results suggest that socket fixation is less secure in patients with advanced inflammatory arthritis.

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Several studies have shown a higher rate of socket loosening in rheumatoid arthritis than in osteoarthritis (Charnley 1979; Stauffer 1982; Carlsson, Gentz and Sanzén 1986; Sarmiento et al 1990). The rate of such loosening in rheumatoid arthritis may have decreased since the introduction of bone grafting of the medial wall in cases of acetabular protrusion (Ranawat and Zahn 1986; Bayley et al 1987), but it still appears to differ between the two diseases. Roentgen stereophotogrammetric analysis (RSA) can accurately measure socket migration at an early stage (Mjöberg et al 1986; Snorrason and Kärholm 1990) and we have used it to compare migration rates in rheumatoid and osteoarthritic hips.

PATIENTS AND METHODS

Charnley total hip replacement was performed on 23 patients with rheumatoid arthritis (RA series) and on 23 with primary osteoarthritis without dysplasia (OA series). The diagnosis of rheumatoid arthritis was established in all cases by an experienced rheumatologist. The two groups were matched with regard to age and sex and there were six men and 17 women in each series. At the time of surgery the mean age of the patients was 65 ± 9 (SD) years (SEM 1.33; range 41 to 79) and the mean weight was 59 ± 12 kg (SEM 2.45; range 41 to 81) in the RA series and 68 ± 11 kg (SEM 2.31; range 54 to 94) in the OA series (p = 0.0144). There were 14 right hips in the RA series and nine in the OA series. Fourteen patients in each series had had bilateral replacements at the time of the latest follow-up. Five patients in the RA series (none in the OA series) had had preoperative acetabular protrusion.

In all patients a cemented Charnley prosthesis was implanted through a lateral transtrochanteric approach with the patient in the supine position, using epidural anaesthesia. Flanged, ogee sockets (Shelley and Wroblewski 1988) were used in all the RA series and in all the OA patients except two who had long posterior wall (LPW) sockets. In these two patients the fit of the socket was such that, had an ogee socket been used, almost all the flange would have had to have been trimmed away. The acetabulum was reamed until bleeding bone appeared centrally. Subchondral bone was preserved superiority and about five 6 mm diameter anchorage holes were drilled. High-pressure lavage was used, with polyethylene plugs and the use of a cement gun in the femur. We used prechilled vacuum-mixed, high-viscosity cement (Palacos). Thin slices of bone cut from the femoral head (Hirst et al 1987) were used to graft the medial wall in cases of acetabular protrusion.

Five to nine 0.8 mm diameter tantalum ball markers (Industrial Technotics, Ann Arbor, Michigan) were
inserted into the pelvic bone and into the polyethylene socket during the operation. The wire marker of the socket was removed so that the balls were not obscured on the radiographs. Marker balls were placed in the medial and lateral edges, as well as into the dome of the prosthesis, after drilling into the polyethylene (Fig. 1).

Stereoradiography was performed with the patient in a supine position at about one week postoperatively using the uniplanar technique (Selvik 1974; Kärholm 1989). With some exceptions it was performed again at 3, 6 and 12 months postoperatively (Table I) and on all patients at 24 months.

The precision of RSA for measuring socket displacement after hip arthroplasty was established in 50 patients. A double exposure of each patient was used to calculate 99% confidence limits for the threshold of minimum significant migrations and rotations (Table II).

From standard pelvic and hip radiographs, centred respectively on the pubic symphysis and the hip, the socket inclination was measured using the teardrop line as a reference. The degree of anteversion or retroversion was assessed by measuring the short and long axes of the ellipsoidal projection of the opening plane of the socket (Fackler and Poss 1980; Pettersson et al 1982).

Student's t-test, Fisher's exact test, simple regression and correlation analyses were used for the statistical analysis.

RESULTS

The mean socket inclination in the RA series was 41° (30 to 53) and in the OA series 43° (28 to 55). The mean anteversion of the sockets in the RA series was 8° (0 to 22) and in the OA series 9° (one socket was in 7° retroversion; the others were in anteversion with a maximum of 28°). There was no significant difference in the socket positions between the two series, nor did these positions influence the migration rate.

The number of stable sockets and the number of

Table I. The number of stable sockets and the number of patients examined at 3, 6, 12 and 24 months after implantation

<table>
<thead>
<tr>
<th>Time since operation (mth)</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA series (n = 23)</td>
<td>7/19</td>
<td>1/11</td>
<td>3/20</td>
<td>1/23</td>
</tr>
<tr>
<td>OA series (n = 23)</td>
<td>5/10</td>
<td>6/14</td>
<td>7/21</td>
<td>8/23</td>
</tr>
</tbody>
</table>

Table II. Mean values and standard errors for migrations at 24 months, along and around the three cardinal axes (longitudinal, transverse, sagittal). Values are in absolute terms, independent of sign, except for migration along the longitudinal axis, where only three values were negative, all well within the confidence limits

<table>
<thead>
<tr>
<th>Migration (mm)</th>
<th>Rotation (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Longitudinal</td>
</tr>
<tr>
<td>RA series</td>
<td>0.6 ± 0.12</td>
</tr>
<tr>
<td>p = 0.0003</td>
<td>NS</td>
</tr>
<tr>
<td>OA series</td>
<td>0.1 ± 0.03</td>
</tr>
<tr>
<td>RA series: with protrusion (n = 5)</td>
<td>1.4 ± 0.33</td>
</tr>
<tr>
<td>RA series: without protrusion (n = 18)</td>
<td>0.4 ± 0.08</td>
</tr>
<tr>
<td>Limits for significant movements*</td>
<td>± 0.2</td>
</tr>
</tbody>
</table>

* at 99% confidence limits
patients examined at intermediate times are given in Table I. According to the limits of significant movement given in Table II, only one socket in the RA series was stable at 24 months, as compared with eight in the OA series (p = 0.022; Table I). Maximum migration and rotation in any direction were 2.4 mm and 5.0° respectively in the RA series, and 0.8 mm and 2.0° in the OA series.

In the RA series most of the migration was along the longitudinal axis, in a proximal direction. By contrast, the largest migrations in the OA series were registered along the transverse axis (Table II). There was no directional preponderance for migration along the transverse and sagittal axes in either series. At 24 months, the sockets in the RA series had migrated significantly more along the longitudinal axis than had those in the OA series (p = 0.0003), and they had rotated more around the transverse axis (p = 0.027). The mean values for proximal migration in each series plotted against time are shown in Figure 2. The mean values for all six degrees of freedom at 24 months are given in Table II.

The sockets in the five patients with acetabular protrusion migrated and rotated on average more than the other 18 sockets in the RA series (Table II). The greatest difference was an average proximal migration of 1.4 mm in the former group compared with 0.4 mm in the latter. Even when these five cases were excluded, the difference in proximal migration between the two series remained significant (p = 0.0009).

In the RA series there was a negative correlation between body-weight and proximal migration (r = 0.52; p = 0.010). No correlation between body-weight and migration was found in the OA series. Age, side or sex did not influence the stereoradiographic outcome.

In both series there was a positive correlation between proximal migration at 3 months and at 6 months (r = 0.83; p = 0.0004), 12 months (r = 0.81; p = 0.0001) and 24 months (r = 0.70, p = 0.0001) (Fig. 3).

DISCUSSION

The relationship between prosthetic migration measured during the first postoperative years and later clinical loosening requiring a revision procedure is still unclear. In knee replacements the cumulative survivorship of some designs of tibial components has been shown to correlate with early migration measured by RSA (Grewal, Rimmer and Freeman 1992). Serial examination of standard radiographs has shown a linear progression in the socket loosening rate in rheumatoid arthritis (Carlsson et al 1986).

We found both an increased frequency and an increased magnitude of migration and rotation at two years in rheumatoid arthritis as compared with osteoarthritis. Most of the migration in the rheumatoid cases was in a proximal direction whereas in the osteoarthritic patients the migration was more often transverse than longitudinal. If the greater migration of the cup in rheumatoid cases reflected simply increased motion at the cement-bone interface, then it would seem likely that the migration would be in all directions. Longitudinal migration suggests that the acetabular roof is weak and that the bone fails under load. The even larger movements recorded in all directions in the hips with acetabular protrusion (those with the most severe arthritis) (Larsen, Dale and Eek 1977) suggest poor socket anchorage from continuing inflammatory disease of the joint.

No difference between rheumatoid arthritis and osteoarthritis has been found in knee replacements with respect to tibial component fixation as measured by RSA (Nilsson et al 1991). This raises the question as to how
the quality and strength of the periarticular bone may differ between the hip and the knee. The finding of a correlation between low body-weight and high socket migration in the rheumatoid patients suggests the need for further studies on the determinants of periarticular bone quality and prosthesis fixation.

For both diagnostic groups the migration rate in the proximal direction was largest during the first six postoperative months. It is uncertain whether the best predictive value lies in the migration rate during the first six months, or in the time interval between six and 24 months. This will be the subject of future long-term RSA studies.

Mjöberg et al (1986) used RSA to study the migration of the all-polyethylene, 32 mm inner diameter socket of the Lubinus prosthesis in patients with osteoarthritis. Eleven of 20 sockets showed significant migration at two years. For two of their three measurements, however, the limits for significant migration were set 2.0 and 2.6 times higher than in our study. If their limits for significant migration are applied to our series, 12 rather than 15 of the 23 sockets in our OA series would have been found to have migrated significantly at two years. The mean proximal migration of these 12 Charnley sockets was 0.2 mm (maximum 0.4 mm) as compared with about 0.7 mm (maximum 1.8 mm) reported by Mjöberg et al for the Lubinus sockets. This remarkable difference in early migration between the Lubinus and the Charnley sockets may reflect the higher socket revision rate reported for hip prostheses with a 32 mm diameter head (Morrey and Ilstrup 1989).

Our study showed a definite correlation between the magnitudes of socket migration during the first three months and at two years. This finding strengthens the case for regarding RSA as a reliable predictor of prosthetic fixation.

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REFERENCES


