Annals of Orthopedic Surgery Research

Case Report
Published: 27 Jun, 2019

Mechanism of Type III Failure of Constrained Hip Arthroplasty with Intact Locking Ring

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Abstract

The use of constrained liners has become increasingly popular as a method of managing recurrent hip dislocations. There are three common mechanisms of failure of these liners recorded. Type III failures are the most frequent and include damage to the locking mechanism. This case report discusses an uncommon mechanism of failure in which a total hip replacement with a constrained liner dislocated despite an intact locking ring. The mechanism of failure in this case was due to impingement of the neck of the femoral component against the rim of the liner, causing gradual wear of the anterior and posterior flanges. Factors that can lead to this type of impingement include a low head-neck offset ratio, reduced medial offset and poor orientation of the acetabular cup.

Introduction

Total hip replacement is considered one of the most successful interventions for management of hip arthritis [1]. However, instability remains a significant complication associated with hip urethroplasty [1]. The incidence of dislocation is about 0.2% to 10% for primary hip replacement but increases to about 28% for revision hip urethroplasty [1]. The dislocation in hip replacement frequently occurs within the first year after surgery, nonetheless late dislocations (more than 5 years post-operatively) do occur and are more likely to be associated with recurrent dislocations [1]. Late dislocations are associated with infection, polyethylene ware, soft-tissue destruction and abductor disruption or weakness [2]. Causes of dislocations can also be grouped into patient factors, implant factors and surgeon factors [2]. Patient factors include age >70, medical comorbidities, abductor weakness and female gender [2]. Implant factors include head diameter, prosthetic head-neck ratio and offset [2]. Surgeon factors include experience of the surgeon, as well as positioning of the patient and surgical approach, with posterior approach having the highest incidence of dislocation [2].

The use of constrained acetabular liners in recurrent dislocations has become increasingly popular, with multiple studies showing success rates of higher than 80% [3]. A literature review showed a mean dislocation rate of 10% following revision total hip arthroplasty with a constrained liner, with the most common mechanisms of failure being pull-out of the femoral head from the acetabular liner due to the failure of the locking ring [4]. Cooke et al. [5] in their case series of 58 patients explained three different mechanisms of failure of a constrained liner. Type I occurred at the interface between the acetabular bone and the prosthesis (loosening), type II was due to the failure of the locking mechanism i.e. polyethylene liner uncouples from the metallic shell, and type III failure involved uncoupling of the femoral head from the liner due to the failure of the metallic ring [5]. Type III failures are the most common, and are usually associated with poor acetabular cup orientation, leading to impingement of the femoral neck on the liner resulting in wear and damage to the locking mechanism, eventually leading to its failure and dislocation of the femoral head [6].

The purpose of this case report is to highlight the uncommon mechanism of failure of constrained hip replacement in which the hip was dislocated despite an intact locking ring of a constrained liner and its management.

Case Presentation

A 81 year old female patient, with a BMI of 31.6, presented to us with history of recurrent dislocation following a cemented total hip replacement which was performed 15 years ago (Figure 1a). This patient was asymptomatic for the first 10 years following her hip replacement. She then had five episodes of dislocation of the hip joint (Figure 1b) and all occurred while performing trivial, activities such as getting up from a chair. As she was asymptomatic in the initial 10 years, any cause related to poor surgical technique was ruled out. Nonetheless, she was investigated for infection and

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Received Date: *02 May 2019*
Accepted Date*: 20 Jun 2019*
Published Date*: 27 Jun 2019*

Citation:
Theodoraki M. Mechanism of Type III Failure of Constrained Hip Arthroplasty with Intact Locking Ring. Ann Orthop Surg Res. 2019; 2(1): 1008.

Figure 1a: X-ray image of primary hip replacement.

Figure 1b: X-ray image of dislocated primary hip replacement.

Figure 2: X-ray image of revised hip replacement with constrained liner.

Figure 3: X-ray image of dislocation of revised total hip replacement with constrained liner intact.

implant wear. Her initial radiographs of the hip joint suggested wear of the polyethylene cup due to the eccentric position of the femoral head.

After discussing the risks and benefits of a revision hip arthroplasty, this patient underwent revision surgery in December 2017 (Figure 2). She was treated with a constrained acetabular liner in view of her old age, history of recurrent dislocation and poor soft tissue around the hip joint (intraoperative finding). The revision surgery was performed with a Pinnacle multi-hole cup (uncemented) and a constrained acetabular liner.

During revision surgery it was noted that there was significant wear of the original polyethylene cup as suspected preoperatively. We also noticed that external rotators of the hip joint were detached and thus these posterior structures were repaired intraoperatively to provide additional stability.

This patient remained asymptomatic for 6 months but in June 2018, she dislocated the hip joint (Figure 3) which again happened while she was getting up from a chair.

This was well fixed and the constrained liner was entirely within the metal socket. However, the locking ring was still completely intact and has decoupled from the liner. It was also found that hip abductors were deficient, and the flanges of polyethylene liner were damaged both anteriorly and posteriorly. Intraoperative assessment of the acetabular cup did not reveal any issues with the position of the cup which could have led to impingement. We believe that the primary cause of wear of the liner both anterior and posteriorly was reduced femoral offset. Hence, the damage plastic constrained liner (54 × 32) and the metal head (32 mm + 1.5) was replaced with a constrained liner (54 mm + 4) and the femoral head (32 mm size + 9) which increased the offset and in turn its improved abductor tensioning and hip stability. Once again, every attempt was made to repair the posterior structures and since her last revision surgery, she has remained asymptomatic.

Discussion

Constrained liners act to hold the femoral head within the socket [3]. The design includes a liner that extends further than typical liners with an inner diameter that is less than the prosthetic head. The head is then maintained within the liner with an external metallic locking ring. This locking ring also helps to maintain the inner diameter and prevent expansion [7]. A constrained liner is more commonly used in revision total hip arthroplasty particularly for patients with history of recurrent dislocation. The other indication to use a constrained liner includes dislocation with no identifiable cause, multiple previous surgeries, deficient soft tissue, neuromuscular disorders and poor patient compliance due to cognitive disorders. In our case report, a constrained liner was used due to multiple episodes of dislocation of the hip associated with deficient soft tissue and advanced age of the patient. A literature review by Williams et al. [4] states that recurrent dislocation is one of the most common reported indications for constrained liners. As per the available literature, the rate of hip dislocation following a use of constrained liner is about 10 %. The most common mechanisms of failure of constrained liners, as documented in the literature is Type III. The locking ring fits over the constrained liner once the femoral head is reduced within the

acetabular component. Its role is to secure the femoral head within the liner. A related feature that has been noted in the literature [5] that is associated with failure of the constraint liner, particularly type 3 failure, is poor acetabular cup orientation which leads to breakage of the metallic ring and failure of the locking mechanism. Improper orientation of the acetabular cup can lead to impingement of the femoral neck on the liner, which can contribute to type 3 failure. Orientation of the acetabular component is a contributing factor for hip stability and most authors agree that the cup inclination should be 45 degrees [8]. In our case report, type III failure occurred though the locking ring was intact. We believe the possible mechanism of failure is impingement of the femoral neck against the flanges of the liner at extremes of hip movements and intraoperatively we found damage to the anterior and posterior flanges of the liner. The impingement of the neck against the rim of liner can also occur due to reduced head-neck offset ratio or due to reduced medial offset [9]. Intraoperative assessment of the cup and the pre-operative radiographs ruled out any issues with acetabular cup orientation. It is possible that the metallic ring was gradually pushed out of the liner due to progressive wear. This wear was due to impingement of the femoral neck against the rim of the liner despite satisfactory cup orientation. There is some evidence of similar mechanisms of failure in the literature [9]. One study has shown that 54% of failed constrained liners show moderate to severe impingement damage of the rim of the polyethylene liner [10].

According to the literature, a common feature of type III failure appears to be poor acetabular cup orientation, usually excessive abduction or version [5]. This can then lead to impingement of the femoral neck on the constrained liner and locking mechanism, resulting in failure of the locking mechanism and subsequent dislocation. However, this did not appear to be the cause of impingement in this case. At the second operation, the polyethylene liner was replaced but with increased medial offset to avoid the neck impingement against the liner and also to improve soft tissue tensioning. As the acetabular cup and the femoral stem orientation were satisfactory and both were well fixed, these two components were not revised.

Summary

The index patient in this case report presented with failure of a ring locked type of constrained liner and acute dislocation of the hip. In contrast to the common mechanism of failure which involves breakage of metallic ring and dislocation of the hip out of the plastic liner, the metallic ring was intact in this case. We believe the possible mechanism is impingement of the neck against the polyethylene liner which caused gradual wear of the anterior and posterior flanges. It is possible that consistent impingement of neck against the liner lead to disengagement of the metallic ring from the liner and lead to dislocation. The common factors which can lead to this type of impingement are low head-neck offset ratio, reduced medial offset and poor orientation of the acetabular cup i.e. excessive adduction or abduction and ante or retroversion. We believe that a constrained liner can be used for recurrent dislocation of the hip, but surgical technique should not be undermined. Basic concepts of hip replacement, which includes correct implant positioning, maintenance of the offset and appropriate repair of the soft tissue also play a significant role and can influence the final outcome.

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