In Vivo Dissociation Of A Dual Articulation Bearing In Revision THA -Case Report-

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Introduction

Revision total hip arthroplasty (THA) can be a difficult reconstructive procedure that challenges the skills of even the adroit orthopaedic surgeon. Revision THA for aseptic failure after acetabular/pelvic fracture is one of the more difficult challenges in the realm of hip reconstruction. The high complication rate associated with this complex reconstruction remains the dominant obstacle for obtaining consistent satisfactory outcomes. The specific problems of bony defects, pelvic malalignment, heterotopic ossification, soft tissue scarring, and muscle atrophy compromise the goals of revision THA, which include osteointegration of implant to host bone, restoration of hip joint biomechanics, and joint stability¹².

Recurrent dislocation in revision THA is one of the more frustrating complications for both the patient and the surgeon, and it remains so even today. Despite this, there continues to be developments in surgical technique and prosthetic design to enhance prosthetic hip stability. One prosthetic design, the dual articulation hip bearing, was developed to enhance THA stability. The dual articulation concept was developed by professor Gilles Bousquet and engineer André Rambert in the late 1970's¹⁴. The dual mobility design incorporates two articular surfaces within the THA bearing. The acetabular cup is composed of a metallic bearing that articulates with an ultra high molecular weight polyethylene (UHMWPE) ball. Within the UHMWPE head is an inner ball that is

enclosed within the polyethylene (figure 1). This design concept increases hip primary arc range before impingement.

The Bousquet dual mobility concept has been used over the last 20 years in Europe with successful clinical outcomes^{6,7,9,11}. In the United States, the dual articulation bearing design received FDA clearance in 2011. However, as with the addition of any modular part, there is the potential for new in-vivo failure mechanisms. With the dual mobility construct, the new failure mechanism is dissociation of the inner head^{1,10}. We report in this case an early traumatic dissociation of a dual mobility bearing utilized in a complex revision THA. To our knowledge, this is the first reported case of a traumatic in-vivo disassembly of a dual articulation bearing THA.

Figure 1 - Picture of dual articulation hip bearing concept. In this example, a UHMWPE head is articulating with an all-metal porous coated acetabular cup. Within the polyethylene head is enclosed an inner ceramic ball that is assembled ex-vivo at the time of surgery. Courtesy Biomet, Inc. Warsaw, IN..

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Case Report

A 52-year-old male underwent a complex revision right THA for mechanical hip pain and functional debility. His problem began 33 years prior when he was involved in an accident in which he was struck by a car while riding his motorcycle. His right hip and pelvis were fractured. He was treated with pelvic and acetabular plating. Three years later, in 1981, a hemiarthroplasty procedure was performed for osteonecrosis. In 1984, he underwent revision THA for mechanical loosening. His pelvic plate hardware was removed at the time of revision THA. In 2004 another revision THA was performed for mechanical loosening resulting from osteolysis. Since his last revision hip surgery, he has never been free of pain around his hip. The patient noted progressive hip stiffness with increasing functional weight bearing pain.

On exam the patient walked with an antelgic gait using a lofstrand crutch in his left hand. The right leg measured 1.8 centimeters (cm) short. Passive hip range was irritable. The patient guarded with flexion and rotation testing. Hip range was limited:

Figure 2 - Preoperative radiograph of the revision THA with post-traumatic pelvic deformities. Note the loss of femoral offset that has allowed the greater trochanter to abut the lateral ilium. Also note the relative protrusion of the acetabular cup. The patient had marked limitation of hip range along with debilitating pain.

flexion measured 50°, extension 0°, external rotation 15°, internal rotation 0°, abduction 25°, and adduction 0°. Aspiration cultures were negative and quantitative C-reactive protein and westergan sedimentation rates were normal. Preoperative radiographs showed a medialized acetabular cup with screws and a revision stem with a lack of offset such that the greater trochanter appeared fused to the lateral ilium (Figure 2). A model of the right hemipelvis was created from a high resolution CT scan. This revealed significant segmental bone defects involving

the acetabulum and pelvis. These deficiencies were treated with a custom triflange porous pelvic

implant (Biomet Inc. Warsaw, IN.).

In the revision, the pelvis was reconstructed with a cementless triflange porous pelvic implant (PPI). A large diameter monolithic metal bearing (Magnum, Biomet Inc.) was cemented into the triflange PPI. The femoral stem was revised with a modular revision stem (Arcos, Biomet Inc). A dual articulation bearing (Active Articulation, Biomet Inc) was mated to the cup (Figure3).

Four weeks post-operatively the patient dislocated his hip while disembarking from the back seat of a car. He was taken to a local emergency room where radiographs confirmed a hip dislocation (figure 4). The closed reduction maneuver was performed in the emergency room suite under sedation. By patient report, the reduction was difficult, requiring multiple attempts and considerable force. After the initial reduction the patient had several subsequent dislocations over the next 3 weeks that

Figure 3 - Postoperative radiograph showing pelvic reconstruction and revision THA. The pelvis is reconstructed with a triflange porous pelvic implant (PPI). The femur is revised utilizing a proximal cone to optimize hip offset and anteversion. A large diameter monolithic metal cup is cemented into the PPI. A dual articulation bearing is in place. Only the inner ball is visualized as the outer ball is made of UHMWPE. Note the dissolvable antibiotic beads (Stimulan, Biocomposites Inc. Keele, England) placed into the hip joint.

Figure 4 - Radiograph of dislocated revision THA. Lateral radiographs confirmed that this dislocation was posterior. Note the greater trochanter has been fractured. This occurred during a prior closed reduction attempt.

were, by patient report, easy to reduce. Additionally, since the first reduction the patient noted the right leg was short and he felt an intermittent hip

Figure 5 - Post reduction radiograph. Note in this radiograph how the inner head is eccentrically positioned. The inner head is now articulating upon the all-metal acetabular cup. This is pathognomonic of an inner head dissociation. Note the arrow which points out the round dark shadow around the lesser trochanter. This shadow is the dissociated polyethylene ball that is resting below the cotyloid fossa.

grind with sit to stand. Eight weeks post-operatively the patient was examined in the office. The right leg appeared clinically located, but a grinding sensation was felt with passive range. The right leg was short. Radiographs showed an eccentric position of the inner ball. The inner ball of the dual mobility bearing was articulating with the metallic cup. Furthermore, there was a fracture involving the greater trochanter and the lateral femoral cortex (figure 5).

The patient's hip was explored and revised. Exam of the hip intraoperatively showed that the inner head of the dual mobility bearing had dissociated from the polyethylene head. The polyethylene head was trapped inferiorly below the acetabular cotyloid fossa. The Magnum cup was grossly scratched as the inner ceramic ball was articulating with the metal cup. The femoral stem was stable despite the fracture of the greater trochanter. The triflange PPI was also stable. Figure 6 shows the retrieved dual mobility bearing. The hip was revised. A constrained acetabular cup (Freedom, Biomet, Inc.) was cemented into the triflange PPI. The greater trochanter was reduced and fixed with a cable claw plate (Arcos System, Biomet, Inc.) with a bolt securing the claw into the lateral aspect of the femoral stem (figure 7). At six months post-operatively, the hip remains stable.

Figure 6 - Postoperative radiograph showing revision. The acetabulum has been revised to a constrained acetabular cup. Note the locking ring around the femoral head. The greater trochanter has been secured with a trochanteric claw plate. A bolt secures the claw into the lateral portion of the femoral stem. Note again, dissolvable antibiotic beads (Stimulan) have been placed into the hip joint.

Figure 7 - Retrieved dual articulation bearing. Multiple metal smears are seen on the ceramic head which was articulating upon the metal cup.

Discussion

The dual articulation bearing construct in THA had enjoyed favorable popularity with most use being centered around France^{4,5,13}. It is estimated that over 25,000 dual articulation bearings have been inserted worldwide (personal communication Stryker Inc, Kalamazoo, MI and Biomet Inc, Warsaw, IN). There are good mid-term (99.6% survival at 5 years) and long-term (85.4% survival at 15 years) outcomes in high dislocation risk populations^{3,8,14}. Dislocation rates with the dual articulation bearing are favorable, reported as low as 1.15% in 16 years^{2,14}. Dissociation of the inner ball is a rare but reported complication with the dual articulation design. Interestingly, the reported inner head dissociations have occurred relatively

late in the life cycle of the prosthesis. The reported incidence of inner head dissociation is 0.2%, with the reported dissociations occurring between 8 to 16 years after surgery⁷. Dissociation resulted from wear and deformation of the UHMWPE head that enclosed the inner head. The inner head can also dissociate by traumatic levering if the outer head is dislocated and entrapped by the surrounding pelvic structures. This mechanism of dissociation has not been reported until now. Assembly of the inner ball into the UHMWPE head requires considerable force. Approximately 75% of the inner ball is enclosed within the UHMWPE head and a very high force is needed to “squeeze” the inner head into the polyethylene. The stated compression force to assemble the inner ball into the polyethylene head is approximately 162 foot-pounds for the Active Articulation bearing (personal communication Biomet, Inc.) and 200 foot-pounds for the Dual Mobility bearing (personal communication Stryker, Inc.) The force to lever out the inner ball once reduced is approximately 150 foot-pounds for the Active Articulation bearing and 180 foot-pounds for the Dual Mobility bearing (personal communication Biomet Inc & Stryker Inc). We believe the dissociation in this case was a result of an entrapped polyethylene head combined with a very forceful levering of the leg during the initial reduction maneuver. The considerable force is evident by the fracture of the greater trochanter that occurred during the reduction maneuver. The stability of the retrieved bearing was impressive. The senior author did not appreciate a difference in the subjective force to reassemble the retrieved bearing compared to a new dual articulation bearing.

The orthopaedic surgeon and emergency room physician need to recognize when a patient presents with a dislocated dual mobility construct. Since the “achilles heel” in the design is its relative lower lever out force for the inner ball, the THA reduction maneuver should be modified. Specifically, forceful angular and levering maneuvers of the leg should be avoided. Remember also, since the dual mobility head is larger than the typical THA head, successful reduction is generally more difficult. We recommend that only one or two reduction attempts be made in the emergency room or radiology suite. If unsuccessful, we advocate that the reduction maneuver be undertaken in the operating room with muscle relaxation under fluoroscopic guidance.

If again the reduction maneuver is unsuccessful, an open reduction procedure is required. Lastly, if the hip is reduced with closed measures, the post reduction radiograph must be carefully evaluated. If after the reduction the small ball is seen eccentrically positioned upon the outer metal cup, a bearing dissociation has occurred. This requires an open revision procedure.

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