PRECISION-FIT SURFACE HEMIARTHROPLASTY FOR FEMORAL HEAD OSTEONECROSIS

LONG-TERM RESULTS

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Cemented Ti-6Al-4V components were used to resurface ten femoral heads in nine young adult patients with osteonecrosis of the femoral head (average age 32 years; range 20 to 51). There were eight hips at Ficat stage III and two at stage IV.

Five hips have maintained satisfactory function for an average period of 11.2 years (10 to 12.2) with no radiographic evidence of component loosening or osteolysis; five have been revised after an average period of 7.8 years (3.3 to 10.3) for pain caused by deterioration of the acetabular cartilage. No component required revision for loosening and the specimens retrieved at revision showed no evidence of osteolysis despite burnishing of the titanium bearing surface and the presence of particulate titanium debris in the tissues.

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The treatment of young active patients with Ficat stage-III osteonecrosis of the femoral head is challenging. Once segmental collapse has occurred, the results from core decompression have been poor both with bone grafting (Phemister 1949; Bonfiglio and Voke 1968; Boettcher, Bonfiglio and Smith 1970; Dunn and Grow 1977) and without (Winters, Pillsbury and Burstein 1986; Tooke et al 1988). Intertrochanteric osteotomies have produced unpredictable results (Ganz and Büchler 1983; Wagner

and Baur, personal communication 1986). Sugioka has reported success with his transtrochanteric rotational osteotomy (Sugioka 1984; Sugioka, Hotokebuchi and Tsutsui 1992) but others have not had similar results (Eyb and Kotz 1987; Tooke, Amstutz and Hedley 1987). Free vascularised fibular grafting remains an experimental method and is unsatisfactory once collapse has occurred (Fujimaki and Yamauchi 1983; Urbaniak et al 1988; Yoo, Chung and Hahn 1992).

Because the acetabulum is relatively normal in stage-III osteonecrosis, the concept of hemiarthroplasty is appealing to defer total hip arthroplasty. Conventional hemiarthroplasty with an intramedullary stem necessitates resection of the normal femoral neck and violates the femoral canal, and if biarticular components are used there is the risk of generating polyethylene wear debris which can result in further bone loss (Schmalzried, Jasty and Harris 1992). Later conversion to a total hip arthroplasty may therefore be more difficult and the result less durable (Amstutz and Smith 1979).

We have previously reported the early outcome of cemented surface hemiarthroplasty in young patients with advanced femoral osteonecrosis (Tooke, Amstutz and Delaunay 1987) and we now present the late results in these same patients.

PATIENTS AND METHODS

Between February 1981 and March 1983 the senior author (HCA) performed hemiarthroplasty on 12 hips in 11 patients. One hip is excluded from this report because a cobalt-chrome implant was used, and one patient has been lost to follow-up.

We describe the results in ten hips of nine patients, two women and seven men. Their mean age was 32 years (20 to 51). Seven of the patients had bilateral disease and all had an operation on the contralateral hip: three THARIES (Zimmer, Warsaw, Indiana) surface arthroplasties, two core decompressions plus grafting, one transtrochanteric rotational osteotomy, and one bilateral surface hemiarthroplasty. The aetiological factors associated with the osteonecrosis were steroid therapy in six (three for disseminated lupus erythematosus), alcohol misuse in three, and trauma in two (one was an alcoholic).

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Fig. 1a

Fig. 1b

Fig. 1c

Figure 1a – A 35-year-old man had bilateral osteonecrosis caused by alcoholism (right) stage III, (left) stage II. Figure 1b – Seven months after right surface hemiarthroplasty there was slight joint-space narrowing. Figure 1c – Eleven years later bone has filled the acetabular fossa (arrow). There is no evidence of femoral neck narrowing or erosions.

Radiographically, eight hips were in Ficat stage III and two in stage IV, with mild degenerative changes in the acetabulum (Ficat and Arlet 1980). All the acetabula were photographed at the time of surgery; all had fibrillation of the cartilage which varied in degree and area of involvement.

The prosthesis, operative technique, and post-operative course have all been described previously (Tooke et al 1987). Briefly, the diameter of the femoral head was measured by radiography with correction for magnification, and three titanium-alloy cups were made with 1 mm diameter increments. Their internal geometry was similar to that of the THARIES surface replacement (Amstutz et al 1977). A lateral transtrochanteric approach

was used with the patient in the lateral position. The femoral head was prepared using the THARIES cylindrical and chamfered reamers and care was taken not to notch the superior neck. All necrotic bone was removed and poorly vascularised, sclerotic areas of the femoral head were drilled with a 1.5 mm bit to a depth of 3 to 5 mm.

Glass hemispheres, in 1.5 mm diameter increments, were used to measure the size of the acetabulum and an intraoperative radiograph was then taken with the appropriate titanium component pressed into the acetabulum after loosely placing it on the prepared femoral head. The component which fitted best was chosen for implantation. Simplex P (Howmedica, Rutherford, New Jersey) acrylic

cement (Howmedica, Rutherford, New Jersey) in a low-viscosity state was then spread over the reamed femoral head and the cup was applied under pressure. The trochanter was reattached with a standard interlocking two-wire technique.

Postoperatively, the patients received prophylactic antibiotics and low-dose warfarin. Early touch-down weight-bearing was allowed, and continued for 8 to 12 weeks to encourage healing of the trochanteric osteotomy before full weight-bearing.

Follow-up evaluations were made at yearly intervals and the clinical result was assessed using the UCLA hip rating system which separately evaluates pain, walking, function and activity with a maximum of ten points for each (Amstutz et al 1984). Standardised radiographs were analysed to assess the fit of the prosthesis in the acetabulum immediately after operation, and to evaluate joint-space deterioration, prosthesis loosening and migration and bone resorption at intervals of time.

During the revision operations, specimens of the joint pseudocapsule were obtained and the resected femoral heads were fixed in 10% buffered formalin and then cut into 2 mm slices with a water-cooled saw. They were then processed into methylmethacrylate and thinned by standard petrographic techniques. The soft-tissue specimens were processed in glycol methacrylate, sectioned at 3 μ m and stained with toluidine blue.

RESULTS

Before operation the mean UCLA rating scores were as follows: pain, 4.1; walking, 5.2; function, 5.3; and activity, 3.9. Preoperatively, the average flexion arc was 110°, abduction 24°, and rotation 37°. All the wounds healed without infection. There were no dislocations and all the trochanteric osteotomies united.

The average follow-up time for the whole group (including five that had been revised) was 9.5 years (3.3 to 12.2). After their operations, one patient returned to college, five to their sedentary occupations, and three to employment requiring a high level of activity. At the last review the average UCLA scores for the entire group for pain, walking, function and activity were 8, 8, 7 and 6. All patients scored more than 7 for pain and walking. The average ranges of motion were as follows: flexion, 120°; abduction, 33°; and rotation, 74°. Four patients had leg-length discrepancies; one leg had been lengthened 0.5 cm, two were 1 cm short, and one was 0.5 cm short.

For the five hips that had not been revised, the average follow-up time was 11.2 years (10 to 12.2). The average UCLA scores for pain, walking, function, and activity for this group were 9, 8.2, 8.8, and 6 respectively. The average postoperative ranges of motion were: flexion 114°; abduction 32°; and rotation 63°.

All the immediate postoperative radiographs showed concentric reduction of the prosthesis into the acetabulum but in three hips the joint space was less than half the

normal width. At the last review the radiographs of all five unrevised hips showed some joint-space narrowing and new bone had filled the acetabular fossa to some degree in them all. There was no evidence of component loosening or migration in any of these cases. Nor was there evidence of neck narrowing, stress shielding or focal osteolysis (Fig. 1).

Five hips had been revised after an average period of 7.8 years (3.3 to 10.3) for pain, associated with deterioration of the acetabular cartilage. In these the average UCLA score for pain one year after the first operation was 8, and one year before revision 7.4. Just before revision it had fallen to 5. At reoperation we found mild metal staining of the soft tissues, wearing away of the acetabular cartilage and new bone nearly filling the acetabular fossa. The femoral components were scratched and burnished but well fixed (Fig. 2). Four hips were revised to cementless total arthroplasties and one to a hybrid surface replacement.

Histological examination of the soft tissues consistently showed macrophages containing metallic debris lining the pseudo-capsule and sparsely scattered throughout a loose connective-tissue stroma. The inflammatory cells were often perivascular. There was no evidence of granuloma formation (Fig. 3).

Coronal sections of the four resected femoral heads revealed, in some areas, a thin soft-tissue membrane interposed between the bone and the cement. This was usually around the femoral neck, not at the dome of the component, and the interposing fibrous tissue was sparse and relatively acellular, with only occasional giant cells and macrophages. The cement mantle was intact, the adjacent bone was not necrotic and areas of viable marrow were seen close to the cement. Contact radiographs of the slab sections showed the normal appearance of trabecular bone and no osteolytic lesions (Fig. 4).

DISCUSSION

In young active patients no prosthetic replacement is likely to last for the whole life span (Chandler et al 1981; Cornell, Salvati and Pellicci 1985; Dorr, Luckett and Conaty 1990; Joshi et al 1993). The concept of hemiarthroplasty is therefore attractive as an interim measure to give relief of symptoms and to defer the need for total replacement. Five of the ten hips described here have maintained satisfactory pain relief, walking, function, and activity levels for an average of 11.2 years. The cause of failure in all the revised hips was loss of acetabular cartilage. All these were revised with little more difficulty than in primary cases since there was no loss of bone stock and the medullary canal of the femur was intact.

The radiographs of all but one of the hips showed new bone formation in the acetabular fossa, possibly a response by the host to increase the surface area of articulation with the femoral component. The site of this bone formation is similar to that of the osteophyte which

Fig. 2a

Fig. 2b

Fig. 2c

Figure 2a – A 20-year-old woman had extensive stage-III osteonecrosis of the right hip. Figure 2b – Ten years postoperatively there is some joint-space narrowing but no evidence of component loosening or osteolysis. The prosthesis was revised because of pain. Figure 2c – The retrieved Ti-alloy component showed burnishing and scratching.

Fig. 3

Fibrous tissue from the rim of a component retrieved at revision nine years after implantation. There are metal particles in the macrophages but no granuloma formation (toluidine blue $\times 60$).

Fig. 4

Contact radiograph of a coronal section from a retrieved femoral head showing normal bone architecture and no osteolytic lesions.

frequently develops in osteoarthritis. The burnishing and scratching of the titanium component may have occurred from contact with the rough bony floor of the acetabulum after the cartilage had become worn.

These cases offer an interesting insight into the periprosthetic tissue reactions which occur in the absence of particulate polyethylene. Metal-on-polyethylene surface arthroplasty was frequently followed by progressive narrowing of the femoral neck, and a thick histiocytic membrane developed at the cement-bone interface often resulting in bone resorption and loosening (Howie, Cornish and Vernon-Roberts 1990). These features were not seen in any of the surface hemiarthroplasties. The retrieved specimens showed no evidence of osteolysis despite mild metallosis, the base of the head and neck was viable, and the cement-bone interface was largely intact. These specimens were distinctly different from those retrieved when a titanium femoral surface replacement had articulated with a polyethylene cup. In these cases invasive histiocytic granulomata replaced much of

the femoral head and neck, the cells containing both titanium and polyethylene particles (Nasser et al 1990; Amstutz et al 1991). Our findings present further evidence that bone resorption, interface degradation, and osteolysis in hip arthroplasty are due to polyethylene wear debris.

The failures in our series were due to loss of the acetabular articular cartilage and wear of the titanium-alloy-bearing surface. Perhaps the use of a harder prosthetic material with a smoother finish, such as alumina oxide, or cobalt chrome with its better wear characteristics may extend the life of the cartilage and the durability of the prosthesis.

We conclude that surface hemiarthroplasty can provide a conservative solution to the problem of the young patient with stage-III osteonecrosis of the femoral head.

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