Harris Galante cementless acetabular replacement in avascular necrosis
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We describe the results of 76 total arthroplasties of the hip for stage-III or stage-IV avascular necrosis of the femoral head. Harris Galante Porous cups were used in 63 patients between 1986 and 1994 and followed prospectively. We reviewed 70 hips with a follow-up of more than five years (mean 7.6).

At the latest review the mean Harris Hip Score had improved from a preoperative value of 29 ± 14.7 to 94 ± 6.8. Radiologically, there was no evidence of acetabular migration. The rate of revision for the femoral component was 8.6%, three being undertaken for loosening and three to allow downsizing of the femoral head. The rate of revision for the acetabular component was 7.1% (five cups). At the time of revision none of the cups was clinically loose, and only required the liner to be changed.

The rate of complications was low with no case of deep infection or dislocation, but nine of the 76 hips (11.8%) showed grade-III heterotopic ossification. Previous studies of patients undergoing cemented total hip arthroplasty for the treatment of advanced avascular necrosis have indicated a high incidence of loosening of the acetabular component. Our findings show good medium-term results using the Harris Galante Porous cup for acetabular reconstruction, together with a variety of cemented femoral components, for the treatment of this difficult problem.

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Avascular necrosis (AVN) was originally described by Konig in 1888. The disease can affect patients of all ages, but is seen typically between the ages of 18 and 50 years. Men are more commonly affected and approximately 50% have bilateral disease. Patients present with unexplained pain, usually in the groin. The diagnosis is often delayed as early routine radiographs are frequently normal. Aetiological factors include alcohol abuse, steroid therapy, trauma, Gaucher’s disease, hyperlipidaemia, haemoglobinopathies, autoimmune diseases and hypercoagulopathies.2-6 There may be no identifiable predisposing cause and around 20% are idiopathic in nature.

The disease is commonly staged according to the classification of Ficat and Arlet,7 although it is recognised that this system does not give a prognosis for the natural history. Treatment of the early stages (I and II) remains controversial8-12 but either hemiarthroplasty or total hip arthroplasty (THA) is recommended for stages III and IV of the disease. Sugioka12 has advocated the use of femoral osteotomy but his good results have not been widely reproducible. In patients with stage-III disease the acetabulum is relatively normal and thus the concept of hemiarthroplasty is appealing in order to preserve acetabular bone stock. Unfortunately, the results have not been encouraging. Lachiewicz and Desman13 reported satisfactory clinical results in only 48% of patients at four to five years using a bipolar prosthesis. Learmonth and Opitz14 reported a rate of failure of 15.8% at a mean follow-up of 56 months, with a further 15.8% showing radiological changes likely to progress to failure.

Although the use of THA for late-stage disease has been regarded as the treatment of choice for AVN, it is not without problems. Salvati and Cornell15 concluded that the failure rate was four times greater in patients with AVN compared to those with osteoarthritis.

Our aim was to assess the outcome of THA in cases of stage-III and stage-IV disease using an uncemented acetabular component (Harris Galante Porous cup; Zimmer, Warsaw, Indiana) with a cemented femoral prosthesis.

Patients and Methods
We followed prospectively all patients with Harris Galante Porous cups (HGP1) which had been inserted by 16 sur-
geons at the Winford Hospital and the Avon Orthopaedic Centre, between 1986 and 1994. They were all reviewed in a special clinic by a dedicated research assistant (MBL).

Standardised radiographs were taken before operation, immediately after, and at six months, 12 months and then annually. The Harris Hip Score was collated before the operation and at each annual review.

Of a total of 1246 HGP cups inserted during this period, 76 were in 63 patients who had stage-III or stage-IV AVN based on clinical and radiological evidence. This was confirmed on histological examination of each surgical specimen. All patients suffered considerable pain in the groin or thigh (or both) and had restricted walking and activities of daily living. They had all received conservative therapy, which included analgesia and aids to mobilising. At the time of surgery the mean age of the patients was 48.2 years (19 to 80) and their mean weight was 74.3 ± 17.4 kg; some patients had more than one aetiological factor. Of the 76 hips at the start of the study 54 were in men and 22 in women; 42 were left- and 34 were right-sided. Previous surgical interventions are shown in Table I and predisposing factors for AVN in Table II.

Some of the HGP1 cups were inserted with screws and others without, either because of the surgeons’ preference or because the press-fit stability was not felt to be adequate at the time of implantation. A variety of different cemented femoral stems was used including 16 Exeter (Howmedica, Rutherford, New Jersey), 28 CPT (Zimmer, Warsaw, Indiana), 3 Charnley (Thackery, Rutherford, New Jersey), 20 Müller (Protek, Bern, Switzerland), 1 Freeman (Corin Medical Ltd, Cirencester, UK), 2 Sheehan (Zimmer Warsaw, Indiana) and 6 Corin-Müller (Corin Medical Ltd). The sizes of the femoral head were 22, 28 or 32 mm and varied with the type of stem implanted. The surgical approach was left to the choice of each of the 16 surgeons involved.

Migration of the cup and angular changes were measured on anteroposterior (AP) radiographs of the pelvis using the technique described by Massin, Schmidt and Engh\textsuperscript{16} (Fig. 1). Sequential radiographs for each patient were assessed to ensure compatibility between measurements. Care was taken that the variation in distance between the obturator line and the teardrop line was not more than 5 mm and that the distance between the vertical line through the pubis and the middle of the sacroiliac line was less than 5 mm. Migration along the horizontal axis was measured from the centre of the cup to a perpendicular line through the teardrop. Vertical migration was measured from the centre of the cup to a

<table>
<thead>
<tr>
<th>Previous surgical procedure</th>
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<tbody>
<tr>
<td>Femoral osteotomy</td>
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</tr>
<tr>
<td>Screw fixation for intracapsular fracture</td>
<td>5</td>
</tr>
<tr>
<td>Open reduction and internal fixation of acetabulum</td>
<td>4</td>
</tr>
<tr>
<td>Core decompression of the femoral neck</td>
<td>3</td>
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<tr>
<td>Relocation of dislocated hip and traction</td>
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<th>Predisposing aetiological factors</th>
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<td>Trauma</td>
<td>18</td>
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<tr>
<td>Steroid or chemotherapy</td>
<td>24</td>
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<tr>
<td>Alcohol abuse</td>
<td>12</td>
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<td>Perthes' disease</td>
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<td>Treatment for septicaemia</td>
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<td>Previous surgery (see Table I)</td>
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<tr>
<td>Idiopathic</td>
<td>22</td>
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Table I. The number of surgical interventions carried out before insertion of a Harris Galante cementless acetabular replacement for AVN

Table II. The predisposing factors for AVN in the 63 patients who had Harris Galante cementless acetabular replacement (several had more than one factor)

![Radiograph showing the method of measurement of migration of the cup, polyethylene wear and cup angle (see text).](image)
Migration was deemed to have occurred if there was a difference of more than 2 mm. The angle of the cup was measured from the horizontal line joining the teardrop across the maximum diameter of the cup edge. This was deemed to have altered if the angle of the cup changed by more than 5° from the first postoperative radiograph.

Radiological evaluation was carried out as recommended by Johnston et al.\textsuperscript{17} using a 'standard system of terminology for reporting results'. Radiolucent lines were measured on the AP films using the zones described by DeLee and Charnley.\textsuperscript{18} These were described as integrated, non-progressive or progressive. The presence of fracture or osteolysis of a screw was also recorded. Heterotopic ossification was assessed using the classification of Brooker et al.\textsuperscript{19} The femoral stems were examined for evidence of migration, subsidence and position of the stem. Radiolucent lines were categorised on AP and lateral radiographs in the seven zones described by Gruen, McNeice and Amstutz\textsuperscript{20} and Johnston et al.\textsuperscript{17}

Fig. 2a
Radiographs showing a) the cup six months before dissociation and b) at the time of dissociation; the white arrows show the edge of the dissociated polyethylene liner.

Fig. 2b

Fig. 3a
Radiographs of a cemented Freeman stem showing a) osteolysis in most Gruen zones and b) after revision. The polyethylene liner did not require changing.

Fig. 3b
Results

Two patients were lost to follow-up and three died from unrelated causes (six hips). The remaining 70 hips were followed for a mean of 7.6 ± 1.8 years (5 to 13).

There were no intraoperative complications. Postoperative problems indicated two cases of deep-vein thrombosis, one of pulmonary embolism in spite of antithromboembolic prophylaxis with unfractionated heparin and t.e.d. stockings, two wound haematomata and one superficial wound infection. There were no deep infections. There were no early dislocations after the primary THA.

Failure was defined as revision of either component or if the patient had pain of sufficient severity to limit normal activities. No patient had failure due to pain. Six hips have been revised (8.6%); in only five (7.1%) did the acetabular component require revision and in all of these the metal shell was noted to be soundly fixed. Only the plastic liner required replacement. Two liners were replaced at the time of revision of the femoral component for aseptic loosening due to osteolysis, one Corin-Müller (32 mm head) at 5.8 years and one CPT (28 mm head) at 9.2 years after the initial operation. Neither of these cups was secured with screws. Two liners in the same patient (both hips) were replaced because of wear at 13 years after the initial operation; both had Müller femoral prostheses which were stable with no evidence of osteolysis at the time of revision, but were revised to allow downsizing of the head. This reduction from 32 to 28 mm allowed a thicker liner to be used. The metal shells, both secured with screws, were noted to be soundly fixed at the time and were not changed.

One liner was revised for late dissociation of the insert 7.9 years after the initial operation; again the Müller femoral component was noted to be firmly fixed, but was revised to allow downsizing of the head from 32 to 28 mm (Fig. 2). One patient with a cemented Freeman stem developed extensive femoral osteolysis in all zones. This was revised at 49 months (Fig. 3) and it was noted that the acetabular component, which was inserted with screws, was firmly fixed with no apparent wear of the polyethylene liner or lysis around the screws. It was not exchanged.

The mean Harris Hip Score for the series was 29 ± 14.7 before operation. At the latest review this had increased to 94 ± 6.8.

The mean lateral opening angle of the cup was 39 ± 9.2°. There was no evidence of migration. Good integration was observed in 55 cups (Fig. 4); 23 had a non-progressive radiolucent line (< 2 mm) and three showed progressive radiolucent lines, of which two were complete and more than 2 mm wide at the latest follow-up.

Wear of the polyethylene was apparent on the radiographs of nine cups of which two have been revised. Of the nine stems there were 32 mm heads (5 Müller and 1 Exeter) and three 28 mm heads (CPT). None of these stems showed evidence of subsidence. Screw fixation was used in 65 of the 76 cups (Fig. 5), with a total of 185 screws inserted; none showed breakage. Only three cups showed radioluencies about the screws, none of which was progressive. Of these one developed 1 mm of screw lysis at
Heterotopic ossification occurred in 47 hips; 28 were grade I, ten grade II, nine grade III and none grade IV. Of the femoral stems, eight showed evidence of subsidence in relation to the proximal tip of the greater trochanter; six had sunk from 1 to 4 mm (mean 1.7) within the cement. These were three CPT’s, two Exeter, one Charnley and one Mülller; one (CPT) showed subsidence together with the cement (mean 2.5 mm; 1 to 4) and one (Müller) showed subsidence both within and with the cement. The position of the stem within the shaft of the femur was neutral in 57 (75%); 12 were in varus and seven in valgus. There was no relationship between the position of the stem and failure.

Using Kaplan-Meier survival analysis at eight years (which is the maximum limit for meaningful analysis) for both the stem and liner, the survivorship was 96.3% (confidence interval (CI) 91 to 100); this gives an effective number of 23 hips at risk. The same figure obtains for the cups. Using the ‘worst-case’ scenario, survivorship was 93.6% (CI 87.4 to 99).

Discussion

The management of the advanced stages of AVN remains a difficult problem and the results of THA carried out for AVN in previous studies have often been disappointing. Salvati and Cornell reviewed a series of 28 hips in 24 patients treated by cemented total hip replacement, and reported a rate of failure of 37% at a mean of eight years after implantation, with 100% failure in those under 30 years of age. Acetabular loosening was responsible in five patients, three had a fracture of the femoral stem, two a deep infection and in one the femoral component was loose. Chandler et al reviewed the results of 33 THAs undertaken in patients under the age of 30 years, of whom 11 were known to have AVN. Complications were reported in over 50% and the revision rate at five years was 21%, with a further 33% showing either migration of the component or progressive radiolucent lines. Saito et al reported the results of cemented THA in 23 patients with 29 hips diagnosed as non-traumatic AVN. The rate of revision was 28% (8 hips) with a mean follow-up of seven years. Overall, the results were unsatisfactory in 48% of patients. Modern cementing techniques have improved the results of THA. Kantor et al, using second-generation cementing techniques, reported an overall rate of revision of 12.5% at a mean follow-up of 7.5 years in 28 hips in 20 patients with non-traumatic AVN.

In view of the high rate of failure and revision in this group of patients, some have advocated the use of uncemented implants. Brinker et al described 81 uncemented arthroplasties in 64 patients with AVN of differing aetiologies. In a follow-up period of four to eight years, the rate of revision was 10%. Piston et al in a series of 35 uncemented arthroplasties in 30 patients with AVN, found a rate of revision of 6% at a mean of 7.5 years.

Uncemented prostheses are not without problems; Kim, Oh and Oh reviewed a series of 78 uncemented THAs in 61 patients with a rate of femoral revision of 5.1%, of the acetabulum of 6.4% and an overall failure of 20.5%. Callaghan, Dysart and Savory in their series of porous-coated anatomic uncemented prostheses, had an incidence of thigh pain of 16%. Katz et al in their series of 34 THAs (31 patients), of which 14 had uncemented components, described an incidence of 29% of severe thigh pain. Lins et al in a series of 37 hips in 33 patients had an incidence of thigh pain of 25%, with nine patients (20%) requiring the aid of a stick. Several studies have shown a variable outcome depending on the aetiology; patients with traumatic or idiopathic AVN were better than those whose AVN was associated with steroids or alcohol. Our results are in keeping with those of Chiu et al who found no statistical difference between these groups.

Using an uncemented cup, we had a rate of revision of 7.1% for the acetabulum at a mean follow-up of 7.6 years. More importantly, none of the cups was found to be loose at the time of revision of the femoral stem, and only required exchange of the polyethylene liners. Polyethylene wear was associated with the use of large heads, small sockets and thin polyethylene. Only three stems were revised for aseptic loosening secondary to osteolysis; in the remainder to allow change to a smaller size of head. This
study provides support for the use of cemented stems in patients with this disease, with a rate of revision of 8.6%.

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References