The concept of bipolar components in hip surgery emerged more than 40 years ago with the introduction of a dual-mobility hip implant. This design used a small femoral head that would decrease the rate of wear because of the smaller surface area but would still provide implant stability because of the larger outer shell that articulated with the acetabulum, decreasing dislocation rates. In April 2011, the E1 Active Articulation Hip System (Biomet, Warsaw, Indiana) was introduced to the orthopedic market. It is considered to be part of the next generation of bipolar designs, with similar designs available from competing companies, such as Stryker (Mahwah, New Jersey). These designs merge the concept of an articulating outer shell with an all-polyethylene spacer with the primary articulation of a ceramic head and an outer polyethylene shell spacer. This case report describes disassembly and dissociation at the site of the primary articulation of a bipolar system that occurred between the ceramic femoral head and the outer all-polyethylene articulating shell in a patient who had revision total hip arthroplasty because of metallosis. The patient had a stable nonpainful metal-on-metal arthroplasty at first, immediately after the initial procedure. Although previous intraprosthetic dislocations (also called retentive failures) have occurred, this case has several unique features. [Orthopedics. 2016; 39(5):e980-e983.]

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The authors have no relevant financial relationships to disclose.

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Received: October 1, 2015; Accepted: December 28, 2015.

doi: 10.3928/01477447-20160526-06
Warsaw, Indiana) was introduced. It was considered to be part of the next generation of bipolar designs (with similar designs from competing companies, such as Stryker, Mahwah, New Jersey), merging the concept of an articulating outer shell with an all-polyethylene spacer with primary articulation of a ceramic head and an outer polyethylene shell spacer.\textsuperscript{2, 3} This case report describes disassembly and dissociation at the site of the primary articulation of a bipolar system, between the ceramic femoral head and the outer all-polyethylene articulating shell, in the setting of revision THA as a result of metallosis. This occurred in a patient with a stable yet painful metal-on-metal THA system. Although previous intraprosthetic dislocations, or retentive failures, have occurred, this case has several unique features.

An extensive review of the literature showed previously documented cases of bipolar arthroplasty disassembly with a variety of causes.

In 5 cases, dissociation between the ball and the cup occurred during attempts at closed reduction of a dislocation in which the cup caught on the acetabular rim and caused a bottleneck effect. The hard metal outer shell was believed to engage the native acetabular bony rim, leading to catching, levering, and disassembly of the inner femoral head and the outer shell.\textsuperscript{4} Many of these cases were believed to occur in patients with dissociation after closed reduction of a dislocated bipolar component in hip hemiarthroplasty.\textsuperscript{5}

In 7 patients, disassembly occurred as a result of failure of an outer locking ring that maintained the primary articulation between the femoral head and the outer shell.\textsuperscript{6} The design of the bipolar arthroplasty system in the current case report had no such locking mechanism; therefore, its failure cannot be attributed to that cause.

In 1 patient, the bearing insert was worn as a result of impingement of the femoral stem neck because of improper surgical technique, leading to implant failure.\textsuperscript{7} In the current case report, the design of the bipolar arthroplasty system showed no such wear pattern. Therefore, the failure cannot be attributed to this cause.

In 4 patients, progressive intraacetabular dislocation occurred after implantation of a bipolar prosthesis for femoral neck fractures in which the metal-backed cup verticalized progressively. This led the femoral head to dislocate, dissociate, and disassemble from the outer shell and subsequently sit inside of the acetabulum. The cause was proposed to be poor outer shell or cup design in association with a weak retention system at the site of the primary articulation. When the centers of the inner and outer components are superimposed, the outer shell has a natural tendency to drop into varus because of its weight, and this tendency is worsened when the center of the outer shell is medial to the center of the ball.\textsuperscript{8}

In 1 patient who had a primary cementless unconstrained THA and 4 prosthetic dislocations over the course of 3 years, revision to a dual-mobility construct (Stryker) was performed. After an asymptomatic period with the dual-mobility cup, the patient had multiple dislocations and eventual dissociation.\textsuperscript{9} The mechanism of dissociation was not proposed.

**CASE REPORT**

A 74-year-old white woman who had advanced degenerative joint disease underwent metal-on-metal left THA. After more than 10 years of retention of this stable implant, the patient had pain in the left hip but no signs of instability. Because a metal-on-metal articulation was placed, serum cobalt and chromium levels were markedly elevated. The patient underwent removal of the metal head of the modular Biomet THA system that was in place. At the time of revision, the femoral and acetabular components showed no signs of osteolysis in the surrounding areas. In addition, there were no signs of wear or pseudotumor. Therefore, these components were retained. The head was replaced with a Biolox Delta ceramic head (Biomet) that was used in association with an E1 Active Articulation all-polyethylene outer shell (Biomet), and these components made up the bipolar system. The outer dimensions of the system matched those of the metal-on-metal system that the patient had received 10 years earlier.

Months after revision surgery, hip dislocation occurred and the patient underwent subsequent successful closed reduction. The procedure was performed in the emergency department without the supervision of the orthopedic department. Since the time of closed reduction, the patient had experienced intermittent clicking, pain, and popping in the treated hip. Because of persistent symptoms, within 1 year of revision, the patient underwent further surgery. The all-polyethylene outer shell was retained within the acetabulum, as was the inner ceramic head, but disassembly occurred between these components of the primary articulation. Open reduction of the ceramic head was performed, the ceramic head was reimplanted within the outer all-polyethylene articulating shell, and closure was performed. Months later, the patient underwent total revision of the hip arthroplasty system, including revision of both the acetabular and femoral components (Figures 1-3). More than 1 year later, the patient was tolerating the new prosthesis well. This patient had the second documented case of acute intra-acetabular dissociation as a result of proposed rupture or failure of the anti-dissociation mechanism (polyethylene ring) that was incorporated into the design of the next-generation implant models.

**DISCUSSION**

In the current patient, implant failure may have been caused by the previously described dislocation status after revision surgery as a result of metal-on-metal THA. The bottleneck effect of the polyethylene articulating liner separated from the femoral head and could have caused...
Fractured bipolar components and metal
Anteroposterior fluoroscopic arthrogram
Revision arthroplasty

Figure 1: Anteroposterior fluoroscopic arthrogram of the left hip before revision of the hip system.

Figure 2: Fractured bipolar components and metal acetabulum from a previous total hip arthroplasty. Photographs were obtained at the time of the latest revision.

Figure 3: Reassembled fractured components.

damage to the anti-dissociation mechanism (polyethylene ring) incorporated into the new designs. This would be the first documented incidence of the bottle-neck effect occurring an all-polyethylene articulating liner and in the setting of THA revision. In all previous cases of disassembly and dissociation of the femoral head from the outer shell, all implicated bipolar component designs used an outer metal shell, and most of these used metal femoral heads. This patient had no contraindications to implant use. Contraindications include infection, sepsis, osteomyelitis, uncooperative patient or patient with a neurologic disorder who is incapable of following directions, osteoporosis, metabolic disorders that may impair bone formation, osteomalacia, distant foci of infection that may spread to the implant site, joint destruction, marked bone loss or radiographic evidence of bone resorption, and/or vascular insufficiency, muscular atrophy, or neuromuscular disease. Implant failure cannot be attributed to any of these causes.

This is the second documented case of acute intra-acetabular dissociation caused by rupture or failure of the anti-dissociation mechanism (polyethylene ring) incorporated into the next-generation implant models. These implants were released worldwide within the past few years, and there are already 2 documented cases of such failures. In comparison, 17 other cases of failure have been reported over the span of more than 40 years. This case is the first in which the Biomet next-generation all-polyethylene articulating outer shell has been associated with dissociation of the primary articulation. Other than the recent case of retentive failure of the Stryker model, all documented cases of dissociation occurred with hemiarthroplasty and the native bony acetabulum articulating with the bipolar components. As stated earlier, each proposed mode of failure has been discussed in detail. The current case is the second case in which disassembly occurred in the setting of THA with a metal acetabulum, but it is the first case to occur in the setting of metallosis. The bipolar component was used in THA revision as a result of metallosis in a patient with a stable but painful metal-on-metal THA system that was implanted more than 10 years previously, and the bipolar implant failed less than 1 year after implantation.

The economic and health implications of these failures are catastrophic. As reported by the Centers for Disease Control and Prevention, approximately 52 million operative procedures are performed in the United States each year. Of these, 719,000 are knee replacements and 332,000 are THA procedures. In the United States, approximately 18% of THA procedures annually are revisions. Revision procedures place a tremendous economic burden on the Medicare system. Patients undergoing revision joint arthroplasty have longer hospital stays, greater postoperative care, and more costly medical comorbidities. For these reasons, the cost of revision total joint arthroplasty has been projected to exceed $8.5 billion per year by 2015. Revision arthroplasty leads to bone loss, subsequent instability with increased chance of future fractures and dislocations, increased rates of infection (eg, urinary tract infection, pneumonia, decubitus ulcers, sepsis), venous thromboembolism, blood loss, pain, debility, decreased quality of life, and increased mortality. Average survivorship at 5 years is 83.3% for all causes of revision for THA, regardless of the reason for revision. However, the 5-year survival rate for patients undergoing revision for instability is 75.9%. Instability is associated with a substantial increase in mortality compared with other causes for revision, which makes this case report and the hardware failure of utmost importance. Patients who undergo an initial revision procedure are 5 to 6 times more likely to need a second revision. Failure leads to more failures, more health care dollars spent, and increasing comorbidities. This is a vicious cycle.

Conclusion

Decades have passed since the introduction of the bipolar hip concept. Thousands of units have been used across the globe, but a comprehensive review of the literature showed only 18 cases of disassembly of the primary articulation. Among these 18 cases, this case report is unique. No case report of this type has been pub-
lished in terms of the findings or the detailed description of the pathology. To avoid more failures, additional research is needed by Biomet and Stryker. The authors hope that these 2 similar case reports in a relatively short period do not indicate that more failures will occur. This report has the potential to contribute to surgeons’ decision-making process in choosing an appropriate implant. Proper implant selection is essential to avoid long-term debility and pain and to ensure patient satisfaction and return to function. Additional considerations are the costs of recurrent need for revision procedures, additional hospital stays, and the risks associated with repeated operative interventions.

### References