Arch Orthop Trauma Surg (2002) 122 : 350–353
DOI 10.1007/s00402-001-0378-z

ORIGINAL ARTICLE

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Five-year follow-up with a ceramic sandwich cup in total hip replacement

Received: 17 August 2001 / Published online: 2 February 2002

Abstract The results of the first 56 consecutive total hip replacements using a new cementless, sandwich (alumina-polyethylene-titanium) acetabular component are reported. From March 1994 to March 1995 we operated on 39 female and 17 male patients; their mean age was 62.8 years (range 32–85 years). The Harris Hip Score was used for clinical evaluation. X-rays were examined according to the DeLee and Charnley method. At an average follow up of 62.4 months, 51 patients had complete clinical and radiographic data. For them, we recorded a good clinical result (average HHS 90.6), and we could detect no acetabular radiolucencies on X-rays. At the 5-year follow-up the results of this ceramic acetabular cup are quite encouraging. As a matter of fact, although the clinical results are very similar to those reported by other authors with conventional ceramic-polyethylene coupling prosthesis, the absence of periacetabular radiolucency and socket migration could mean less debris formation, less acetabular wear and, consequently, a longer life of the implant.

Keywords Acetabular component · Alumina · Cementless primary total hip arthroplasty

Introduction

The problem of wear of the materials which constitute the components of arthroplasty of the joints has been one of the main topics of discussion among orthopaedic surgeons for several years. The outcome of a hip arthroplasty is directly linked to the wear of the articular components, head and acetabular cup. Initiation of the biological processes responsible for the prosthesis loosening is strictly connected with the amount of debris formed at the articular interface.

Ultra high molecular weight polyethylene, due to its high rate of wear, has been indicated as the main agent responsible for processes of loosening of an arthroplasty [14].

In answer to these problems, a number of different solutions concerning the improvement of the quality of the polyethylene used or its substitution with other couplings such as metal/metal or ceramic/ceramic have been suggested.

Though recognising the tribological superiority of the ceramic/ceramic coupling versus ceramic/polyethylene, our experience with the implant of an acetabular component with a ceramic insert is quite limited, having started in March 1994. Until that date we had been fairly suspicious of the ceramic/ceramic coupling. Uncertainty, diffidence, acceptance of some common prejudices against ceramic implants had always led us to choose the more traditional ceramic-polyethylene coupling for arthroplasty.

We are aware that this kind of implant is subject to the problem of wear of the polyethylene component. On the other hand, it is common knowledge that the coupling ceramic-ceramic, first proposed over 20 years ago [2], whilst offering the best results from the point of view of wear and of biocompatibility, presents the relevant problem of material stiffness.

Due to this stiffness, ceramic is unable to reduce the dynamic stresses transmitted from the articular components to the bone at every step. It is for this reason that the best results of ceramic implants have been described in young patients or in those patients with good bone trophism [3, 11]. Another relative disadvantage described in the use of this kind of arthroplasty is the need for a very precise surgical technique. All situations which can cause uneven load, such as an excessive verticality (>50°) of the acetabular cup or anomalous contacts of the articular components, can cause a rapid loosening of the implant and an equally fast ceramic wear or breakage [7, 8].

The ideal prosthetic components should in theory combine ceramic's and polyethylene's favourable features, especially at the level of the acetabular cup.

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The proposal of a modular socket with a sandwich insertion ceramic-polyethylene-titanium assembled by a Morse cone system appeared to us the solution which, at least in theory, could satisfy our expectations. The mechanical stability guaranteed by an implant of this type of the polyethylene in the metallic cup should neutralise the micromovements between these two components and, consequently, avoid the formation of debris [4, 6]. The Morse cone assembling system should furthermore guarantee a very good mechanical hold among the single components of the acetabular cup, which has always been considered the critical point of modular systems.

We therefore decided to clinically verify the theoretical assumption of this ceramic/ceramic coupling.

In the past 6 years, from March 1994, 348 ceramic-ceramic coupling prosthesis were carried out in our Institute. We have limited the study to those implants which, at the moment, have more than 5 years' follow-up.

Patients and methods

From March 1994 to March 1995, 69 consecutive hip arthroplasty implants with ceramic-ceramic coupling were carried out at our Institute. During the first 6 months of the study period, the smaller sizes (46 and 48 diameters) of the ceramic liner were not covered with polyethylene; all of the other sizes were ceramic-polyethylene liners. Thus, only 56 hips were available for study.

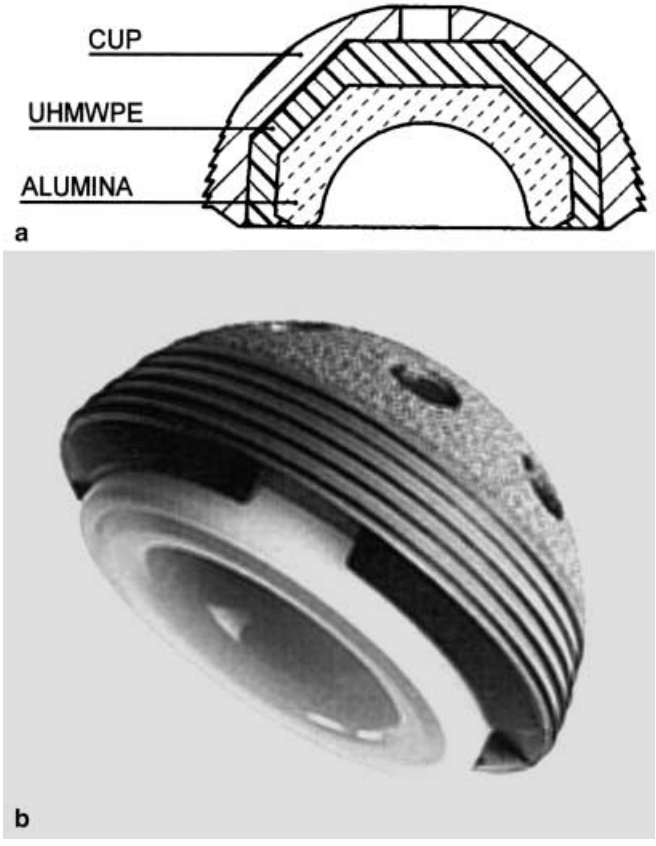

Fig. 1 **a** Diagram of the Contact acetabular component section showing the three different layers. **b** The socket as a whole

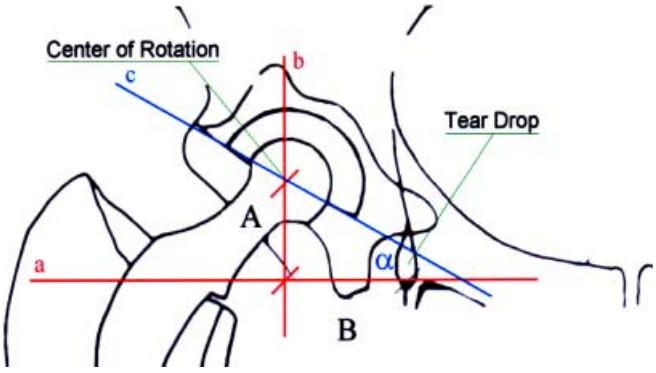

Fig. 2 Socket migration evaluation method

Thirty-nine patients were female and 17 were male, with ages ranging from 32 to 85 years (mean 62.8 years). Patients were referred for primary or secondary arthritis of the hip (44) in 78% of cases, congenital dislocation of the hip (7) in 12.5%, avascular necrosis of the femoral head (4) in 7.1% and coxa plana (1) with epiphysiolysis in 1.8%.

Surgery was performed by two authors (F.R. and V.S.) using the lateral direct access according to Bauer.

Thirty-eight total hip replacements (68%) were non-cemented implants and 18 (32%) were hybrid (cemented stem and cementless cup). The acetabular component was never cemented.

The Lima LTO Contact acetabular component (Fig. 1) was always used for all prosthetic implants. This cementless cup consists of a ceramic liner housed in a polyethylene shell which is held in a titanium metal cup. The three components are assembled into each other reciprocally by a Morse cone system.

The ceramic liner is made in one size for all sizes of the acetabular component, whilst the polyethylene shell varies in thickness. At the beginning of the study period, the smaller sizes (46 and 48 diameters) of the ceramic liner covered with polyethylene were not available. For this reason, all the patients (13) who had a 46 or 48 diameter cup implanted were excluded from the present study. The femoral components used were straight or anatomical stems cemented or not according to the patient's age and bone stock conditions. A 28-mm diameter ceramic head was always used.

Clincal results were measured using the Harris Hip Score, and x-rays were evaluated using the DeLee and Charnley method.

All patients were clinically examined before surgery, at 6 months and 1 year after surgery, and at the time of the last follow-up, between 64 and 76 months after surgery.

X-rays of the pelvis and axial view of the involved hip were taken before surgery, after 6 months, 1 year and every 2 years after surgery. The standard enlargement of the pelvic X-ray was obtained at 1 m fixed fire-film distance. On all postoperative X-rays we examined the presence of periacetabular radiolucency and the inclination of the acetabular component in the front plane.

To evaluate the socket migration and/or the wear on the liner, the distance between the most distal point of the tear drop and (1) the centre of rotation of the prosthetic head and (2) the cranial edge of the acetabular cup were also measured (Fig. 2).

Results

Of the original 56 patients examined, we registered the clinical data and complete X-rays of 51. Their average follow-up was 68 months (range 64–76 months). All patients showed a significant increase in the clinical score before surgery, on the date of their last check-up (47.8 average preoperative vs 90.6 average final result). Compared with the immediate postoperative X-rays (Fig. 3),

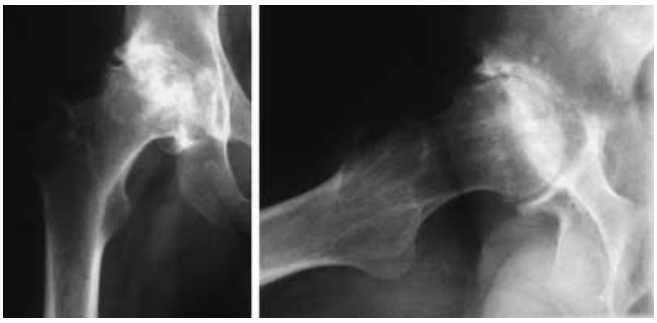

Fig. 3 Preoperative radiographs of the right hip of a 32-year-old man with avascular necrosis of the femoral head

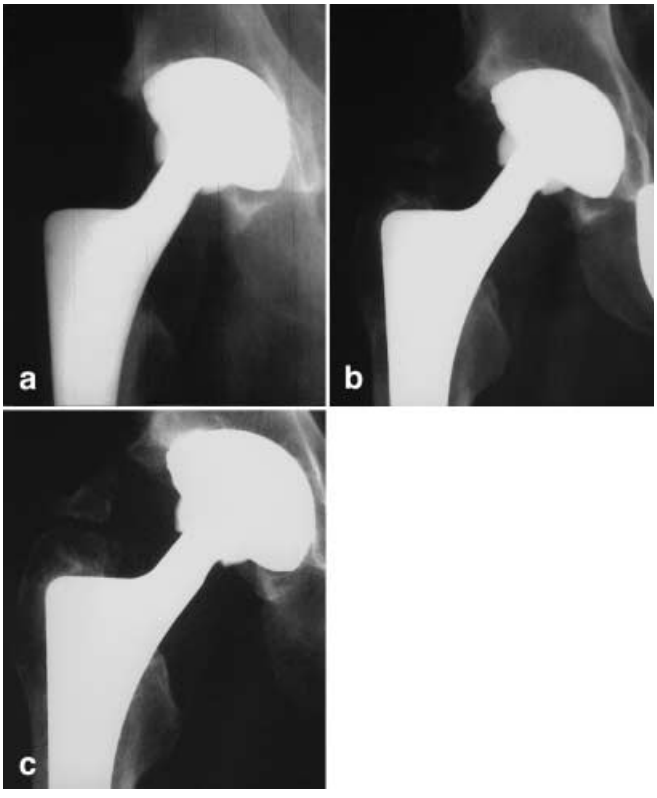

Fig. 4 **a** Early postoperative hip radiographs of the same patient shown in Fig. 3, after total hip prosthesis with the cementless Contact acetabular component. Unchanged position of the socket, with no loosening and no osteolysis after 1 year (**b**) and 5 years (**c**)

no lines of periprosthetic radiolucency nor migration of the acetabular component were observed at 6 months and 1 year after surgery and at the final check-up (Fig. 4).

The worst result with a final clinical score of 57.4 was obtained in a patient complicated by an intraoperative longitudinal fracture of the femoral shaft and with two episodes of dislocation in the first postoperative month. This patient was treated in a spica cast after closed reduction and developed Brooker periprosthetic ossifications that greatly limited the articular range of motion.

An early failure was due to an excessive retroversion of the acetabular cup, enough to produce repeated impingement between the prosthetic neck and cup. The patient had to undergo surgery for an acetabular implant revision 2 weeks after the previous operation. Also in this patient, onset of periprosthetic ossifications was seen on X-ray. In another patient an intraoperative fracture of the greater trochanter occurred and required a metallic cerclage. This complication did not influence the outcome of the operation.

An excessive verticality of the acetabular components (>50°) was found in 3 patients. Nevertheless, all of them showed an excellent radiographic result at every follow-up.

Discussion

If there appears to be a common agreement on the superiority of ceramic versus polyethylene in terms of resistance to wear and biocompatibility, the limit has always been its stiffness, so that its use was recommended only in young patients with a good bone quality [11]. A further limitation to the use of ceramic-only implants is the need for a precise surgical technique. An excessive verticality of the acetabular cup or a tendency to dislocation such as to create a conflict between the socket and the collar of the femoral stem can initiate prosthetic loosening and massive ceramic wear.

The average age of our patients (62.8 years) is higher than that reported by Sedel in his series. We have, in fact, extended the indication for the use of a non-cemented acetabular cup also to patients who could be suitable for a cemented implant supported, in this decision, by experimental data according to which a sandwich ceramic-polyethylene liner appears to be up to 30 times less stiff than a ceramic-only acetabulum of similar size owing to the layer of polyethylene [5]. Not having performed any revision of this kind of implant for loosening and consequent wear until today, we can suppose that the 3-layer modular system, owing to the presence of polyethylene, may be able to reduce the tension peaks generated during gait and transmitted to the bone. This would allow it to overcome the known limits of the use of ceramic, due to its high stiffness.

Our 5-year follow-up study gave results comparable to those of similar studies reported in the literature for conventional acetabular cups [1, 12, 13], in terms of improvement of the clinical situation evaluated according to the HHS score.

The radiographic absence of lines of periprosthetic radiolucency and of migration of the acetabular component after 60 months is very interesting and may be considered proof of the stability of the implants. This result differs from what is reported in the literature. Maloney and Sharkey consider the presence of periacetabular osteolysis normal in 18% of polyethylene acetabular implants after 60–86 months after surgery [9, 12]. If periacetabular osteolysis is to be considered an expression of the presence of debris in the acetabular bone [10], our results, though with some hesitation due to the relatively short follow-up period which is the minimum time span required for the ra-

diologic appearance of osteolysis reported in the literature, seem to be significant as far as limitation of the production of polyethylene debris is concerned.

On the basis of our favourable clinical experience, we may assume that the index cup is actually able to express the two positive features of ceramic as well as of polyethylene. More precisely, on the one hand, ceramic confirmed its well-known superiority over polyethylene in terms of resistance to wear; on the other, the layer of polyethylene which encloses the ceramic liner may reduce the stiffness of the ceramic-ceramic coupling. The concern about polyethylene wear at the interface with the metal back should be minimized by the Morse cone system, which appears very stable at the interface. The absence of micromovements which could produce polyethylene debris and start osteolytic phenomena has been documented in retrieval studies performed on conical liners which utilize the same assembling system between polyethylene and metallic shell [4].

The absence of polyethylene debris due to stability of the system finds further confirmation in the results of the histological study on periprothesic soft tissue obtained during surgical revision of hip implants with an acetabular ceramic sandwich. In two later cases not included in the present study, we substituted the acetabular cup for repeated implant dislocations due to an incorrect position of the cup. The histological studies showed no polyethylene debris in the examined tissues [6].

Moreover, in daily use we have verified that the presence of the polyethylene layer eases the introduction of the ceramic liner into the metallic socket, and in the case of a substitution of the ceramic, this manoeuvre is easier to perform than with ceramic-only implants.

In conclusion, the short- and medium-term results appear to be very encouraging and convince us of the superiority of the ceramic-ceramic coupling versus the conventional ceramic-polyethylene. It is, however, necessary to extend the follow-up at least by an additional 5 years before being able to issue a more definitive judgement on the long-term reliability of the composite acetabular cup.

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