POLYETHYLENE WEAR IN THE CHARNLEY
OFFSET BORE ACETABULAR CUP
A RADIOLOGICAL ANALYSIS
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We studied wear in the ultra-high-molecular-weight polyethylene offset bore socket in 54 hips which had had Charnley low-friction arthroplasty. At an average follow-up of 8.1 years, the mean penetration rate was 0.04 mm per year. Correlation between the depth of socket penetration and the incidence of socket migration was confirmed, but socket migration occurred with lower penetration than had been previously reported.

Received 12 January 1994; Accepted after revision 10 August 1995

Wear of ultra-high-molecular-weight polyethylene (UHMWPE) sockets is of major concern for the long-term survival of total hip arthroplasty (THA). It is debatable whether the problem is mainly mechanical (Wroblewski 1985) or biological (Schmalzried et al 1992). For the Charnley low-friction arthroplasty (LFA) the reported average penetration rate of the socket ranges from 0.07 mm per year (Griffith et al 1978) to 0.21 mm per year (Wroblewski 1985). The thickness of the UHMWPE components is especially important, particularly in young patients in whom deficiency of acetabular bone stock does not allow the use of sockets of standard size.

In 1975, Charnley introduced an offset bore socket to overcome this problem (Charnley 1979). Since wear of the offset bore socket has not previously been reported our aim was to study polyethylene wear and migration in this socket.

PATIENTS AND METHODS

Since its introduction the offset bore socket has been used in approximately 1.6% of patients treated at Wrightington Hospital. Its use is dictated by the availability of bone stock for socket fixation. Figure 1 is a diagrammatic comparison of this socket with the small ogee-flanged long-posterior-wall Charnley socket. Because of the offset of the bore, the thickness of UHMWPE is about 7 mm superiorly while the outside diameter is maintained at 31 mm. The standard socket has an outside diameter of 43 mm, and the small socket one of 40 mm. The offset bore socket has no chamfer.

For this study we selected a series of 42 patients (54 hips) which we have previously reported (Wroblewski and Siney 1992). There were 37 women and 5 men of average weight 54.2 kg (32 to 70) and average age at surgery 36.5 years (12.5 to 51). The mean follow-up was 8.1 years (2.4 to 18.1). The underlying hip pathology is shown in Table I.

In 33 patients the LFA had been the first procedure. Nine had previously had an intertrochanteric osteotomy, five an open reduction for congenital dislocation, one a hip fusion and six various soft-tissue procedures.

Measurement of radiological wear was as described by Charnley and Halley (1975). The most recent radiograph was compared with a postoperative film and magnification was corrected by using the known diameter of the head of the femoral component (22.25 mm).

Because of the asymmetry created by the offset bore and the unknown direction of socket penetration in any particular case, we made extra measurements. For the direction of
socket penetration, for the orientation of the socket (angle open laterally) and for migration we used an inter-teardrop horizontal line as a reference base, measuring angles from a perpendicular which passed through the centre of the head of the femoral component.

The distance between the head of the femoral component and the wire wear marker was measured in five directions on lines passing through the centre of the head of the femoral component (Fig. 2):
1) perpendicular to the inter-teardrop line F (B);
2) 15° medial to it (C);
3) 45° medial to it (D);
4) 15° lateral to it (A); and
5) between the head and the most inferior part of the wire marker (E).

To minimise any error all measurements were carried out twice by the same observer (RJI-A) but on two separate occasions. The greatest difference measured between the first and the latest radiograph, corrected for magnification, was taken to be the total depth of penetration.

The direction of penetration was assessed in relation to the differences between distances 1 to 4 and confirmed by the difference in the inferior wire marker-head distance (5). The angle of the socket, open laterally, was measured by joining the ends of the wire marker and extending it to the inter-teardrop line.

Migration was defined as “change of socket position as observed on serial radiographs” (Hodgkinson, Shelley and Wroblewski 1989). Any increase in the distance between the inter-teardrop line and the most inferior part of the wire wear marker or change in the angle of the socket open laterally was recorded as socket migration. The criteria for defining socket migration were therefore very strict.

RESULTS
In 19 hips (35%) there was no measurable wear. The remaining 35 had a mean total penetration of 0.34 mm (0.1
to 1.93) and a mean penetration rate of 0.04 mm per year (0.007 to 0.13). The mean difference between the two measurements by the same observer was 0.03 mm (0 to 0.31), an observer error of about 15%. The direction of penetration followed the perpendicular to the inter-teardrop line in seven cases, was 15° medial to it in seven and 15° lateral to it in six. In some the direction of penetration was intermediate; in six it was in the vertical and lateral direction and in seven in the vertical and medial direction. In two cases there appeared to be penetration in three areas, medial, vertical, and lateral. No hips showed socket wear at 45° medial to the perpendicular.

The mean acetabular angle, measured on the immediate postoperative radiograph, was 44° (22 to 60). There was no correlation between the ‘angle open laterally’ and the direction of wear. At the latest assessment nine sockets (16.7%) had migrated, as defined by Hodgkinson et al (1989). There was no correlation between the patients’ weight and the rate of migration or is due to a change in position of the socket.

We found no correlation between the angle of the socket open laterally and the direction of wear. A new finding on our series of films was that in 15 cases (28%) wear was obviously not unidirectional. It is unknown whether the direction of wear can change with time and the depth of penetration, or is due to a change in position of the socket.

A penetration rate which we report of 0.04 mm per year is lower than some previously reported for the Charnley LFA, comparing favourably with some of the lowest penetration rates (Wroblewski, McCullagh and Siney 1992). We found no correlation with the weight of the patients.

Socket migration was exponentially related to the depth of socket penetration, but more importantly it appeared to occur at a much lower total penetration than previously reported (Fig. 3 and Table II). It seems possible that some other mechanisms are involved in the process (Wroblewski 1985); this will require further study.

The offset bore Charnley socket is a valuable addition to the LFA when deficient acetabular bone stock does not allow the use of standard components. Although the penetration rate is lower, socket migration may occur at lower mean penetrations.

This study was supported by the Peter Kershaw Trust.

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

<table>
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<th>0</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
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<td>11</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Number migrating</td>
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<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Migration</td>
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<td>6.3</td>
<td>25</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

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