Acute Intraprosthetic Dissociation of a Dual-Mobility Hip in the United States

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Abstract

After decades of use in Europe, dual-mobility (DM) components for total hip arthroplasty (THA) were approved by the US Food and Drug Administration (FDA) in 2011 for use in the United States. DM-THAs are designed with an inner articulation between the femoral head and a larger polyethylene insert, and an outer articulation between the mobile polyethylene and a highly polished metal insert, to increase motion and minimize impingement.

Intraprosthetic dissociation (IPD), defined as separation of the femoral head from the inner polyethylene articulation, is usually caused by polyethylene wear, and occurs 3 to 10 years after implantation. Early recognition of this complication is important for appropriate treatment. Late chronic IPD is caused by polyethylene wear, blocked motion of the outer bearing, or acetabular loosening. Acute IPD (AIPD), which occurs within 1 year after implantation, is rare and poorly understood. Only 2 cases of this early complication have been reported in the United States. The exact mechanism of injury is unknown, but AIPD may be associated with closed reduction maneuvers or neck impingement (large-diameter femoral neck, femoral head with skirted neck).

In this article, we report the case of a nondemented 63-year-old man who developed AIPD 3 months after implantation of a DM component for recurrent dislocation.

Take-Home Points

- AIPD of DM-THA is defined by dissociation within 1 year of implantation resulting from component impingement or closed reduction maneuvers.
- This is a distinct entity from "late" IPD (>1 year) from implantation as this is associated most often with polyethylene wear, component loosening, and arthrofibrosis.
- A history of DM dislocation followed by subjective "clunking," instability, and a series of more frequent dislocations should raise concern for AIPD.
- Classic radiographic findings of AIPD include eccentric hip reduction and soft tissue radiolucency (ie, halo sign) from dissociated polyethylene component.
- Treating practitioners of AIPD should consider closed reduction with general anesthesia and sedation in the operating room to limit risk of dissociation.

Dual-mobility (DM) components were invented in the 1970s and have been used in primary and revision total hip arthroplasty (THA) in Europe ever since.[1] However, DM components are most commonly used in the treatment of recurrent hip instability, and early results have been promising.[2] In DM-THAs, a smaller (22-mm or 28-mm) metal femoral head snap-fits into a larger polyethylene ball (inner articulation), which articulates with a highly polished metal shell (outer articulation), which is either implanted directly in the acetabulum or placed in an uncemented acetabular cup. The 2 articulations used in these devices theoretically increase hip range of motion (ROM) and increase the inferior head displacement distance (jump distance) required for dislocation.[3]

However, this DM articulation with increased ROM may also cause chronic impingement of the

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Figure 1. Initial revision to the MDM (Modular Dual Mobility) prosthesis (Stryker) with a 28-mm + 7-mm head with a skirted neck (StelKast).

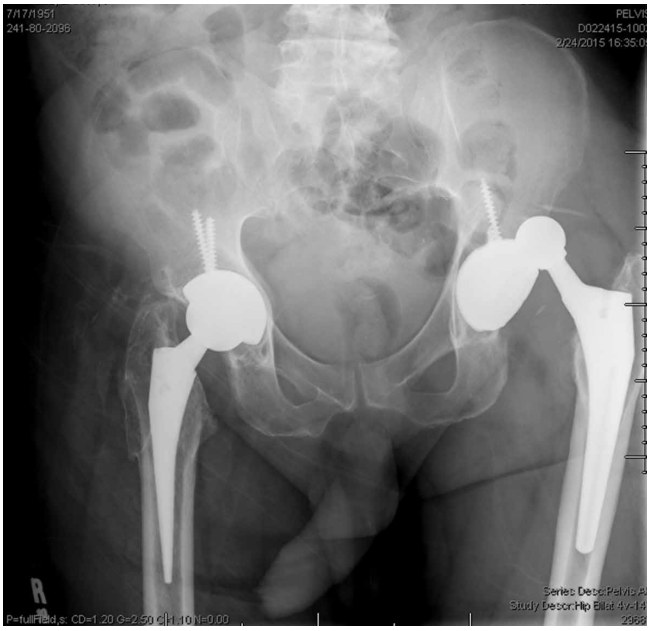

Figure 2. Patient's third dislocation, 3 months after initial implantation of dual-mobility components.

femoral component neck or Morse taper against the outer polyethylene bearing, resulting in polyethylene wear and late intraprosthetic dissociation (IPD) (separation of inner articulation between femoral head and polyethylene liner). In 2004, Lecuire and colleagues[4] reported 7 cases of IPD occurring a mean of 10 years after implantation during the period 1989 to 1997. In 2013, Philippot and colleagues[5] reported that 81 of 1960 primary THAs developed IPD a mean of 9 years after implantation. These IPD cases were attributed to polyethylene wear or outer articulation blockage caused by arthrofibrosis or heterotopic ossification. Reports of acute IPD (AIPD), however, are rare. In 2011, Stigbrand and Ullmark[6] reported 3 cases in which the DM prosthesis dislocated within 1 year after implantation. It was suggested that the inner metal head dissociated from the larger polyethylene component after attempted closed reduction for dislocation (separation of larger polyethylene component from acetabulum or acetabular liner).

DM components were unavailable to surgeons in the United States until 2011. The first US Food and Drug Administration (FDA)-approved DM device was the MDM (Modular Dual Mobility, Stryker). To our knowledge, 2 cases of AIPD with this prosthesis have been reported.[7,8] As with the cases in Europe, closed reduction was the suspected cause, but there was no explanation for the initial dislocation event.

In this article, we present the case of a nondemented man who developed AIPD of a THA with the MDM component and a 28-mm femoral head with a skirted neck (StelKast). His operative findings suggest a poor head-to-neck ratio caused by a larger diameter femoral neck or a skirted prosthesis, or a forceful reduction maneuver, may predispose DM components to AIPD. The patient provided written informed consent for print and electronic publication of this case report.

Case Report

In 2012, a 63-year-old man with a history of drug abuse underwent left primary THA. Seven posterior dislocations and 3 years later, the acetabular component was revised to the MDM prosthesis; the well-fixed StelKast femoral component was retained (**Figure 1**).

Within 3 months after revision surgery, the left hip dislocated 3 times in 1 week, when the patient bent over to retrieve an object on the ground. The first 2 dislocations were treated with closed reduction under conscious sedation at an outside emergency department. Shortly after, the patient, with complaints of left hip pain and clunking, was seen by a physician assistant, but the treating team did not notice the eccentric reduction on radiographs. The third dislocation was treated with closed reduction under conscious sedation in the emergency department at our institution (**Figure 2**).

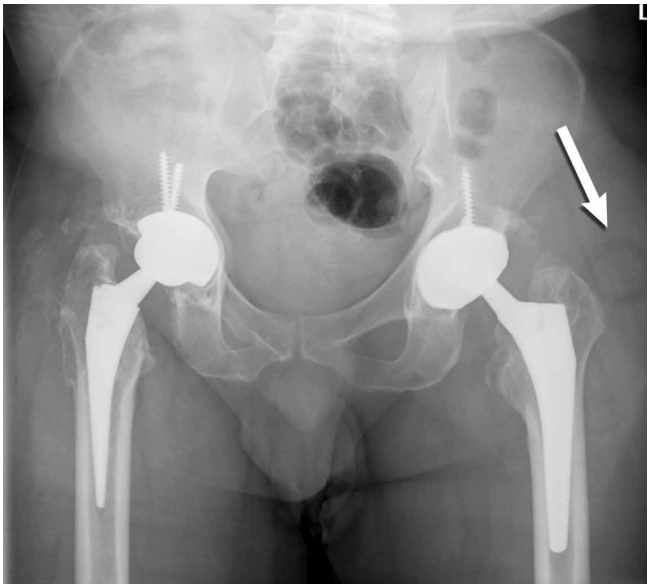

Figure 3. Postreduction radiograph shows superior migration of the femoral head in the acetabulum (eccentric reduction) with soft-tissue halo sign (arrow) corresponding to the location of the dissociated polyethylene liner superior to the greater trochanter.

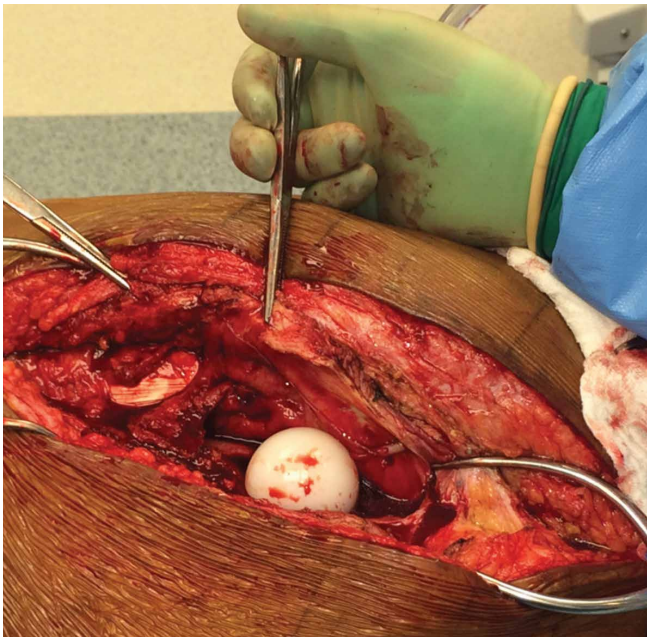

Figure 4. In situ dissociated polyethylene head just superior to the greater trochanter in the posterior gluteus maximus musculature. Once removed, the smaller femoral head rests in the metal-lined socket.

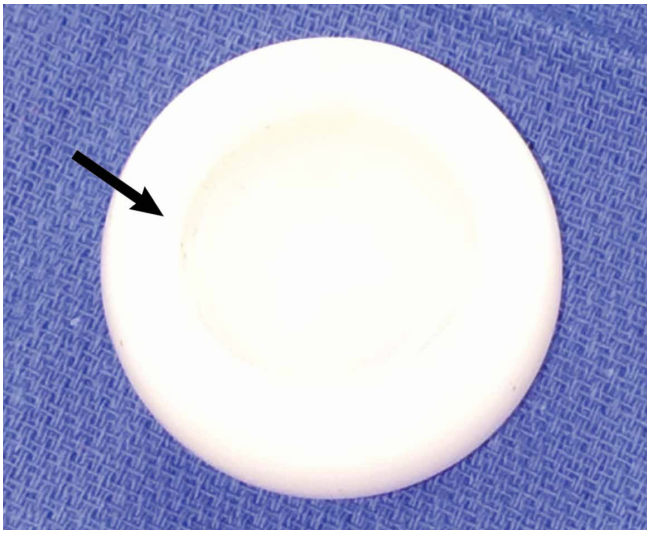

Figure 5. Retrieved polyethylene component shows eccentric wear and metal debris particles at the 9 o'clock position (arrow).

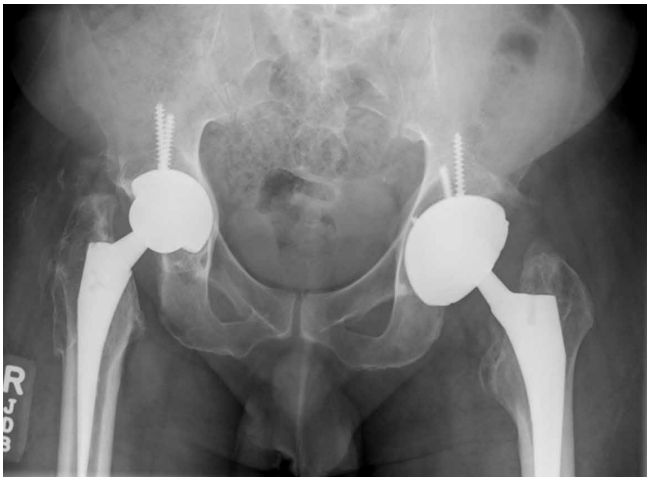

Figure 6. Second revision with upsized MDM (Modular Dual Mobility) acetabular component (Stryker) and downsized femoral head without skirted neck (StelKast).

Postreduction radiographs still showed the eccentric reduction, and a radiolucent halo was visible superior to the greater trochanter (**Figure 3**).

With the patient's erythrocyte sedimentation rate and C-reactive protein level both normal, a second revision was performed. During surgery, the polyethylene head was found beneath the gluteus maximus (**Figure 4**). Gross inspection revealed a small amount of eccentric polyethylene wear and metal debris of the inner articulation (**Figure 5**). As the abductor muscles were intact, it was decided to proceed with revision to a larger DM component and to downsize the femoral head to a skirtless component (**Table, Figure 6**).

Discussion

Recurrent dislocation and instability accounts for 22.5% of THA revisions in the United States.[9] Until 2011, options for managing recurrent dislocation in the United States included modular component

Table. **Case Reports of Acute Intraprosthetic Dissociation Reported With MDM (Modular Dual Mobility) Prosthesis**

Details	Study		
	Banzhof et al[7]	**Ward et al[8]**	**Present Study**
Study year	2013	2013	2015
Patient demographics			
Age, y	68	87	63
Sex	Female	Female	Male
Index THA			
Years prior	10	11	10
Approach	Posterior	N/A	Posterior
Indication	N/A	N/A	Osteoarthritis
Dislocations, n	3	N/A	7
Subsequent ipsilateral revision surgery	1	2	0
Dislocations after revision, before DM components	2	6	0
DM components			
Manufacturer	Stryker	Stryker	Stryker
Cup size, mm	52	54	56
Polyethylene, mm	42	42	42
Femoral components			
Manufacturer	Stryker	DePuy Synthes	StelKast
Head size, mm	28 + 0	28 + 1.5	28 + 7
Skirt	No	No	Yes
Offset	N/A	N/A	Standard
Dislocation of DM components			
Mechanism of injury	Rise from chair	Rise from chair	Rise from bed
Time from DM components, mo	2	2	3
Reductions, n	1	1	3
Emergency department	1	1	3
Operating room	1	0	0
Proposed etiology	Metal shell locking mechanism	Off-label component mismatch	Impingement of skirt on polyethylene head
Intraoperative findings			
Abductors	Intact	N/A	Intact
Polyethylene position	Psoas sheath	Gluteus maximus	Gluteus maximus
Metallosis	None	None	None
Polyethylene wear	None	Scuffing	Inner articulation
Final treatment	Revision to conventional THA with 58-mm cup and 44-mm + 12-mm head	Conversion to conventional THA with constrained liner	Revision to 66-mm MDM Trident cup with 52-mm ID metal liner, 52 mm × 28 mm × 3 mm polyethylene, and 28-mm + 3.5-mm StelKast cobalt-chromium head

Abbreviations: DM, dual-mobility; N/A, not applicable; THA, total hip arthroplasty.

exchange, component revision for malposition, and use of constrained components.[10] However, the decreased motion of constrained components may produce excess stress that eventually results in failure.[11-13]

In 1974, Bousquet first reported use of the DM prosthesis in primary THA; the prosthesis allowed increased stability without sacrificing motion or fixation.[1] However, longer-term studies of DM components disclosed a new complication, IPD. In 2004, Lecuire and colleagues[4] reported 7 cases of IPD occurring a mean of 10 years after implantation of the Bousquet prosthesis. Philippot and colleagues[5] reported that 81 of 1960 primary THAs with DM components developed IPD a mean of 9 years after implantation. They described 3 types of IPD based on mechanism of injury: type I, caused by wear of the inner articulation without arthrofi-

brosis or cup loosening (n = 26); type II, resulting from blocked outer articulation motion, caused by arthrofibrosis, nonunion, calcification, or heterotopic ossification (n = 41); and type III, associated with acetabular component loosening (n = 14). IPD occurred an average of 11 years (type I), 8 years (type II), and 9 years (type III) after implantation.

AIPD, which occurs within 1 year after implantation, has been reported much less often than late IPD. Stigbrand and Ullmark[6] reported 3 cases of AIPD that developed within 7 months after implantation of Amplitude and Advantage (Zimmer Biomet) DM prostheses. The authors proposed that AIPD is related to incomplete coupling of the metal head and the inner polyethylene liner or to shearing of the large polyethylene component on the acetabular rim during a closed reduction maneuver. According to their description, the femoral head in the acetabulum had an "eccentric" radiographic appearance. The authors recommended administering muscle relaxants during closed reduction to avoid dissociation of the liner during the reduction.

This unusual complication apparently is not confined to a specific implant or region. Since the MDM component was introduced in the United States, 2 more cases of AIPD have been identified (Table). Banzhof and colleagues[7] reported the case of a 68-year-old woman who, 2 months after the MDM was placed for recurrent instability, dislocated the component while rising from a seated position. Her IPD most likely resulted from a closed reduction. The affected hip eventually required closed reduction in the operating room. Postreduction radiographs showed the characteristic eccentric appearance; a halo, also visible in the soft tissues, corresponded with the dissociated radiolucent polyethylene liner. The authors attributed the early failure to an eccentrically seated metal liner that separated the locking mechanism. The MDM component was revised to a conventional THA, with the femoral head upsized and length added.

Ward and colleagues[8] reported the case of an 87-year-old woman who had a conventional THA revised to an MDM component for recurrent instability. Two months after surgery, this patient, who had dementia, experienced 2 posterior dislocations while rising from a chair. Closed reduction in the emergency department seemed successful, but later she presented to the surgeon's office with symptoms of instability and clunking, complaints similar to our patient's. Radiographs showed an eccentric reduction caused by IPD, and the MDM component was revised to a constrained liner. Adding a MDM component to a retained DePuy (DePuy Synthes) femoral stem and head is considered "off-label use," which, the authors proposed, may have been related to the AIPD in their patient's case. However, one manufacturer's femoral component and head are often mated with another manufacturer's acetabular component to allow for a less complex revision. Our recommendation for surgeons is that, before proceeding with this treatment option, they investigate each component's exact dimensions to ensure there are no subtle size differences that could cause problems. For example, a 28-mm head diameter that is actually 28.2 mm may affect mating properties, with the inner polyethylene articulation causing AIPD to develop.

Other cases of earlier IPD have been described, but they do not fit the APID definition given in this article. Riviere and colleagues[14] reported the case of a 42-year-old man who, because of a previous adverse reaction to metal debris, underwent revision to a DM polyethylene ball in a retained BHR (Birmingham Hip Resurfacing) acetabular shell (Birmingham Hip, Smith & Nephew). Unfortunately, IPD occurred 14 months after surgery. Banka and colleagues[15] reported the case of a 70-year-old woman who underwent revision to a DM cup for recurrent instability, but they did not specify the length of time between implantation and IPD and did not offer an explanation for the complication. Finally, Odland and Sierra[16] reported the case of a 77-year-old man, with previous intertrochanteric and pelvic fractures, who underwent revision to a DM cup with retention of a Waldemar femoral component (Waldemar Link). He spontaneously developed IPD with ambulation 2 years after surgery.

Certainly, our patient's presentation course is similar to other patients'. Within 3 months after revision to the MDM component, his left hip dislocated 3 times in 1 week. We contend his AIPD resulted from closed reduction, with the polyethylene dislodged from the femoral head with contact on the acetabulum. A larger or skirted neck may increase impingement during normal activity and thereby widen the polyethylene opening excessively and/or reduce the polyethylene ball ROM to impinge during the relocation maneuver. In this case, dissociation was noted only after the third dislocation. Pathognomonic eccentric positioning of the head in the acetabulum and, less commonly, the halo sign were evident on postreduction radiographs. Optimal

treatment for AIPD of a DM component is controversial. Choices are limited to a constrained liner or, if possible, repeat DM with larger components. For recurrent dislocation, our patient underwent revision to an MDM component, but a femoral head with a skirted neck was used in an attempt to increase soft-tissue tension. During the second revision, minor eccentric wear of the inner articulation of the polyethylene component (consistent with impingement) was noted, and wear was visible on inspection of the outer articulation. We think his AIPD resulted from femoral neck impingement of the skirted head against the polyethylene ball.

AIPD is a discrete entity, with sudden failure of a DM component within 1 year after implantation. AIPD is characterized by dissociation of the femoral head from the inner articulation, resulting from impingement or closed reduction. More studies are needed to determine which patients with DM components are at highest risk and which treatment is most appropriate. We recommend taking extra care when reducing hips with this articulation and adopting a low threshold for general anesthesia use in the presence of paralysis.

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This paper will be judged for the Resident Writer's Award.