International Orthopaedics (SICOT) (2001) 25:286–289
DOI 10.1007/s002640100265

ORIGINAL PAPER

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Cementless cup fixation in total hip arthroplasty after 5–8 years

Accepted: 17 April 2001 / Published online: 24 August 2001

Abstract A series of 199 total hip arthroplasties was performed using a porous-coated, hemispherical press-fit acetabular cup. At a mean follow-up of 91.5 months 158 cups were available for clinical and radiological review. The mean age of the patients at the time of the index arthroplasty was 62.5 years. The mean Harris Hip score at final follow-up was 87.3. No shells were revised although eccentric polyethylene wear prompted liner replacement in two cases. Osteolysis was noted in six cases but predominantly in relation to the femoral stem. Focal pelvic osteolytic lesions were rare. All the cups were classified as stable on radiography.

Résumé Une série de 199 arthroplasties totales de la Hanche a été exécutée utilisant une cupule acétabulaire hémisphérique avec surface réhabitable de type "press-fit". Cent cinquante cupules étaient disponibles pour étude une clinique et radiologique à un suivi moyen de 91.5 mois. L'âge moyen des patients à l'arthroplastie était de 62.5 ans. Le score de Harris au dernier examen était 87.3. Aucune cupule n'a été révisée bien que l'usure du polyéthylène excentrique ait conduit au remplacement du liner dans 2 cas. Une ostéolyse a été notée dans 6 cas, d'une manière prédominante au niveau de la tige fémorale. Toutes les cupules ont été classées comme stables radiologiquement.

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Introduction

Failure of acetabular components remains one of the major limiting factors in the longevity of total hip arthroplasties (THA) [11]. Cementless cups were introduced in part to reduce the problems that were perceived to stem from the polymethylmethacrylate cement (PMMA) used in cemented acetabulae. However, cementless cups may be complicated by their own unique set of problems, related to modularity and design features – such as polyethylene bearing thickness and shell-liner coupling mechanisms [2, 9, 12, 13].

The aim of the study is to present mid-term results of a specific cementless bone ingrowth modular socket in primary THA.

Materials and methods

Between July 1991 and December 1993, the senior authors (L.A.S., D.L.P. and W.E.B.Jr.) at the Louisville Institute for Joint Replacement and The Arthroplasty Foundation, performed 199 primary THAs by using a press-fit acetabular component.

Nineteen patients were lost to follow-up and 22 died before their 5-year follow-up examination. The status of their hips was unknown and as a result they were excluded from the study. Complete clinical and radiographic data were therefore available for 158 THA (143 patients), at a minimum follow-up of 5 years. Clinical evaluation was performed by physical examination, evaluation forms in order to compute the Harris Hip score (HSS) [7] and annual patient questionnaires (short form 36).

Radiographic examination included an anteroposterior pelvic film, centered on the symphysis pubis, and a Lowenstein lateral radiograph. The radiographs were performed immediately postoperatively, at 3, 6 and 12 months after the THA and annually thereafter. The angle of inclination of the cup was recorded [26], as was the presence or absence of linear and focal (expansile) osteolysis [27] in the three zones described by DeLee and Charnley [3].

Stable bony ingrowth was assumed in the absence of radiolucent or reactive lines in zones one or three. 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 91.5 months (range 60–120 months). The mean age at the time of surgery was 62.5 years (range 24–

Fig. 1 The Osteolock acetabular cup

84 years). There were 89 female and 69 male patients. The preoperative diagnoses were: osteoarthritis (119 cases), avascular necrosis (18 cases), rheumatoid arthritis (10 cases), posttraumatic arthritis complicating previous acetabular fracture (8 cases), failed cannulated screw fixation of an intracapsular fracture of the hip (2 cases) and developmental dysplasia of the hip (1 case).

The Osteolock acetabular component (Stryker, Howmedica, Osteonics Inc, Rutherford, N.J., USA) was used in all patients (Fig. 1). This is a porous-coated, hemispherical press-fit acetabular shell. The shell and screws are manufactured from titanium-6-aluminium-4-vanadium (Ti6Al4V) alloy. The shell coating is CP titanium plasma spray. The implant's ultra-high molecular weight polyethylene (UHMWPE) liner was produced by a ram extrusion process, machined and sterilised in air (3 Mrad). Stability is achieved by a snap-lock mechanism into the shell.

The acetabulum was underreamed by 1-mm to obtain a stable press-fit. If ideal press-fit could not be obtained or if the bone was very osteopenic, additional supplemental screw fixation was utilized (21 cups). Shell sizes averaged 53.4 mm (range 42–64 mm) with a corresponding polyethylene liner thickness averaging 6.6 mm (range 4.8–12.1 mm). Structural autograft was used to augment a dysplastic socket in one case.

Uncemented femoral components from various manufacturers were used in 91 cases. Eighty of these uncemented femoral components were Osteolock stems (Stryker), and 67 components were cemented using Precision stems (Stryker). We used 149, 28 mm cobalt chrome femoral heads (CoCr), 8, 32 mm heads and 1, 26 mm head.

Postoperatively, a gait rehabilitation program allowing immediate partial weight-bearing was employed for the first 6 weeks. Patients were evaluated at 6 weeks, 3 months, 6 months and annually thereafter. The patient completed SF 36 forms preoperatively and in conjunction with their annual visit.

Survivorship analysis for the cup was performed using the method of Dobbs [5] at final follow-up for the purpose of reporting this current study.

Results

The mean preoperative HHS was 47.2 (range 3–76). At latest follow-up, the mean HHS reported was 87.3 (range 37–100). No significant difference in scores was noted for variables such as sex, age or preoperative diagnosis. No infections were identified. Although an undisplaced fracture (Fig. 2) occurred during insertion of an HA-coated femoral component (managed with prophylactic cerclage wiring) no other major perioperative complications occurred. Three hips sustained late, traumatic dislocations, more than 2 years postoperatively, but have all been managed conservatively.

Fig. 2 Focal pelvic osteolysis and polyethylene wear noted at 7 years post-implantation

Cup positioning was judged satisfactory (>90% bony coverage and <50° 'open') in all cases at last review. Penetration rates of the UHMWPE liner were not assessed, 6 of the 158 THA were revised. In 4 cases this was for problems confined to the femoral component (stem loosening/subsidence in 3 cases and for asymptomatic, progressive femoral osteolysis in 1 patient). Routine 'prophylactic' liner exchange was performed simultaneously with the femoral component revisions – although in only 2 cases was polyethylene wear noted and then – only following intraoperative inspection.

In 2 cases, painful, eccentric wear of the UHMWPE liner prompted liner exchange. In the first revision eccentric liner wear was noted in a 61-year-old male with a 54 mm cup at 7 years. Minor non-progressive focal osteolysis was identified around the femoral component in zones 1 and 7 and in DeLee zone 2 around the acetabular shell. Both the femoral and acetabular components were solidly fixed and therefore not revised. The other case, a 31-year-old female with a 52 mm cup, required liner exchange for wear that was also identified at 7-year follow-up (Fig. 2). Non-progressive focal osteolysis was also evident in DeLee zone 2, but again both components were stable at surgery and therefore not revised. Retrieved liners in both cases showed eccentric wear and cold flow at the bearing surface, but no demonstrable back-surface wear.

Focal pelvic osteolytic lesions were only seen in these two cases showing gross polyethylene wear. No acetabular shells were revised for loosening or migration during the study period.

Supplemental screw fixation (1 to 3 screws) was used in 16 cases. Such additional screw utilization had no effect on results.

Discussion

Until relatively recently, fixation on the acetabular side of a THA was dominated by cemented cups. The impetus to the development of cementless fixation was in part a response to the problem of progressive loosening of cups affixed with polymethylmethacrylate (PMMA) and to the 'cement-disease' (PMMA induced osteolysis) that it was felt to promote. With the implementation of cementless components (and along with the modularity that accompanied them) it soon became apparent that such designs were far from being problem free [1]. Although cementless cup fixation in the revision situation is now felt by the majority to be the method of choice [16, 21, 23], in the absence of long-term results, the method of optimal cup fixation in the primary situation (PMMA compared with biological fixation) continues to be debated. However, intermediate results of cementless cups are, with a few exceptions [8, 18], encouraging.

Osteolysis in part relates to particulate debris generated at the bearing surface. Although numerous factors have been described that mediate such particulate production [6, 10], one well-recognized factor is femoral head size. Along with the theoretical improvement in stability that accompanies increased size, linear penetration rates are reduced. However, the greater bearing 'sliding distance' mitigates against the benefits and acts to increase the rate of particulate production. That acetabular failure rates are greater in patients with larger head sizes has been confirmed by several clinical studies [15, 19]. A previous report from our institution reported the results of a similar, contemporaneous, cementless porous-coated press-fit acetabular cup, incorporating a snap-lock shell-liner couple [22]. In this series, at an average of 10.6 years, pelvic osteolysis was noted in 11% and revision rates for liners exchange or shell revision were 4%. In this study nearly 86% of those cases showing osteolysis were associated with 32 mm femoral heads [22]. The use of smaller femoral heads also allows for the beneficial effect of increased polyethylene thickness. The liners that were revised in the current study were sized between 6.6 mm and 8.1 mm. Twenty-five liners with polyethylene thickness less than or equal to 6.6 mm have shown no obvious wear problems.

Any modular connection can generate debris. Recent concern centers on the debris formed at the interface between the liner and shell (backsurface wear). Such wear is a function of the locking mechanism, the amount of micromotion present, and the surface finish of the interface [24]. The design of the Osteolock snap-lock liner into the Ti-alloy shell provides both dome and circumferential rim contact along 12 semi-spherical marginal scallops (Fig. 1). The addition of a peripheral locking mechanism is purported by the manufacturers to minimize such back surface wear by minimizing motion between the surfaces of liner and shell.

There has been much recent interest in developing manufacturing techniques aimed at improving the structural and physical characteristics of polyethylene liners. Since the present study, cross-linked polyethylene (e.g., duration stabilized polyethylene: Stryker) has been introduced with the aim of reducing free-radicals to minimize oxidative degradation of the UHMWPE liner. Theoretically attractive, only prolonged in vivo study will reveal whether such changes significantly affect implant longevity.

The prevalence and location of osteolytic lesions depends not only on particulate generation, but also on the 'effective joint space' – that is, the accessibility of particles to the implant-bone interface and periprosthetic bone [20]. In addition to particulate egress at the periphery of the cup and liner, the presence of holes in the shell produces a further possible pathway for particles to reach underlying pelvic bone [13, 25].

The use of supplemental screws, while helping to achieve initial stability, also raises concerns about possible fretting at the screw-cup interface and thus further metallic debris generation [9, 17]. Although all of the current series utilized components with screw holes, and 16 cases achieved stability with the addition of screws, this has not so far resulted in a significant incidence of observable pelvic osteolysis.

Activity level may perhaps ultimately be one of the most important factors in relation to particulate debris generation [4, 14]. The generation of such particles and hence the incidence of osteolysis might be expected to be much greater in a heavy, young osteoarthritic patient with a 'high' demand joint and might provide an explanation as to the poorer results often reported in such patients. One shortcoming of the present study is the fact that activity level was not assessed.

To our knowledge, results of the Osteolock cup have not been previously reported. The results we report are still only mid-term. Our findings of early, stable fixation of the shell are encouraging and would be expected to be maintained, but polyethylene wear of the liner and the possibility of late developing osteolysis remain concerns. Prolonged study of the group is required to ensure that these initially good results are maintained with time.

Statement on conflict of interest 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.

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