Failure of a Constrained Acetabular Liner Without Reinforcement Ring Disruption

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Abstract

Several risk factors for dislocation after total hip arthroplasty (THA) have been identified including operative-, patient-, and implant-related factors. The following case report describes the dislocation of a revision THA without disruption of the constrained liner or containment ring. The possible mechanisms leading to this type of failure include lever-out impingement and poor abductor function, or tension secondary to prior surgery. Dislocation without disruption of containment ring has not been described for the Pinnacle Acetabular Cup with the Enhanced Stability Constrained Liner (DePuy Orthopaedics, Warsaw, Indiana).

The risk of dislocation after total hip arthroplasty (THA) can be attributed to both surgical and patient factors. Surgical factors include the operative approach, soft tissue balancing, impingement, head-neck offset, design of acetabular liner, component alignment, and trochanteric nonunion. Patient risk factors include cognitive or neuromuscular disorders, number of prior hip surgeries, and insufficient musculature.[1-5] The reported incidence of hip dislocation varies from 0.04% for primary THA to as high as 25% in revision THA.[1,6-14] If addressed early in the postoperative course, many dislocations can be treated without surgery. Closed reduction is successful in more than 60% of cases especially if the femoral and acetabular components are properly oriented. However, in cases of recurrent instability, surgical intervention is often required.[15-18]

The patient provided written informed consent for print and electronic publication of this case report.

Case Report

A 55-year-old woman with a history of multiple traumatic injuries to her right hip, including a femoral neck fracture treated with open reduction and percutaneous pinning as well as a subtrochanteric femur fracture treated with a dynamic hip screw, developed a femoral nonunion requiring medial displacement osteotomy and internal fixation. Subsequent hip arthritis and greater trochanter nonunion necessitated primary S-ROM THA (DePuy Orthopaedics, Warsaw, Indiana) with a 50 mm Pinnacle Acetabular Cup (DePuy Orthopaedics), a 28 mm ceramic femoral head (Biolox Delta, DePuy Orthopaedics, Warsaw, Indiana), and greater trochanteric fixation with a claw plate (**Figure 1A, 1B**).

Four months later, the patient sustained a ground level fall resulting in a posterior hip dislocation and treated with closed reduction. Four months after her reduction, the patient sustained a second posterior hip dislocation secondary to failure to adhere to posterior hip precautions, and was treated with revision THA to a 28 mm metal femoral head and a 50 mm Enhanced Stability Constrained (ESC) Liner (DePuy Orthopaedics).

The Pinnacle acetabular component (DePuy Orthopaedics) appeared in neutral anteversion on the available radiographs (**Figure 2A, 2B**). Intraoperatively, the acetabular component was well-fixed and in acceptable abduction and anteversion.

Figure 1. Anterioposterior radiograph (A) of the pelvis demonstrating right hip osteoarthritis and a greater trochanter nonunion after medial displacement osteotomy and internal fixation. Anterioposterior radiograph (B) of the pelvis after primary S-ROM total hip arthroplasty and greater trochanteric fixation.

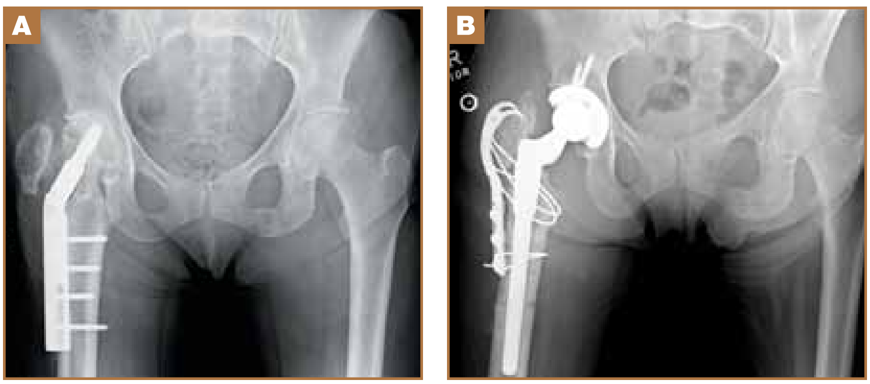

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Figure 2. Anteriorposterior radiograph (A) after the second posterior dislocation event. Anteriorposterior radiograph (B) of the pelvis after revision to an Enhanced Stability Constrained Liner (DePuy Orthopaedics).

The S-ROM femoral component (DePuy Orthopaedics) was also well fixed and in acceptable anteversion.

Two months later, the patient sustained a third posterior hip dislocation after failure to adhere to posterior hip precautions and was treated with an open reduction. Radiographically, the containment ring was intact (**Figure 3A**). Intraoperatively, the uncemented femoral and acetabular components were well-fixed and in acceptable abduction and anteversion. The 28 mm metal head was also securely fixed to the neck of the prosthesis. The ESC liner was engaged securely into the acetabular cup and appeared undamaged without evidence of abnormal wear. The titanium containment ring remained engaged with the constrained liner, and no defect in the liner or containment ring was visualized (**Figure 3B**). At this point, the femoral head was exchanged for a plus 3 mm, a 28 mm metal head, and a 50 mm ESC acetabular liner with a 10° lip was impacted into the well-fixed acetabular cup (**Figure 3C**).

The final leg lengths were grossly equal by palpation and abductor tension was adequate during intraoperative examination. The hip was put through range of motion testing and was found to be stable and without impingement through full extension and 90° of hip flexion. The hip had 50° of abduction in extension. At 45° of hip flexion with maximal adduction, the hip was internally rotated maximally by the ankle revealing a stable hip. At 90° of hip flexion the hip was also stable to 45° of internal rotation. At the time of this report the patient is doing well and has had no further complications or dislocations for greater than 18 months.

Discussion

Constrained acetabular liners are one option for patients with recurrent instability after THA. Failure rates for constrained liners have been reported from 4% to 47%.[19-24] However, a meta-analysis of 1199 hips with a mean follow-up of more than 4 years, suggests a 10% dislocation rate after constrained THA.[25] A retrospective review of 29 dislocations in the setting of a constrained THA determined that 10 (34%) of the dislocations were due to failure of pelvic fixation, 11 (38%) of the dislocations were due to dissociation of the constrained liner and the acetabular cup, 6 (21%) due to biomaterial failure, and 2 (7%) due to dislocation of the femoral component with failure of the outer retaining ring.[26] However, when failed constrained THAs are evaluated by retrieval analysis 29 (51%) of 57 were due to containment ring failure. Late dislocations occurred at a mean of 4.1 years and 5.9 years with an intact retaining ring as a result of acetabular liner/shell dissociation or acetabular shell loosening, respectively. However, late dislocations occurred at a mean of 1.9 years with a broken retaining ring. Forty-six (94%) of 49 retrieved containment rings have signs of material wear secondary to impingement.[27] There are reports of early dislocations of a constrained implant and an intact retaining ring—these typically occur due to a lever-out mechanism where femoral neck/apron/skirt or bi/tri-polar implant impinges on the acetabular cup or liner causing a dislocation event.[22,28]

There are 4 main modes of failure for constrained acetabular liners previously described in the literature.[22,26,29] Failure can occur at the bone-prosthesis interface and may be related to osteolysis, allograft strut failure, or trauma. The polyethylene liner may separate from the acetabular cup, which usually occurs when the liner is cemented into a well-fixed acetabular cup. The most common mode of failure is at the femoral

Figure 3. Anteriorposterior radiograph (A) after the third posterior dislocation event showing an intact containment ring. Intraoperative photograph (B) of the extracted femoral head and containment ring. Anteriorposterior radiograph (C) of the pelvis after revision to a 10° lipped Enhanced Stability Constrained Liner (DePuy Orthopaedics).

head locking mechanism due to fracture of the containment ring. Containment ring fracture may occur secondary to poor acetabular cup orientation with increased anteversion or abduction resulting in impingement. The fourth type of failure is at the level of the femoral head-neck trunnion.

This case illustrates key points with the use of constrained acetabular liners. Young patients with posttraumatic arthritis have a higher likelihood of recurrent dislocation even with the use of a constrained liner.[14] According to the manufacturer, high demand patients are poor candidates for an ESC acetabular liner because this can lead to interface failure.[30] An ESC acetabular liner is indicated for use in primary or revision THA patients at high risk of hip dislocation due to a prior history of instability, bone loss, joint or soft tissue laxity, neuromuscular disease, and/or intraoperative instability.[30] The maximum amount of hip flexion is 92° for a 28 mm femoral head.[30] In addition, the lever out strength of the liner used in this case is 319 kg, which compares favorably with other constrained implants on the market.[30]

Risk factors for failure of the constrained implant in the patient presented in this case report include the small native acetabulum limiting the femoral head size to a 28 mm, laxity of the soft tissues allowing for increased motion about the constrained implant, and atrophy of the abductor sleeve. Maximizing the size of the femoral head increases the head-to-neck ratio and lever-out distance; thereby decreasing the risk of impingement.[3,22] One should also consider the use of a high offset stem to decrease the likelihood of impingement. The ability to assess for impingement intraoperatively by way of trial reduction is difficult due to the nature of the constrained liner design. Constrained liner use is therefore technically demanding. Proper sizing and alignment is crucial to keeping impingement to a minimum.[21,26] In THA patients with a history of recurrent dislocation, intraoperative instability, soft tissue laxity, and neuromuscular disease, the use of a constrained liner serves as an important tool.[3,20,21] Although some have reported the success rate of constrained liners to be upwards of 96%, this likely only applies to low demand patients, a well-aligned acetabular cup, and minimal risk factors. The constrained acetabular system compensates for reduced abductor strength, however, instability can still occur without wear or locking ring failure.

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