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Cementless hemispheric acetabular component in total hip replacement

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Abstract A series of 198 total hip arthroplasties was performed using a porous-coated, hemispheric press-fit cup. One hundred and twenty-seven cups were available for clinical and radiological examination at mean follow-up of 10.6 years. The mean age at the index procedure was 61.2 years. The mean Harris hip score at final follow-up was 89.8. Three cups were revised for aseptic loosening and two liners were changed for eccentric wear and pelvic osteolysis. Nine additional patients showed mild or suspected osteolysis. Two cups were rated “fibrous” stable. There was no correlation between additional screw fixation of the press-fit cup and osteolysis or revision.

Résumé Nous avons réalisé une étude rétrospective comprenant 127 prothèses totales de la hanche en utilisant une cupule acetabulaire non cimentée. L'âge moyen des patients lors d'intervention était de 61.2 ans. La durée moyennée d'observation post-opératoire était de 10.6 ans. Le score de Harris lors du dernier examen clinique était de 89.9. Trois cupules étaient révisées pour descellement aseptique et deux inserts en polyéthylène étaient changés pour usure et ostéolyse. Neuf autres patients montraient une ostéolyse discrète. Deux cupules étaient stables avec une fixation dite «fibreuse». Aucune corrélation entre utilisation de vis pour la fixation primaire et le développement d'ostéolyse n'a été trouvée.

Introduction

Optimal fixation for acetabular components in total hip arthroplasty is controversial [12,24]. Whereas stem fixation has shown significant improvements in mid- and long-term outcome studies for cementless and cemented (modern cement technique) fixation [14,32], the cup fixation has clearly become the major factor for hip replacement failure rates [4,12,13,24]. Many reported series show increasing osteolysis and loosening of cemented and cementless bone ingrowth sockets at mid- to long-term follow-up [2,5,11,15,16,18,21,24,26]. Current problems include modularity [1,5,17], socket-fixation [7,21,30,33], thickness [3,28,31] and backside wear [6] of polyethylene liners as well as size and quality of articulating heads [22]. Because of the high costs of revision surgery, the cup fixation has become a major concern not only for patients and orthopaedic surgeons, but also for third party payers.

The purpose of this study is to present the results of our series of cementless bone ingrowth modular sockets of one specific design with mean follow-up of 10.6 years.

Materials and methods

Between May 1987 and July 1993, 198 total hip arthroplasties (THA) using a press-fit acetabular component were performed by the senior authors (L.A.S., D.L.P., W.E.B.Jr.) at The Louisville Institute for Joint Replacement and The Arthroplasty Foundation, Louisville, Ky., USA.

The THAs were performed in routine primary cases. Thirty-eight patients did not return for follow-up and 33 patients died due to unrelated causes before their 6-year follow-up. The status of their hips was unknown and they were considered lost to follow-up and therefore not included in the study. At the time of review, 127 THA in 115 patients with a minimum 6-years follow-up had complete data and were included in the final study group. Clinical follow-up information was obtained by physical examination, interview and patient evaluation forms and questionnaires.

Radiographic examination included an anteroposterior pelvic film, centered over the pubic symphysis and a Lowenstein-lateral roentgenogram. The roentgenograms were taken immediately

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Fig. 1 *Opti-Fix cup*. Porous coating with titanium beads. Holes allow additional screw fixation at multiple sites

postoperative, at 3, 6 and 12 months after the THA and annually thereafter. The angle of inclination of the cup was measured [34] and radiolucent lines („linear“ osteolysis) and expansile osteolysis (dissolution of bone) [35] were evaluated in the three zones described by DeLee and Charnley [9].

Cups presenting without any radiolucent line or a discrete line in zone one or three were considered as bone ingrown and stable. Cups presenting with a radiolucent line in two or three zones in an asymptomatic patient were considered as fibrous stable. Cups presenting with a radiolucent line in two or three zones in a symptomatic patient (groin pain) were considered as fibrous unstable.

The mean follow-up was 10.6 years (range 6–13 years). The mean age at the time of surgery was 61.2 years (range 29–85 years). There were 75 females and 52 males. The preoperative diagnoses were: osteoarthritis 88 hips, avascular necrosis in 23 hips, rheumatoid arthritis in 4 hips, hip fractures combined with osteoarthritis in 10 hips and 2 developmental dysplasia of the hip. Other co-morbidities included coronary artery disease (23 patients), hypertension (19 patients), obesity (8 patients), diabetes (10 patients) and nonmetastatic cancer (7 patients).

The Opti-Fix acetabular component (Smith and Nephew Richards Orthopaedics, Memphis, Tenn., USA) was used in all patients. This is a porous coated, hemispheric press-fit acetabular shell with multiple holes (15–21) placed symmetrically over the entire hemisphere (Fig. 1.) allowing additional screw fixation in any position. The shell and the screws consist of a titanium 6 aluminium 4 vanadium alloy. The shell is coated with titanium beads (porosity 250–350 m). The liner (UHMW-polyethylene) is snap-locked into the shell. The acetabulum was under-reamed by 1 mm to obtain a press-fit of the cup. In very osteoporotic bone or if ideal press fit could not be obtained, additional screws (one–three) were inserted to enhance primary stability.

In addition to the Opti-Fix cup, 89 procedures incorporated a noncemented femoral stem (73 Opti-Fix stems and 16 stems of different manufacturers). The remaining 38 hips received a cemented stem of a different manufacturer (Precision stem, Howmedica, Rutherford, N.J., USA). Two head sizes were used; 32 mm (in 100 hips; 70 metal and 30 ceramic) and 28 mm (in 27 hips; 19 metal and 8 ceramic). The diameters of the cups were measured for the hips by using 32 mm and 28 mm heads. Survivorship analysis for the cup was performed according to Dobbs [10]. Clinical results were calculated using the Harris hip score (HHS).

Results

Preoperatively the mean HHS for all 127 hips was 43.7 (range 3–79). At the most recent follow-up evaluation the mean HHS reported was 89.8 (range 57–100). No patient was eliminated due to debilitating factors other than the joint. When comparing clinical scores, no significant



Fig. 2 *Roentgenogram (Lowenstein-lateral view) of an Opti-Fix cup*. A 43-year-old, symptomatic, female patient, at 9-years follow-up. Linear radiolucent line present in zone 1, 2 and 3; cup fibrous „unstable“. Small acetabular component measuring 46 mm, 28 mm head (ceramic) and (thin) excentrically worn polyethylene liner

differences were found with respect to age, sex or disease process. No early or late infections were observed. One patient experienced a nonfatal pulmonary embolism.

Radiographic evaluation at the last visit revealed that all hips had 90% or greater coverage of the acetabular shell and no vertical position over 50° was observed. The linear penetration rate was not measured. Three cups were revised for aseptic loosening, two loose and one fibrous „unstable“ at 2.4, 5 and 9 years after the initial procedure. One of these cups (fibrous „unstable“) was very small (46 mm diameter) and a 28 mm ceramic head was used (Fig. 2.); at revision surgery at 9 years, the liner showed eccentric wear and cold flow. The other two revised cups had a 50 mm (32 mm head) and a 52 mm (28 mm head) outside diameter. In two other patients the liners were revised for painful eccentric wear and mild expansile osteolysis in zone 2; no additional bone grafting was necessary at the time of revision surgery, but the head size was changed from 32 mm to 28 mm. None of the revised cups were initially inserted with additional screws.

Fourteen of the 127 hips showed some amount of osteolysis [35]. These changes occurred after the 4 years follow-up in 13 cases. The 5 revisions have been described above. In 9 additional hips osteolysis was mild or suspected and the patients were asymptomatic. Twelve (6 ceramic and 6 metal) of these 14 THA used heads of 32 mm diameter. Two of the 28 mm cups showed osteolysis. This difference was statistically not

significant at $P < 0.10$. In respect to whether the femoral head was made of metal or ceramic no difference in the occurrence of osteolysis was observed. There was almost no difference between the mean diameters of the cups used with 32 mm or 28 mm heads (0.5 mm).

There was a total of 18 cups fixed additionally by one to three screws. Only 1 (not revised) of the 14 cups showing osteolysis was fixed by two additional screws. Cumulative survivorship for this cup type between 12 and 13 years is 0.94 according to Dobbs [10].

Discussion

Acetabular cup fixation has become the major concern in THA since the introduction of so-called second generation cementing techniques. Several noncemented stem designs improved medium and long-term results for stem fixation drastically [14,32]. Although the new cementing techniques had also improved the results of cemented cup fixation, reported revision (and loosening) rates were still relatively high with 10% (and 22%) at 15 years [20,24]. Loosening rates for noncemented acetabular cups for short-term follow-up range between 0 and 8% with appearance of radiolucencies in 0–11% [2,8,11,13,18,25,29]. A few studies reported results for a minimum of 10 years follow-up with loosening rates from 0 to 15% and radiolucencies from 0–56% [19,27].

We present a series of 127 THA performed with a press-fit porous-coated acetabular cup that has the special characteristic of having multiple, symmetrically placed holes over the entire hemisphere. This allows additional screw fixation at any desired location in the cup to enhance primary stability.

To our knowledge, this is the only study with a long-term follow-up of 10.6 years of this specific type of implant [23]. Although the Opti-Fix-cup is no longer available our findings may be of interest with regard to the ongoing discussion about cementless cup fixation, additional fixation by screws, backside wear and osteolysis because of the specific design features of this implant.

In our series of 127 primary THAs, the rate of mechanical failure for aseptic loosening was 2.4% and the combined revision rate for aseptic loosening as well as liner exchange only, was 4%. Overall, pelvic osteolysis (linear and expansile) [35] was noted in 11%.

In one symptomatic fibrous unstable cup (Fig. 2.), the polyethylene liner was thinner than 6 mm. This has been demonstrated as being a major risk factor for polyethylene wear [3]. At revision surgery, the liner showed eccentric wear and cold flow. In three of the other four revision cases, as well as in all additional 9 cases presenting with some amount of (linear or expansile) osteolysis, heads of 32 mm diameter were used. This head diameter has been shown to increase shear stresses [22] and therefore polyethylene wear and potentially osteolysis, which are supported by our findings. Additionally, it has been shown that in THAs with use of modular acetabular components, thinner polyethylene liners are used and, as

a result, more wear was found than in nonmodular cups [1,5,17].

Although the number of our cases is limited, we could find no difference in the occurrence of osteolysis between metal and ceramic 32 mm heads. We found no evidence that the use of additional screws increases the incidence of osteolysis [13].

Our results suggest that the Opti-Fix cup with multiple holes presents sufficient surface of porous coating with good ingrowth capabilities of the titanium beads as well as a stable locking mechanism, and therefore minimized polyethylene backside wear. Although the 10.6-year follow-up results are promising and match well with other successful implants, attention must be paid to the fact that holes in the metal shell are pathways for backside generated polyethylene particles. That may lead to osteolysis as suggested by Maloney and Yamaguchi [21,33] and as demonstrated in our radiological examinations. The specific design of this cup with multiple holes placed symmetrically over the entire hemisphere may favor circumferential osteolysis that could lead to microfractures of ingrown bone-bridges.

We therefore believe that metal acetabular shells should have only a minimum of holes for additional fixation. If stable fixation can possibly be achieved without screws, the holes in the cup should be turned (inferiorly) away from the optimal fixation zones of the acetabulum.

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