Hybrid alumina total hip arthroplasty using a press-fit metal-backed socket in patients younger than 55 years

A SIX- TO 11-YEAR EVALUATION

Between 1990 and 1992, we implanted 71 hybrid alumina-on-alumina hip arthroplasties in 62 consecutive patients under the age of 55 years, with a mean age of 46 years at surgery. There were 56 primary and 15 secondary procedures. The prostheses involved a cemented titanium alloy stem, a 32 mm alumina head, and a press-fit metal-backed socket with an alumina insert. Three patients (four hips) died from unrelated causes. Four hips had revision surgery for either deep infection, unexplained persistent pain, fracture of the alumina head, or aseptic loosening of the socket. The nine-year survival rate was 93.7% with revision for any cause as the end-point and 98.4% with revision for aseptic loosening as the end-point.

The outcome in the surviving patients (50 patients, 57 hips) with a minimum five-year follow-up (mean eight years) was excellent in 47 hips (82.5%), very good in eight (14%), good in one and fair in one. A thin, partial, lucent line, mainly in zone III was present in 38% of the sockets and one socket had a complete lucency less than 1 mm thick. One stem had isolated femoral osteolysis. There was no detectable component migration nor acetabular osteolysis.

This hybrid arthroplasty gave satisfactory medium-term results in active patients. The press-fit metal-backed socket appeared to have reliable fixation in alumina-on-alumina hip arthroplasty. The excellent results using cemented fixation of the stem may be related to the low production of wear debris.

Hybrid total hip arthroplasty (THA), combining a cemented stem and a cementless socket, is an alternative to a fully cemented or cementless arthroplasty. The main argument for the hybrid configuration is concern about the long-term fixation of the cemented all-polyethylene cup.1-6 Although progress in cementing techniques has significantly improved the fixation of implants, this improvement has been more significant for the stem than for the socket. A survival rate for a cemented stem of over 90% after more than ten years’ follow-up is common.1,7,8 Other arguments include the uncertainty about the long-term results of modern uncemented stems and the promising results obtained with the new generation of cementless metal-backed sockets.8-13 With the increasing durability of fixation, polyethylene wear has become a major limiting factor, especially in young and active patients.5,6,14-16

The alumina-on-alumina couple was introduced in the 1970s in order to suppress wear and its consequences.17,18 Initially, the main limiting factors were the failure of fixation of the socket and the risk of fracture of the component.17-20 During the last decade the quality of the materials has improved significantly and the risk of fracture reduced.17,18 Consequently, fixation of the socket became the weak link of an alumina-on-alumina arthroplasty.17-23 Since 1990, we have used a press-fit metal-backed socket with an alumina insert.

The aim of our study was to present the results of this hybrid alumina arthroplasty, comprising a press-fit metal-backed socket and a cemented collared stem, which was implanted between 1990 and 1992 in active patients who were aged 55 years or younger.

Patients and Methods

Between 1990 and 1992, we implanted 71 hybrid alumina-on-alumina THAs in 62 consecutive patients under the age of 55 years. The criteria for exclusion from the study were a history of infection of the hip or failure of a previous THA. There were 36 men and 26 women. Nine procedures were bilateral. The mean age of the patients at the time of surgery was 46 ± 7 years (21.3 to 54.8). All patients were active, with 49 (79%) being in employment before surgery (including ten who were involved in strenuous activities or sports) and 13 being unemployed.

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The pre-operative diagnosis is shown in Table I. The main diagnosis was primary osteoarthritis or osteoarthritis secondary to minimal hip dysplasia (20 patients), while 18 patients had atraumatic osteonecrosis, including osteonecrosis secondary to alcohol abuse (four patients), steroid intake (seven patients) and idiopathic osteonecrosis (seven patients). THA was a primary procedure in 56 hips (79%). A total of 15 hips had undergone a previous operation, including a shelf procedure or femoral osteotomy (five hips), cup arthroplasty (three hips), drilling of the femoral head (three hips) and internal fixation of fractures of the proximal femur (three hips) or of the acetabulum (one hip).

The operation was undertaken through a posterolateral approach in 51 hips, the Hardinge approach in 17 hips and a trochanteric osteotomy in three hips. All patients received the same design of prosthesis, manufactured by Ceraver-Osteal (Roissy, France). The prostheses comprised a cemented, collared, smooth stem of anodised titanium alloy, a 32 mm alumina head and a press-fit, hemispheric, metal-backed socket with an alumina insert (Fig. 1). The stem was cemented with low viscosity cement after the insertion of an intramedullary polyethylene plug. The cement was introduced with a syringe using a plastic tube for air venting and pressurised manually immediately before inserting the stem. The socket comprised a titanium shell with screw holes covered with a pure titanium mesh. The shells had outer diameters from 50 to 64 mm and were impacted into a 2 mm under-reamed acetabulum. Additional screw fixation was required in 57 sockets (80%). The primary stability of the shell was already achieved after impaction in 50 sockets but screws were still used. In seven sockets, additional screws were required in order to achieve primary stability of the shell. Nine patients (nine hips) underwent an acetabular autograft for cavitary (four hips) and segmental defects (five hips). Partial weight-bearing was allowed on the second post-operative day, and full weight-bearing after four to six weeks.

Clinical results were analysed with the Merle d’Aubigné and Postel function score. Radiological analysis included radiolucent lines around both the socket and the stem according to DeLee and Charnley and Gruen, McNiece and Amstutz, respectively. Migration of the components and periprosthetic osteolysis were also recorded. For the survival analysis we used both the actuarial and Greenwood methods in order to calculate the confidence intervals. Statistical significance between different groups was calculated using the log-rank test with a probability level of $p < 0.05$.

Results

Three patients (four hips) with excellent or very good results at the last follow-up, died within two to four years post-operatively from unrelated causes. Early complications included one patient with phlebitis, one with a femoral nerve palsy with partial recovery, and two with dislocation which did not recur.

Four patients (four hips; 5.6%) underwent revision of their THA. A 44-year-old man with a destructive hip lesion of unknown origin developed a deep infection due to Staphylococcus aureus within three months of surgery and underwent a one-stage revision. He had further loosening eight years later and required a further revision. Another patient underwent a revision of the socket 2.5 years after THA for persistent pain which may have been caused by anterior impingement of the shell with iliopsoas. This patient, whose contralateral THA was excellent, initially underwent bilateral procedures for steroid-induced osteonecrosis after failure of a core decompression. The socket was well fixed, but was changed to a cemented polyethylene component. Seven years post-operatively there was persist-
ent discomfort without, however, any abnormal radiographic features. A 48-year-old obese woman sustained a fracture of the alumina head eight years post-operatively. Both the femoral head and socket were exchanged for another alumina head and a press-fit metal-backed socket with an alumina insert. The result was good two years after this procedure. One patient, with bilateral THA for steroid-induced osteonecrosis, developed unilateral aseptic loosening of the socket within 5.5 years. At revision, the wire mesh of the cup, although broken, was partially integrated into the acetabular bone. The stem was well fixed and was retained. The socket was changed to a cemented polyethylene component with a very good result four years postoperatively.

**Survival analysis.** Taking revision for any reason as the end-point, the overall survival rate was 93.7% at nine years (87.7 to 99.7). Taking revision for aseptic loosening as the end-point, the overall nine-year survivorship was 98.3% (95.0 to 100) with a survival rate of 98.3% for the socket and 100% for the stem (Fig. 2).

**Clinical and radiological outcomes.** The results were assessed in the surviving patients with a minimum follow-up of five years. Five patients from overseas (six hips; 8.5%) were lost to follow-up. Excluding those who died (three patients, four hips), and those who underwent revision (four patients, four hips), 50 surviving patients (57 hips) were available for final assessment. All had clinical and radiological assessment at the last follow-up, except nine patients (nine hips) who were only interviewed by telephone. The mean follow-up was 8.0 ± 1.1 years (6 to 11.5, median 7.8).

At the last follow-up, the mean Merle d’Aubigné and Postel score was 17.8 ± 0.6 (14 to 18) compared with 11.5 ± 2.3 (4 to 15) pre-operatively. The outcome was excellent in 47 hips (82.5%), very good in eight (14%), good in one, and fair in one hip due to hemiplegia. At the last follow-up, 14 patients remained employed, and 36 patients were unemployed or retired.

Radiological data were documented in 43 patients (50 hips). There were no abnormalities in 31 sockets (Fig. 3), but 19 (38%) had a thin and partial lucent line, mainly localised to Charnley and DeLee zone III. One patient, with an excellent result at seven years, had a non-progressive complete lucency around the socket. It was less than 1 mm thick, and there was no detectable migration, acetabular osteolysis, stem subsidence or signs of femoral bone remodelling. Four stems (8.0%) had isolated and partial lucencies that involved two to four zones. In one hip with an excellent clinical result there was femoral osteolysis. This was in a 44-year-old man who had undergone THA for post-traumatic osteoarthritis and had required acetabular reconstruction with an autograft fixed with screws. Seven years post-operatively, femoral osteolysis was visible in Gruen zones II and III, associated with partial lucencies around the stem. He was symptom-free.

**Discussion**

Despite improvements in technique and design of the components, the results of THA are less satisfactory in younger patients.2-6,10,28-31 Accelerated polyethylene wear due to increased activity in the younger patient is assumed to be the principal mechanism of failure. One can argue that age and levels of activity vary widely in any series of arthroplasty in younger patients, so that correlations between age, activity and polyethylene wear are not precise.15,16,32 The difference in the initial diagnosis between older and younger patients may also influence the final outcome. Many studies into the use of cemented or cementless designs have reported a higher rate of osteolysis in young people and have recognised polyethylene wear as the principal cause of long-term failure in these patients.2-4,6,10,14,28,30,31 Our results support this conclusion. Compared with conventional THA in younger patients, the reduction of wear achieved by using alumina appears to give better results.2-4,10,13,28-30 These results are comparable to those reported at a similar follow-up for older patients.8,9,11,12 A flaw in our study may be the limited follow-up and the age limit of 55 years, as this may represent a middle-aged rather than a younger population. All the patients were active and the majority were either employed or involved in some sporting activities.
Alumina wear was impossible to measure on serial radiographs and special attention was, therefore, paid to the occurrence of osteolysis. We have 25 years’ experience with the alumina couple, and have reported a low rate of osteolysis, even in young people.17,18 True osteolysis has only been reported in abnormal situations, such as inadequate implant positioning, abnormal contact, or with instability of the components.17,18 Individual instances of femoral osteolysis after alumina hip replacement have been reported in the literature, although all were associated with the Mittlemeier design.33-35 Yoon et al36 have reported a high rate of so-called linear femoral osteolysis. These were thick radiolucent lines or bone-implant demarcation which corresponded to a fibrocytic reaction without osteoclastic activity on histological analysis. This might reflect the poor design of the prosthesis with poor fixation and high contact alumina stresses due to impingement with the mushroom-shaped alumina head. In our study, no osteolysis occurred around the acetabular component and femoral osteolysis was only seen in one patient who had undergone massive acetabular reconstruction. Animal studies and histological analysis of pseudomembranes from loosened alumina cups suggest that this unexpected osteolysis was probably induced by metal or cement debris rather than by alumina particles.37-39 Metal abrasion might occur between the shell and the screws which hold the acetabular graft or be due to fretting of the stem.

The main consideration when using a hybrid combination was concern about the fixation of the alumina socket. In the past, failure of this fixation was the commonest indication for revision of an alumina hip replacement. Many methods of fixation have been explored, both cemented and cementless,17-23 and it was concluded that failure was not wear-dependent, but was related to poor design or to designs which did not allow for the intrinsic properties of the material, especially its high rigidity and biologically inert nature.20-22,36 This compromised the fixation of cemented or press-fit, plain alumina sockets.17-20,22 Press-fit metal-backed sockets have been introduced in order to obtain durable fixation through direct bone ingrowth and to reduce the peak stresses in both the acetabular bone and the liner. Promising results have been reported in metal-polyethylene hip replacements with the use of hemispherical, porous-coated metal-backed shells, although additional problems due to modularity of the socket have been noted. Our results are satisfactory and show a significant improvement in fixation of the socket when compared with earlier series of alumina-on-alumina arthroplasties.17-23 We encountered no problems related to the modularity of the socket. The locking mechanism of the alumina insert with its conical sleeving appeared to be safe and reliable, provided that a careful technique was used. The latter thus required a more horizontal position of the shell in order to reduce peak stresses in the alumina insert and to minimise

Radiographs showing (a) a 44-year-old man with severe secondary osteoarthritis of unknown aetiology and (b) hybrid alumina total hip arthroplasty at one month. At 10 years follow-up (c), the radiograph shows no abnormalities apart from moderate resorption of the calcar. The clinical result is excellent; the patient is employed and enjoys sporting activities.
wear. Great attention was paid to cleaning the interior of the metal-backed shell, and to position the insert correctly before sealing it by gentle hammering. The relatively high rate of acetabular lucencies encountered in our series may be of concern, although most were partial and non-progressive and none associated with migration of the socket. No patient-related parameters were associated with the occurrence of lucencies around the socket. We concluded that partial socket lucencies possibly indicated limited bone ingrowth through the grid which appeared, however, sufficient for durable fixation. This has also been seen in other series which have used press-fit metal-backed cups with polyethylene liners and in animal studies.12,40

Excellent results were obtained with the cemented stem. Care was always taken to choose the largest stem and thus to obtain the optimal bone-stem fit and collar-calcar contact in order to limit the mechanical role of the cement. We have used this femoral component with the same cementing technique since 1977. The overall survival rate, 97% after 15 years, is even better in younger patients.17,18 The use of the so-called second generation cementing technique offers excellent results which compare favourably with other series.1,7,9 This demonstrates the optimal design of the stem and the greater resistance to wear of alumina.

The hybrid alumina-on-alumina hip prosthesis, which uses a press-fit metal-backed socket and a cemented stem, has provided excellent results in the medium-term. A significant improvement in fixation of the alumina socket has been obtained with the use of a hemispheric press-fit metal-backed component. The excellent wear resistance of alumina suggests that these results may be maintained in the longer term. Hybrid alumina-on-alumina hip arthroplasty appears to be a good alternative to other, more conventional arthroplasties in younger, more active patients.

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


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