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Case report

Late intraprosthetic dislocation of a monoblock dual-mobility cup cemented into a well-fixed cementless acetabular shell. A case report

Maurizio Ulgelmo[1], *Andrea Sandri*[1], *Dario Regis*[1], *Edoardo Casablanca*[1], *Giovanna Toso*[2], *Roberto Valentini*[1], *Bruno Magnan*[1]

[1]Department of Orthopaedics and Traumatology, University Hospital of Verona, Verona, Italy; [2]Department of Orthopaedics and Traumatology, Cittadella Civic Hospital, Cittadella, Italy

Abstract. Intraprosthetic dislocation (IPD) is a specific implant-related complication of dual mobility (DM) implants, which is defined as a dissociation of polyethylene (PE) liner from the femoral head. We report a unique case of late IPD of a monoblock DM cup cemented into a well-fixed cementless acetabular shell for recurrent dislocation of total hip arthroplasty (THA). A 77-year-old woman was admitted to our department for acute right hip pain, functional impairment and inability to bear weight without any trauma. Three years earlier, she underwent revision THA for recurrent dislocation with a monoblock DM cup cemented into a well-fixed cementless acetabular shell according to the "double-socket" technique. Three months after that revision the patient experienced an anterior THA dislocation, which was managed by closed reduction under sedation in the emergency room. No additional episodes of prosthesis instability occurred. Upon admission, radiographic evaluation showed right THA dislocation. X-rays performed after closed reduction revealed eccentric positioning of the head inside the cup, and a direct contact between the metal head and the cup was revealed by subsequent CT scan, confirming the suspicion of IPD. The patient underwent revision surgery, during which the PE liner was found lodged within the cup in a subluxated position, disassembled from the inner head. Both the acetabular cup and modular femoral stem proved well-fixed and impossible to remove, therefore they were retained. The explanted DM components were replaced with new ones of the same size and, thanks to the femoral neck's modular nature, it was substituted with a longer one, which resulted in improved stability against intraoperative stress maneuvers. The postoperative course was uncomplicated. At 1-year follow-up, the patient had a good functional recovery. (www.actabiomedica.it)

Key words: total hip arthroplasty, dual mobility implant, intraprosthetic dislocation, revision hip surgery

Introduction

Total hip arthroplasty (THA) is a highly successful orthopedic surgical procedure. Dislocation after THA remains a major complication and one of the most common causes of surgical revision (1).

Dual mobility (DM) acetabular systems have been gaining interest to reduce the risk of dislocation (2-5), and in recurrent dislocation they are commonly performed replacing the cup already in place.

Shell-retaining revision represents an alternative option in selected cases which show a stable and well-positioned acetabular socket. However, the most frequently used shell-retaining techniques, including modular component exchange or cementation of constrained liners within the retained cup, suffer from high postoperative redislocation rates (6). In this challenging setting, the "double-socket" technique implying the cementation of a DM system into a well-fixed metal acetabular shell has been reported

occasionally (7), even with the off-label cementation of a cementless DM cup.

A unique failure mode for DM systems is intraprosthetic dislocation (IPD), consisting in femoral head detachment from the retentive chamfer of the polyethylene liner, which may migrate out of the acetabular shell and into the soft tissues surrounding the hip (8).

Although IPD was a concern for first-generation DM cups, it has become very rare in contemporary designs (9). However, little is known about the risk of IPD cementing a monoblock DM cup into a retained acetabular shell.

We report a unique case of late IPD of a monoblock DM cup cemented into a well-fixed cementless acetabular shell. A similar case has been previously reported (10), but this complication occurred early, 9 months following surgery, and the DM construct was not designed for cementation.

Case report

A 77-year-old woman presented to our hospital's emergency room (ER) with the spontaneous occurrence of right hip pain, functional impairment, and inability to bear weight.

Ten years before the patient underwent bilateral primary THA because of painful end-stage osteoarthritis, and on the right side a cementless metal-on-metal prosthesis with a modular neck femoral stem was performed.

One year after the operation, early aseptic loosening of the right cup occurred , requiring revision with a 60-mm Dynasty Biofoam® shell (Microport Orthopedics®, Shanghai, PRC). The well-fixed modular femoral stem was retained, while the modular components were replaced by means of a 44-mm Conserve® Plus head and a Profemur® VVS short 127° modular neck (Microport Orthopedics®, Shanghai, PRC), with a large-diameter metal-on-metal coupling (Figure 1).

Five years later the patient experienced recurrent anterior THA dislocation (3 episodes in a 5-month time span) and a second revision surgery was planned and performed. The Dynasty® shell and the femoral stem were found to be both stable and were left in place, and a monoblock DM component was cemented inside the retained shell, according to the "double socket" technique, inside of the retained shell (Liberty ATF dual mobility system®: 46-mm cemented Liberty-AC shell, 46- x 22-mm ultra high molecular weight polyethylene liner, 22-mm Cr-Co L-size modular head; Microport Orthopedics®, Shanghai, PRC) (Figure 2).

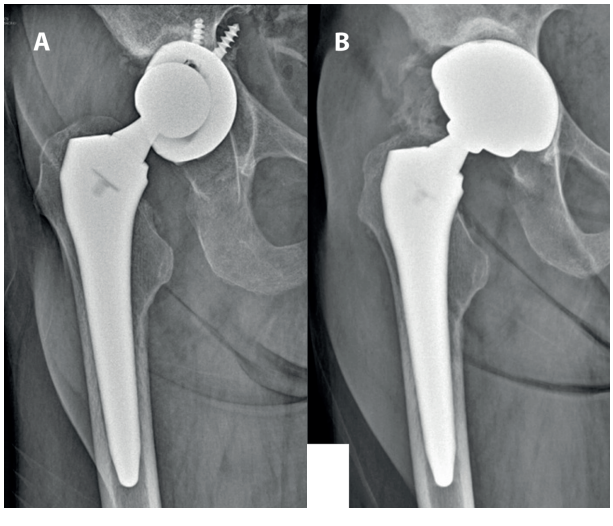

Figure 1. X-ray showing aseptic loosening of the right acetabular component (a) which was replaced using a press-fit cup and a large-diameter metal-on-metal (MoM) head (b).

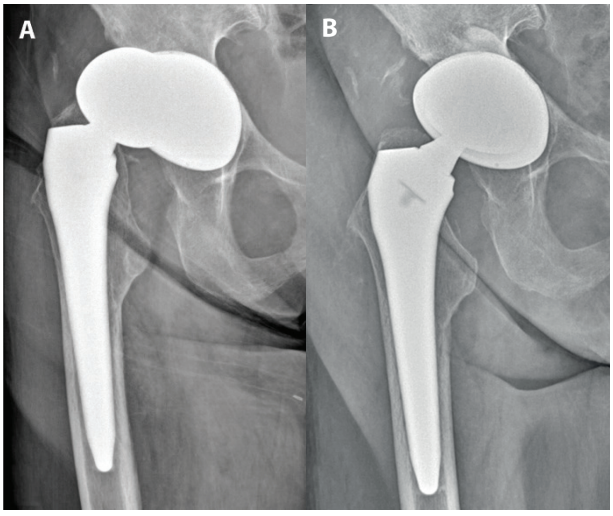

Figure 2. Radiographs demonstrating dislocation of right MoM THA after 5 years, (a) and acetabular revision with a DM system including Liberty-AC shell cemented inside of the retained shell (b) according to the "double socket" technique.

Three months following the second revision an anterior dislocation of the large DM articulation took place, which was successfully managed by closed reduction under sedation in the ER (Figure 3).

At last admission to the ER, three years following the second revision, physical examination revealed groin pain, leg shortening and limited hip mobility, with inability to ambulate. Radiographic evaluation showed right THA dislocation. A closed reduction was attempted, but the eccentric position of the femoral head inside the cup suggested an IPD. Due to the attenuation of the X-ray beam induced by the double layer of metal, CT scan failed to determine the precise positioning and integrity of the liner. However, migration of the liner into the soft tissues surrounding the hip was ruled out with certainty.Consequently, an IPD, possibly associated with a PE liner damage, was reasonable suspected (Figure 4).

The patient was scheduled for revision surgery. The surgical procedure was conducted through an anterolateral approach under spinal anesthesia. In the fascia and capsule, a focal area of degenerative tissue, which was histologically consistent with adverse reaction to metal debris (ARMD), was identified. The PE liner was found to be lodged within the cup, which was disassembled from the inner head, and a free cement fragment with maximum diameter of 35 mm was extracted (Figure 5).

The modular components of the stem (neck, metal head and PE liner) were easily removed and accurately assessed. The femoral head showed no significant irregularities, while a wear-related transversal damage of the superior aspect the modular neck was detected. The two acetabular shells displayed some scratches as well. Surprisingly, the PE liner appeared perfectly intact, with no evident signs of wear. The explanted components were reassembled using the head assembler press, thus demonstrating the integrity of the retentive PE liner (Figure 6).

Both femoral stem and the double-socket acetabular cup were stable, and consequently they were retained. The removed components were replaced by an equivalent 46x22-mm DM liner, a medium-sized 22-mm metallic head, and a long and straight modular neck. The postoperative course was uncomplicated. At 1-year follow-up, the patient had a satisfactory

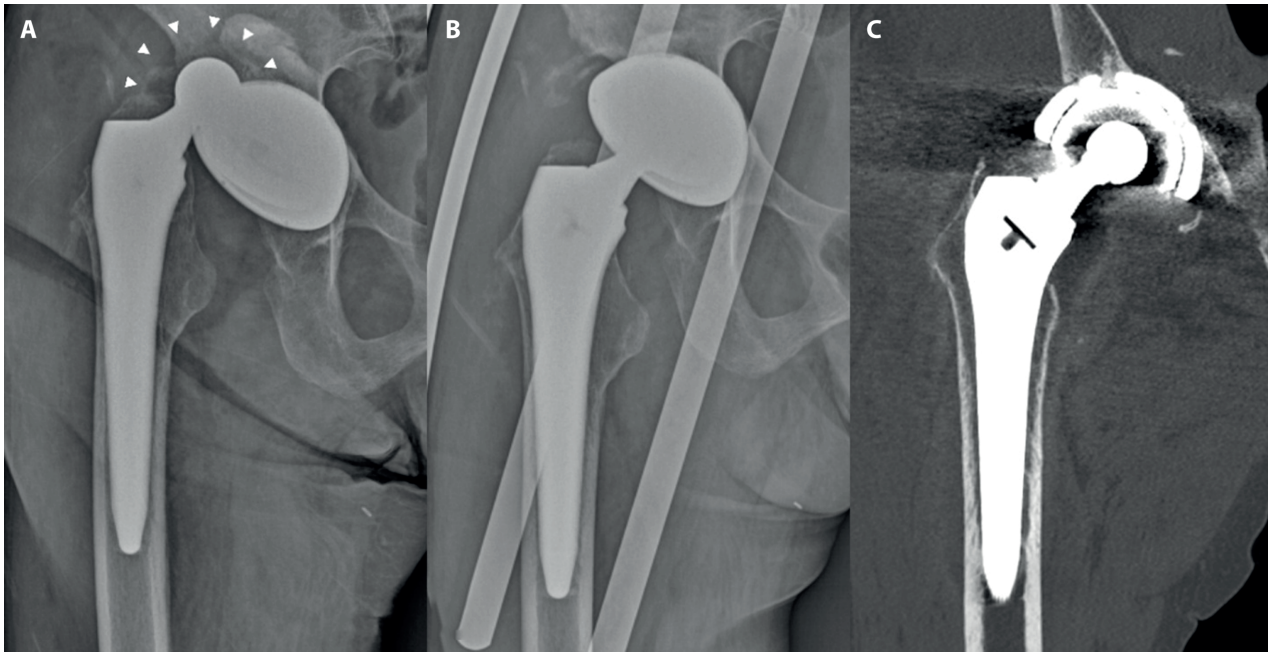

Figure 3. Radiograph, 3 months after "double socket" acetabular revision, demonstrating early dislocation of the large DM articulation (a): note a narrow radiolucent ring identifying the PE liner attached to the head (*arrowheads*). X-ray (b) and CT (c) performed after closed reduction confirming the success of the procedure.

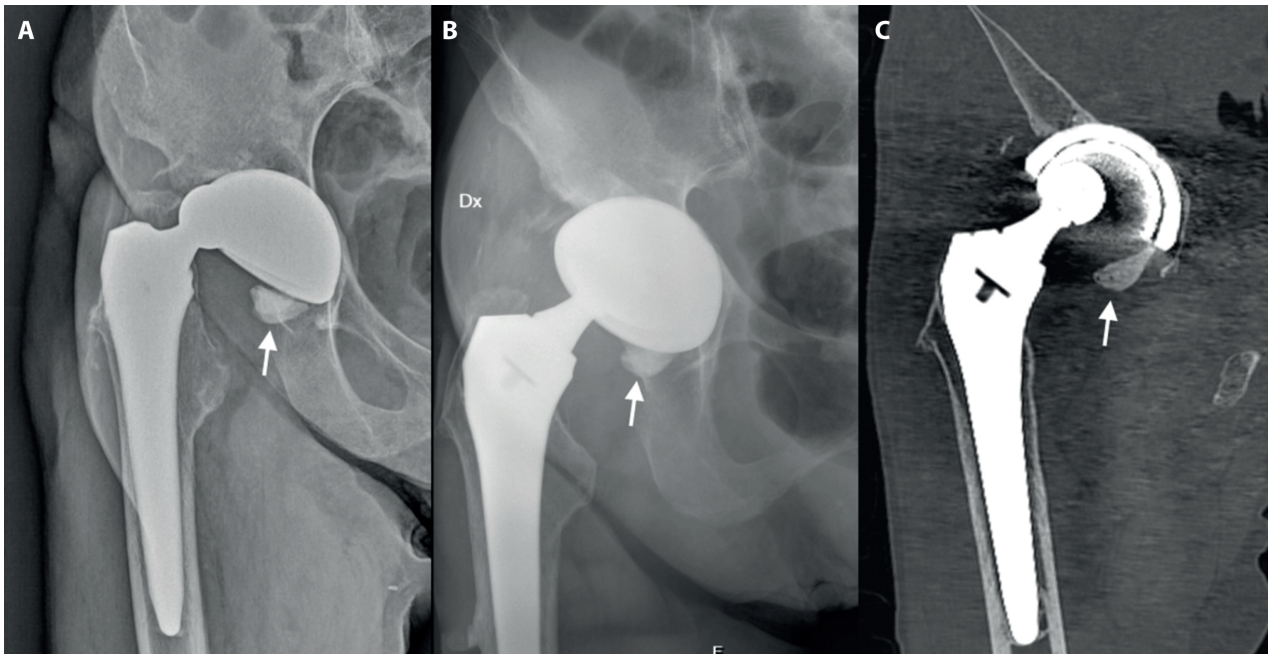

Figure 4. Radiograph, 3 years after "double socket" acetabular revision, showing late dislocation of the large DM articulation (a). AP x-ray after closed reduction demonstrating eccentric positioning of the head inside the cup (b). CT imaging of confirmed eccentric location of the inner metal head inside of the "double-socket" acetabular cup (c). Note a free cement fragment (*arrow*).

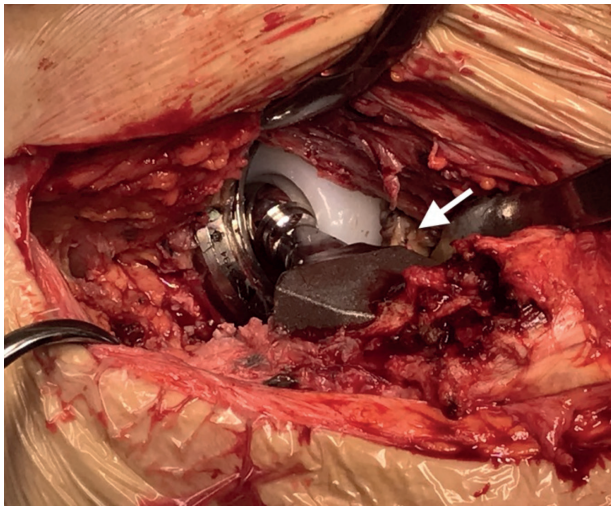

Figure 5. Intraoperative finding view showing intra-acetabular disassembly of the femoral head and the PE liner: a periprosthetic cement fragment (*arrow*) is in close relationship to the medial border of the liner.

radiological result (Figure 7) and good functional recovery. The Harris hip score was 84.5. Informed consent was obtained from the patient for publication of this case report.

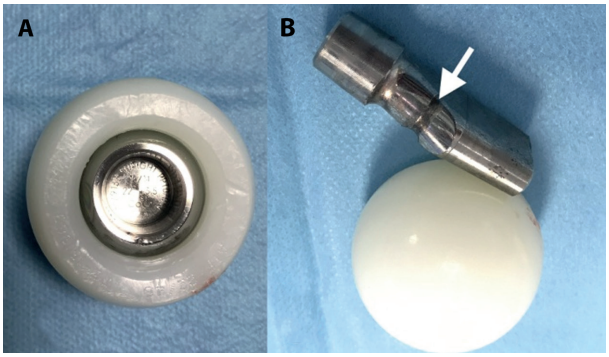

Figure 6. Intraoperative reassembly using the head assembler press, demonstrating the integrity of the explanted retentive PE liner (a). Tranverse notch (*arrow*) at the superior aspect of the explanted modular neck indicative of localized wear (b).

Discussion

Dislocation following THA is a common reason for surgical revision. Furthermore, a cumulative risk of recurrence up to 34.5% at 15 years has been reported after revision performed for dislocation (11).

The dual mobility concept was developed in the 1970s in France by Bousquet et al. in order to reduce

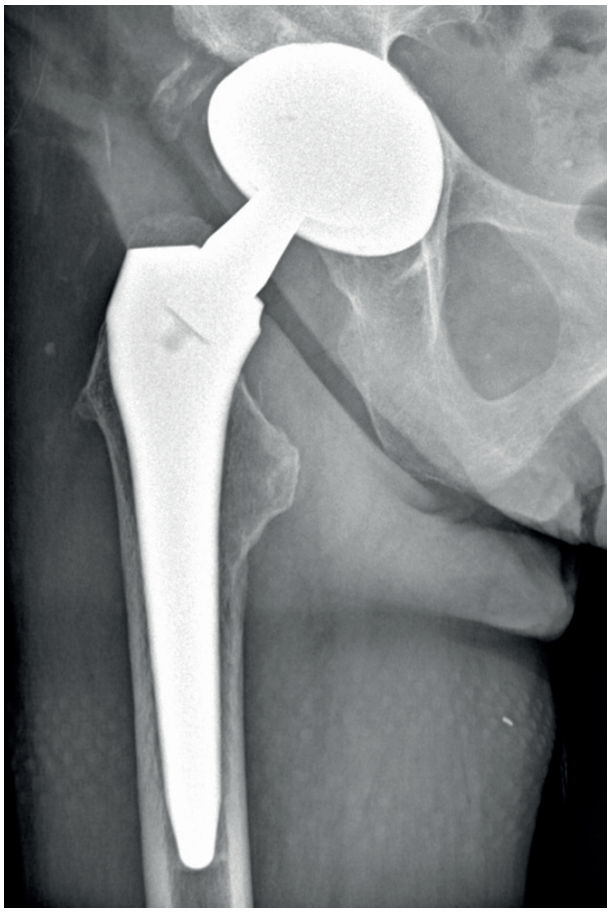

Figure 7. Postoperative x-ray 1 year following revision surgery, which included replacement of the DM liner, the inner head and the modular neck.

the risk of dislocation (2). Also known as tripolar hip implant, the DM system consists of three core components including two different articulations: an external metallic acetabular shell is mated to a mobile intermediate PE liner constituting the large articulation, and in turn the liner is coupled to an inner, small-diameter femoral head forming the small articulation. Consequently, this composite device acts as an effectively large-diameter increasing the jump distance. Over the years, several generations of DM implants have been devised, each introducing technical and design improvements (12).

Traditional shell-retaining techniques for revision THA include exchange of the modular components, and cementation of constrained liners into the socket (13). However, these methods involve a high risk of recurrence of dislocation, and a mechanical failure due to the dissociation at the cement-liner interface.

A 18% to 22% dislocation rate at 5 to 7 years of follow-up for cemented liners (6,14), and up to 33% at 5 years for modular component exchange have been reported (15).

Revision THA with DM cups performed for instability showed a re-dislocation rate of 8.5% (including IPDs) at a mean of 6.4 years (16).

Although shell-retaining procedures result in higher complication rates, they may be still considered in elderly or otherwise frail patients who require shorter operative times and reduced blood loss.

Therefore, in the last decade, the use of DM cup elements in innovative shell-retaining procedures has been suggested (17,18).

The "DM double socket" technique in particular has been developed in order to combine the advantages of shell-retaining approaches and dual mobility components (7). Obviously, the pre-existing acetabular cup must be well-fixed and large enough to accept the DM insert providing the minimum 2-mm cement mantle thickness. Some authors recommend removal of all acetabular screws prior to cementation of monoblock DM cup into a well-fixed cementless acetabular shell, because the layer of cement would compromise any future attempt at their removal in case of need. As for all DM constructs, intraprosthetic dislocation represents a specific mode of failure.

Philippot et al. identified three types of IPD which were secondary to PE wear or rupture, extrinsic blockage of the liner, or cup loosening (19). Furthermore, it can also be caused by trauma at the PE retentive chamfer-head interface during an attempt at closed reduction of a dislocation of the prosthesis (iatrogenic IPD) (20).

Long-term IPD predominantly due to PE wear significantly affected the first generation of DM cups (4,71%) (21), and it has never been observed with the newer models up to 10 years of follow-up (22,23). A recent comparative review between constrained and DM sockets in revision THA showed an overall mean IPD rate of 0.6% (24), and iatrogenic etiology was responsible for the latest reported cases (20, 25, 26).

A systematic review including 130 shell-retaining revisions with DM of metal-on-metal prostheses and hip resurfacing arthroplasties found 6 IPDs (4.6%), and two occurred within the first year and were associated with catastrophic deformations of the PE (27).

We found a total of seven studies, most including only a few DM double socket cases, and one of which had a very short follow-up time of only 3 months (Table 1) (10, 28-32). Only 4 cases of large articulation dislocation (5.6 %) and 1 of early IPD of unmentioned etiology (1.4 %) out of 71 implants were described. In addition, Bellova et al. are the only ones that recorded one case of a dissociation at the cement-cup interface (33).

The most recent and largest available series (28 cases) reported no recurrence of dislocation or IPD (32). Because of recurrent dislocation, our patient received a DM cup which was cemented into a retained shell, but two more episodes of true dislocation occurred, the second one 3 years after revision surgery, and was associated with IPD. The most recent cases of IPD have been described as the result of an attempted closed reduction, but this reason is not likely in the presented report. Although not absolute, the lack of the radiolucent halo sign of the PE liner around the dislocated femoral head at the first ER radiographs documents that IPD had probably already occurred at that point. Furthermore, the intraoperative finding of a disassembled but completely undamaged PE insert which was fully seated in the double-socket acetabulum is poorly compatible with a iatrogenic cause. Finally, the corrosion and notches found on the modular femoral neck in association with focal ARMD, as well as the presence of a large cement fragment in contact with the medial rim of the liner may indicate extrinsic blockage as the cause of IPD. Consequently, we consider this case as a type 2 IPD according to the classification of Philippot et al. (19).

Conclusion

DM bearings have been gaining great interest in order to reduce the risk of dislocation in primary and revision THA, despite the risk of a specific implant-related complication.

We described a very unique case of IPD as it occurred late (39 months) after cementation into a well-fixed, retained shell of a DM cup which was designed for cemented application. Careful radiographic evaluation and early revision surgery are required to prevent further complications.

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Correspondence:
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Ulgelmo Maurizio, MD
Department of Orthopaedics and Traumatology
University of Verona
Piazzale Aristide Stefani 1,
Verona, 37124 Italy
Phone: +39 045 8123542
Fax: +39 045 8123578
E-mail: ortopedia.traumatologia@aovr.veneto.it,
maurizio.ulgelmo@studenti.univr.it
ORCiD: https://orcid.org/0000-0003-3074-3756