Acetabular revision of total hip arthroplasty using a press-fit dual mobility cup

P. Massin\textsuperscript{a,}\textsuperscript{*}, L. Besnier\textsuperscript{b}

\textsuperscript{a} Bichat Claude Bernard Teaching Hospital, 46, rue Henri-Huchard, 75877 Paris cedex 18, France
\textsuperscript{b} Angers Teaching Hospital, 4, rue Larrey, 49933 Angers cedex 09, France

Accepted: 19 October 2009

Introduction:
Dual mobility cups are especially indicated in total hip replacement revision, the risk of recurrent instability being greater than in primary surgery. In revision, however, primary cup fixation is uncertain without routine anchoring screws.

Hypothesis:
The stability of dual mobility cups impacted without cement, supplementary screw(s) or anchoring pegs fixation is satisfactory in total hip arthroplasty acetabular component revision, and prevents instability accidents.

Patients and Methods:
Twenty-three patients were operated on by the same surgeon between January 1999 and December 2006 and prospectively followed up to a mean 4.5 years (range, 2–10 yrs). A Collégia\textsuperscript{TM} cup (Wright Medical France, Créteil, France) was impacted in 23 total hip arthroplasty acetabular component revisions, including 17 cases of SOFCOT grade-1 bone-stock loss and six of grade 2.

Results:
There were six clinically poor results on the Merle D’Aubigné scale. One case of early migration occurred, in a multioperated acetabulum. There was one isolated dislocation and one recurrent dislocation associated with loose greater trochanter nonunion, but tolerated as it was infrequent.

Discussion:
This option simplifies revision surgery and limits the risk of dislocation if the abductor muscles unit is continuous. It is indicated when local bone-site compromise encompass a wall-contained cavitary defect at most. A medial wall defect, if moderate, does not in our view preclude using a primary cup, impacted with a certain degree of protrusion. Longer-term follow-up will be needed to confirm these medium-term findings.

Level of evidence: Level IV. Prospective non-comparative therapeutic study.

© 2009 Elsevier Masson SAS. All rights reserved.
ness in reducing postoperative dislocation rates has been fully demonstrated in primary surgery [7—9], and Langlais et al. [10] have extended this indication to revision. In their series, the dual mobility cups were cemented into Kerboull cross-plates: this assembly is necessary in order to combine bone reconstruction with lasting fixation in case of severe loss of acetabular substance [10].

Cementless fixation of large cups, following the recommended procedure for standard implants (simple impaction), is hard to extend to revision surgery. Primary fixation is uncertain, and is usually reinforced by secondary screws, although their precise role is debatable [11]. Moreover, this attitude is difficult to apply with a dual mobility cup, the inner surface of which has to be kept smooth, with no sharp edges such as screw-heads affecting the mobile polyethylene insert. There remain dedicated revision cups, with extra-acetabular fixation enabling support to be found in various areas around the acetabulum, but which are hard to fit in simple revision without reconstruction and the effectiveness of which, moreover, has yet to be demonstrated.

Primary cups, without secondary screws, thus seem to have limited role to play in revision surgery. There are, however, cases of revision in elderly subjects on moderate loss of substance where implanting a primary cup without reconstruction greatly simplifies surgery [12], especially when the time needed for femoral component revision is long.

We explored this option by implanting cementless primary dual mobility cups without reconstruction or secondary screwing in a series of 23 patients without history of sepsis, operated on by a single surgeon (PM) between January 1999 and December 2006, prospectively followed up for a mean 4½ years (range, 2—10 yrs). This series was just a small part (10%) of the aseptic revision surgery performed by the main author over the same period, the technique used in the other 90% being acetabular structural allograft reconstruction (with (85%) or without (5%) cement. Patients were selected on peroperative criteria as observed after removal of the previous cup and cleaning of the fibrous membranes: integrity of the lower third of the medial wall (to provide a support at the ischiopubic notch), and absence of segmentary loss of anterior and posterior acetabular wall substance that would impair coverage of the new cup. The aims were: to define indications for this type of implantation in terms of observed acetabular bone damage, to report clinical results, notably in terms of hip stability, and to assess medium-term radiographic cup fixation.

**Patients and methods**

**Patients**

A primary Collégia™ cup (Wright Medical France, Créteil, France) was used in 23 total hip arthroplasty revisions involving acetabular component replacement. The stainless steel cup included hemispheric reinforcement with rough macrostructures. The hydroxyapatite-coated dome was in corundum, without surface porosity.

All 23 patients were operated on by the same surgeon. Mean age at revision was 68 years (range, 43—90 yrs); 16 female, seven male. Sixteen were assessed as Charnley class A, and seven as class C. Eighteen had been first operated on for hip osteoarthritis (four posttraumatic, one congenital dislocation), two for idiopathic necrosis, one for hip involvement in a spondylotic ankylosis, and two secondary to femoral neck fracture. Revision was for recurrent instability in six cases, aseptic loosening in 16 (including four with bipolar involvement), and analgesic-resistant psoas irritation (psoas/cup conflict) in one. Seven patients had had at least two previous implants.

**Surgical procedure**

Surgery used a posterolateral approach (with trochanterotomy in four cases, two involving former trochanteric nonunion). Bone damage was assessed peroperatively on the SOFCOT scale [13] after removal of the previous cup and cleaning of pseudomembranes: there were 16 grade-1 cases (general cavitary defect) and seven grade-2 (conserved anterior and posterior walls but with medial wall defect). After reaming down to live bone, a cup trial component of adequate dimensions was inserted anatomically, without impaction, blocked at the edge to provide an impaction chamber behind the dome. The Collégia™ cup was then impacted, without reconstruction, and complete coverage without anterior protrusion was checked. Mean cup diameter was 52 mm (range, 44—62 mm). In 16 cases, the femoral component revision was performed in the same step, using cemented primary implants except in three cases requiring long stems (two cemented and one cementless). Head diameter (chrome cobalt) was 22 mm in 17 cases and 28 mm in six. The two trochanteric nonunions were fixed using a tension band method.

Postoperatively, immediate weight-bearing was allowed except in the four cases of trochanterotomy, where three months’ non-weight-bearing was prescribed.

**Assessment**

Follow-up was prospective; clinical (Merle D’Aubigné score [14]) and X-ray data were entered in a computer file at 45 days, 6 months, 1 year and then every 2 years. Cup center position was calculated on AP pelvis views using an orthonormal frame for each side: the x-axis was the horizontal tear-drop line and the y-axis was the vertical line through the tear drop. Comparison with the healthy side assessed cup center deviation from the anatomic reference position. Cup stability was assessed on an AP pelvis view with constant 110% magnification, measuring the vertical distance between cup center and the tear drop-line, following Massin et al. [15]. The bone/implant interface was examined for radiolucency at the cup-edge, not seen on the immediate postoperative image, in the three Charnley zones.

A reminder was sent out to patients at the time of the study; full follow-up (i.e., at least one FU consultation during the last 2 years of the study) was obtained in 19 cases, four patients having died.

A Wilcoxon test was used to compare preoperative and end-of-follow-up clinical scores.
Table 1 Preoperative and end-of-follow-up Merle D’Aubigné scores.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative score</th>
<th>End-of-follow-up score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Good</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>VG and excellent</td>
<td>4</td>
<td>14</td>
</tr>
</tbody>
</table>

Results

Seventeen patients showed clinical improvement, four maintained scores that had been excellent before surgery apart from frequent dislocations (the cause of the revision), and two showed deterioration. Mean score overall improved from 11 (0—18) preoperatively to 15 (7—18) at end of follow-up ($p < 0.001$; Table 1). At a mean 4½ years’ follow-up, there was one early mechanical acetabular fixation failure and three other complications, partially accounting for the six poor results, the others of which were due to poor general health status.

The mechanical failure was unsurprising, in an invalid previously operated on five times in repeated unsuccessful attempts at acetabular ring reconstruction (Fig. 1), although the acetabulum had seemed strong enough to receive a primary cup after very laborious femoral revision. The bone, however, was an allograft from one of the previous reconstructions: the indication had obviously expired and the aim of biological fixation of a cementless cup was illusory. The cup migrated by month 3 (Fig. 1), and the patient was not subjected to further revision before her death 1 year later.

Another reintervention for iterative implant replacement was indicated for a syndrome of groin pain implicating the psoas. Subsequent evolution eventually showed a malign groin tumor, which proved fatal. The cup was stable and no fibrous membrane was found on the fixation interface after extraction.

There were two dislocations: one isolated dislocation, in the patient reoperated for groin pain (above), following a Figure 1 60-year-old overweight female patient, with history of iterative surgery for acetabular component loosening, in whom femoral reconstruction was very difficult. The second revision, using an Octopus™ (DePuy) cup (a), showed rapid failure with protrusion. The third revision used a large 60 mm mobile insert cup (b), which rapidly migrated (c). Being by then an invalid, she did not undergo further surgery.

Figure 2 65-year-old female patient, initially operated on for congenital hip dislocation (Crowe 2), in whom iterative acetabular component loosening (a) required revision with a 56 mm mobile insert cup in a context of severe roof and anterosuperior segment bone defect (b). At 5 years’ FU, the Merle D’Aubigné score was 15; the cup was stable, without radiolucency (the broken screw remaining from the previous Müller ring) (c).
fall and reduced by closed surgery; and one dislocation with loose greater trochanter nonunion, showing yearly recurrence, in an elderly patient living at home who died of other causes, at home, after 4 years’ follow-up without repeat surgery.

Postoperative X-ray comparison in the 16 cases where the contralateral side was healthy showed a mean 6 mm (range –1 to 15 mm) medialization and 7 mm (0–25 mm) ascension of the hip. The dome of the cup crossed the iliosciatic line (protrusion) in four cases, including one marked protrusion within the pelvis beyond the superior strait; in the other 19 cases, it remained flush, without protrusion. Apart from the unstable cup, X-ray follow-up found no particular remodeling and, notably, no radiolucency (Fig. 2).

Discussion

At medium-term follow-up, these primary cups behaved well in revision without secondary screws, apart from one failure in poorly trophic bone having undergone iterative revision. Otherwise, there were no signs of cup mobility on X-ray. A minimum of anatomic conditions is obviously mandatory for a primary cup to be stabilized in an acetabulum that has already been subjected to arthroplasty. Ideally, bone damage should be moderate, with no more than a moderate wall cavitary defect. We do not consider a medial wall defect, if incomplete, to contraindicate the use of a primary cup, impacted with a certain protrusion.

When a cup with equatorial thickening is used for peripheral impaction, an impaction chamber should remain behind the dome when the peripheral part meets the surrounding bone. This criterion is hard to assess with the final cup, leaving no window of visibility onto the medial wall, and a pierced phantom should be used in an exploratory test run. When the final cup is impacted, its edges should lie entirely within the bone cavity at the end of the impaction, especially on the anterior wall. As long as the impaction chamber remains, each hammer blow rings “hollow”; when the sound turns “solid”, the dome of the cup is probably in contact with the bone and the cup in its final position. The problem is to assess stability. The handle of the impactor can be used as a lever to test stability, but it is hard to define acceptability limits, which are left up to the operator’s judgment. Once the operator is satisfied and leaves the cup in place, reduction should be possible without the cup being moved. Finally, perfect freedom of dual mobility should be checked, eliminating any interposition liable to hinder joint movement and exacerbate the friction couple.

Analysis of the hip center showed that cup elevation, which might be expected in the absence of any reconstruction, was relatively moderate, at no more than a mean 7 mm. Finally, secondary bone anchorage is a prerequisite, with the cup in contact with live trophic bone.

When these conditions are met, reimplantation is straightforward and the complications rate is moderate. Dual mobility limits the rate of dislocation, or at least improves tolerance in difficult situations such as that of our elderly patient who was able to live at home, independently, for 4 years without repeat surgery despite loose greater trochanter nonunion with dislocation occurring every year. The few published series all testify to the efficacy of the dual mobility concept in revision surgery: Leclercq et al. [16] reported only one dislocation, without recurrence, in 13 patients managed for recurrent dislocation, despite four incidences of greater trochanter nonunion of which three remained after surgery. Langlais et al. [10] reported only one posttraumatic dislocation in a series of 83 revisions (1.1%), including seven patients with greater trochanter nonunion and five (6%) revised for implant instability. The present series included six revisions for implant instability (26%) and seven patients who had had at least two implants prior to the present operation.

In conclusion, we apply this technique whenever possible, as it simplifies surgery while reducing the risk of postoperative dislocation, with reliable medium-term cup fixation. Technically, it is important to achieve equatorial press-fit without protrusion. The use of a pierced phantom enables the presence of an impaction chamber to be ensured and peripheral blocking to be checked before the dome touches the inner surface, with the possibility of letting the cup protrude slightly in case of medial wall defect. Longer-term follow-up will be needed to confirm these medium-term results.

Conflict of interest

Neither author has any present conflict of interest regarding this material. The first author (PM) was a consultant for Wright Medical Technology from 1998 to 2006.

References


