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Case report

Catastrophic failure of a dual mobility bearing in a revision total hip arthroplasty

Brett G. Brazier, BA [a, *], Ethan R. Wren, DO [b], Michael J. Blackmer, DO [b], Dominic V. Marino, DO [b], Jason M. Cochran, DO [c]

[a] College of Osteopathic Medicine, Michigan State University, East Lansing, MI, USA
[b] Department of Orthopedic Surgery, Michigan State University, East Lansing, MI, USA
[c] Department of Orthopedic Surgery, McLaren Greater Lansing Hospital, Sparrow Hospital, Michigan State University, East Lansing, MI, USA

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ABSTRACT

The following case demonstrates an example of a catastrophic failure of a dual mobility (DM) bearing used in the setting of a revision total hip arthroplasty for an acetabular component with an excessive abduction angle. Currently, in the literature, it has been demonstrated that DM bearings have decreased polyethylene wear at abduction angles up to 65°; however, this has only been shown in in vitro studies. To our knowledge, there have been no reports of in vivo DM bearings that have demonstrated these same results. In this case, a DM bearing was used in a revision surgery with a retained acetabular component that had an abduction angle of approximately 70°-75° which ultimately led to catastrophic polyethylene failure.

Introduction

An option in total hip arthroplasty (THA) has been the dual mobility (DM) bearing. This concept has been around for more than 40 years; however, it was only recently approved for use in the United States in 2009 [1]. The DM acetabular bearing uses 2 articulations: an inner smaller diameter articulation between the head and polyethylene bearing and an outer larger articulation between the bearing and acetabular shell. It is believed that this increases stability by creating a larger jump distance, making a larger head-to-neck ratio, and increasing the range of motion. This provides a theoretical advantage for patients at higher risk of instability [2]. Although DM bearings may provide increased stability, aseptic loosening, secondary to polyethylene wear, is still a concern for this type of prosthesis [3].

Even with the many recent improvements to polyethylene, such as the use of crosslinking through controlled irradiation [4] and additives like vitamin E [5], catastrophic polyethylene failure is a reason for revision and can be accelerated secondary to other factors. One of these proposed factors suggested by Charnley [6] and Kabo et al. [7] is that the acetabular component orientation might influence the wear vector and cause accelerated polyethylene wear. Many recent studies have shown that when the abduction angle or inclination of the cup is greater than 45°, it directly causes accelerated wear in traditional THA [8].

A traditional THA with an increased abduction angle can cause increased polyethylene wear. It has also been suggested that a DM construct increases wear as well [9]. The question this report poses is does the combination of both synergistically increase wear? Looking at this question, Loving et al. [10,11] found a significantly lower wear rate and volumetric loss with the 22.2-, 36-, or 48-mm DM bearings in comparison to single articulation THA at an inclination angles of 65° in vitro. Although this may be the case in vitro, we are unaware of any studies replicating these results in vivo [12]. The following report examines a case where a DM bearing was placed during a revision surgery, in which the primary acetabular abduction angle was approximately 70°-75° which resulted in catastrophic polyethylene failure.

Case history

The authors of the following case report have had the patient's consent to having her data being submitted for publication. A 66-year-old female with a body mass index of 40.9 kg/m^2 presented to the

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* Corresponding author. 4185 Cornell Road, Okemos, MI 48874, USA. Tel.: +1 517 347 3735.
E-mail address: brazier.brett@gmail.com

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clinic with a painful left THA after undergoing an elective metal-on-metal left THA via a minimally invasive posterolateral approach for the treatment of osteoarthritis at an outside institution. At this time, there was concern for metallosis secondary to the metal-on-metal bearing. In addition, it was noted that there was excessive abduction of the acetabular component (Fig. 1a and b). She had increasing pain and elevated metal ion levels with chromium at 77.8 ppb and cobalt at 131 ppb. We opted not to obtain a preoperative MRI as we offered revision because of the markedly elevated serum metal ions and would be prepared for abductor insufficiency if encountered.

At the time of revision surgery, a posterolateral approach using the previous incision was extended, and it was found that there was atrophy of the gluteus maximus with some metallosis-type debris deep inside it. A thorough synovectomy was completed. Upon inspection of the femoral head articulation, there were signs of metallosis and some wear of the femoral head component with no corrosion at the head/neck junction noted. The femoral head was dislocated and removed. Intraoperatively, we determined that the femoral component was well fixed and that the monoblock acetabular component was also well fixed with no visual evidence of damage to the polished surface of the acetabular shell. The decision was made to leave it in place. Owing to the increased abduction angle, it was postulated that a dual articulation ceramic femoral head would provide a mechanical stability advantage and allow us to limit the morbidity associated with explanting the cup. The Biomet Biolox Option hip adapter with an active articulation

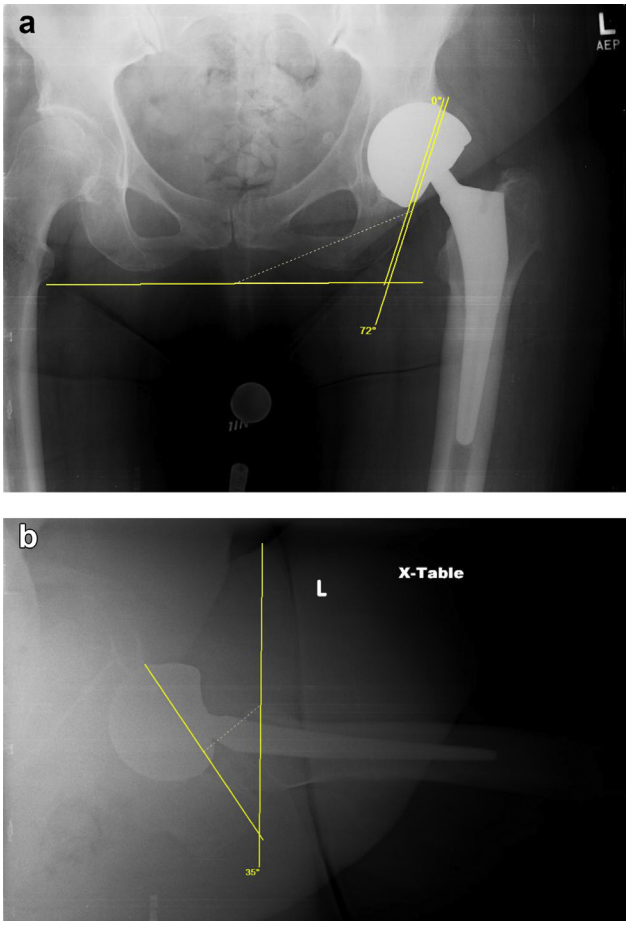

Figure 1. Anteroposterior (AP) pelvis radiograph (a) demonstrating an approximate abduction angle of 72°. Cross-table lateral radiograph of the left hip (b) demonstrating approximately 35° of anteversion.

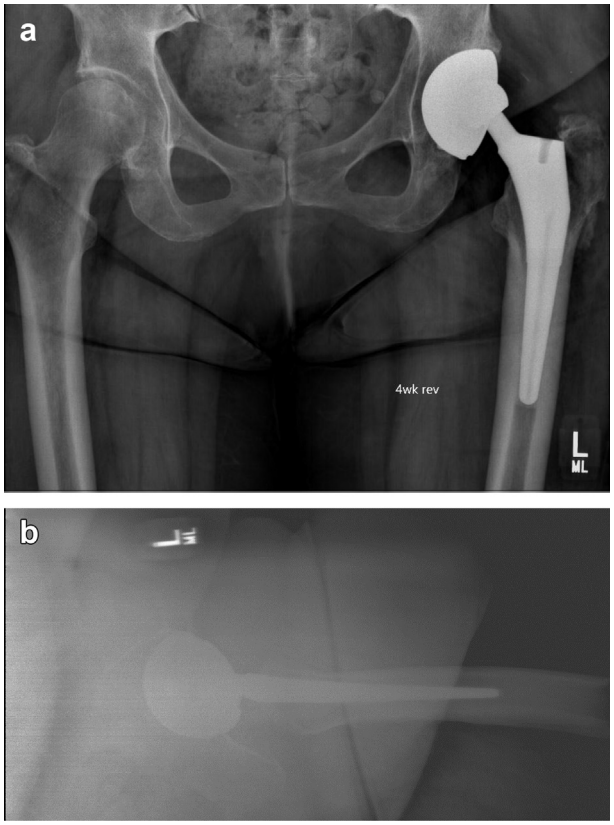

Figure 2. AP pelvis radiograph (a) completed 4 weeks after revision surgery. Cross-table lateral radiograph of the left hip (b) completed 4 weeks after revision surgery demonstrating acceptable position of components.

size 28 × 54 bipolar articulating femoral head was inserted (Zimmer Biomet, Warsaw, IN) (Fig. 2a and b). Surgery and the postoperative course ensued uneventfully until 2 years after revision when the patient started to have increased groin and anterior thigh pain. Radiographs taken in the office showed eccentric femoral head placement (Fig. 3), and those taken in laboratories which were completed showed a mild elevation of erythrocyte sedimentation rate and C-reactive protein. A hip aspiration was negative for infection. The patient was then scheduled for a second revision THA.

One month before the scheduled surgery date, the patient presented to the emergency department for a left superior prosthetic hip dislocation. She stated at this time that she had previous recent incidents where she felt her left hip dislocate but that it would spontaneously reduce. Upon examination of the radiographs, it was found that the DM bearing had disarticulated (Fig. 4), and the decision was made to attempt closed reduction under conscious sedation. The attempt at closed reduction was unsuccessful, and a revision surgery was planned for the following day.

Using the posterolateral approach, a synovectomy was performed. A pseudotumor was encountered and excised (Fig. 5). There was also some residual metallosis-type debris removed. Upon dislocation and removal of the femoral head, it was noted that the femoral head had dissociated from the polyethylene bearing. The DM head was removed and showed evidence of catastrophic wear and extreme plastic deformation of the polyethylene bearing, likely because of an edge loading phenomenon which caused pseudosubluxation and dissociation of the bearing (Fig. 6a and b). The acetabulum was next inspected, removed, and reamed to accommodate a 58-mm hemispheric acetabular shell (Zimmer Biomet, Warsaw, IN). After impacting and trialing, we placed a

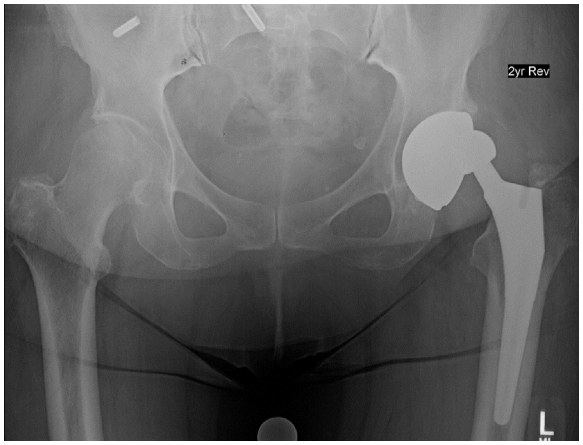

Figure 3. AP pelvis radiograph demonstrating left revision THA failure secondary to eccentric femoral head placement.

36-mm acetabular polyethylene bearing and a 36 mm + 6 mm cobalt chromium femoral head (Zimmer Biomet, Warsaw, IN) (Fig. 7). All components were implanted via a press-fit technique, and the postoperative course has ensued uneventfully for 1 month.

Discussion

It was originally thought that the increased stability in DM bearings would offset a projected increase in wear because of their use of 2 articulating surfaces. Although this was the initial thinking, many groups are demonstrating that DM bearings cause little or no increased wear when compared to traditional THA and give added stability [13,14]. Some wear studies carried out by manufacturers even go so far as to suggest that there is a significant reduction in wear with the use of DM bearings; however, clinical studies are needed to clinically validate such use in vivo [9]. Although studies have shown that in vitro testing of particular DM bearing sizes at an abduction angle of 65° does not increase wear, there have been no in vivo reports confirming this. In that same study, it was hypothesized that DM bearings may even withstand edge loading at steeper inclination cup abduction angles without a substantial increase in wear [10].

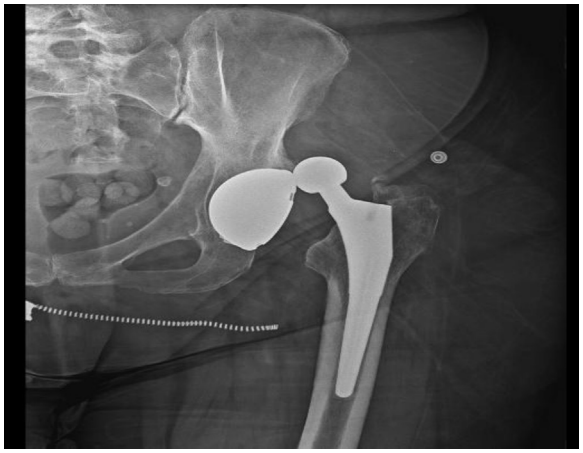

Figure 4. AP radiograph of the left hip demonstrating superior dislocation of revision THA.

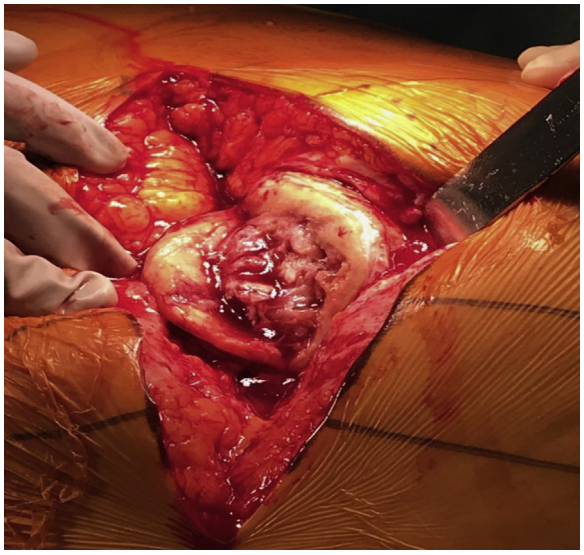

Figure 5. Evidence of pseudotumor formation secondary to polyethylene wear.

In this particular case, a DM bearing was used to try and compensate for an acetabular component with an abduction angle of approximately 70°-75° in a revision THA surgery. Our thought was that if we used a DM bearing, we could compensate for the excessive abduction angle and theoretically increase mechanical resistance to dislocation while preventing a larger revision surgery, preserving pelvic bone stock, and limiting potential complications. Its early failure, albeit at a higher than previously tested abduction angle, challenges the in vitro testing completed at higher abduction angles.

There are multiple limitations associated with this report. First, this is an isolated report of in vivo failure in an obese patient at an unusually high abduction angle. Second, this was used in a revision surgery where only the femoral head and polyethylene components were exchanged in the setting of primary THA metallosis. Third, although it is most likely that the majority of the wear was from the component orientation, there is the possibility for preexisting unseen damage to the polished surface of the acetabular shell that could have also contributed to the wear pattern seen. Fourth, DM bearings have an extra mode of failure due to the second articulation, and an attempt at closed reduction of the large articulation can predispose to an intraprosthetic dislocation which could have played an additional roll in failure [15]. Fifth, in the Loving et al. [10] study, they only looked in vitro at 2 sizes of DM bearings (femoral head diameter of 28 mm/polyethylene insert outer diameter of 42 mm/acetabular shell diameter of 54 mm; femoral head diameter of 22.2 mm/polyethylene insert outer diameter of 36 mm/acetabular shell diameter of 48 mm) at 50° and 65° abduction angles. The authors of this case used a 28-, 42-, or 54-mm DM bearing at an angle greater than 65°. Despite these limitations, this case challenges the use of DM bearings with a retained acetabular component. More research, however, is needed to determine a safe abduction angle for such reconstructions. DM bearings may have a potential use in revision surgeries; however better guidelines need to be defined through further testing before using a DM bearing with an increased abduction angle can become a standard of care.

Summary

In summary, this case report demonstrated a catastrophic failure of a DM bearing in a revision THA for an acetabular component with

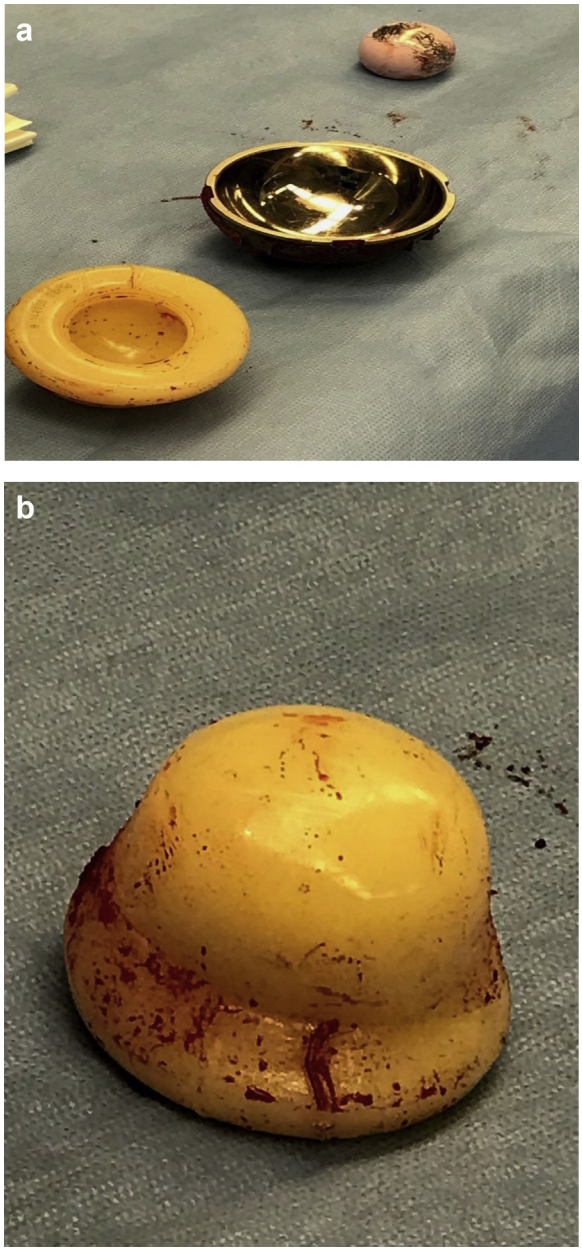

Figure 6. (a) Evidence of wear to the ceramic head and damage to the polished surface of the acetabular shell. (b) Evidence of catastrophic polyethylene wear and plastic deformation secondary to edge loading of the polyethylene against the acetabular shell.

an excessive abduction angle. This contradicts the results found in in vitro studies which showed that CM bearings have no increased, and possibly even less, wear than traditional THA. More studies need to be completed to determine the amount of wear associated with DM bearings at elevated abduction angles. Until that is accomplished, we would recommend not to use a DM device to compensate for a malpositioned cup in a revision setting.

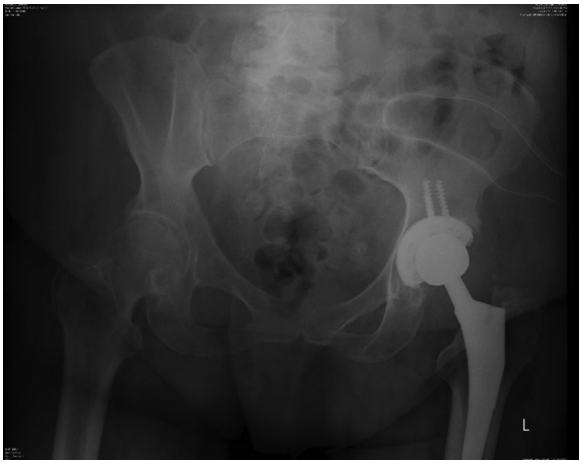

Figure 7. AP pelvis status after second revision surgery demonstrating acceptable position of components.

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