

Late Dissociation of the Polyethylene Liner from a Modular Acetabular Metal Shell after Primary Total Hip Arthroplasty

— A Report of Five Cases —

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Modular designs of hip prostheses have become popular recently. Along with complications inherent in all hip arthroplasty systems, modular systems have the additional potential for dissociation of components. Five male patients underwent total hip arthroplasties, in which all of the acetabular components were Harris-Galante II porous acetabular cups. Many years after the operation, the polyethylene liners were dissociated without any previous trauma or dislocation of the femoral heads. These dissociations and dislodgements were managed with open reduction. This complication can be predicted from clinical symptoms and signs. Roentgenograms must be taken and carefully compared to previous roentgenograms. We postulated two causes for the dissociation. First, the polyethylene liner was not fixed securely within the acetabular metal shell at the time of operation. Second, the locking mechanism of the acetabular metal shell was not strong enough to firmly hold the polyethylene liner within the acetabular metal shell. It does warrant that certain precautions must be taken when implanting modular components. The locking mechanism of the Harris-Galante II porous acetabular component is mechanically weak and fails easily, therefore its design must be improved in an attempt to prevent postoperative dissociation of the polyethylene liner.

Key Words: Total hip replacement, modular prosthesis, polyethylene dissociation, acetabular metal shell, locking mechanism

Modular designs of hip prostheses have become popular recently (Kitzinger *et al.* 1990). Along with complications inherent in all hip arthroplasty systems, modular systems have the additional potential for dissociation of components (Kitzinger *et al.* 1990; Star *et al.* 1992). This complication has been documented for bipolar endoprotheses and one-piece pre-assembled uncemented acetabular components

(Anderson and Milgram, 1978; Miller, 1983; Barnada and Mess, 1987; Brien *et al.* 1990; Woolson and Pottorff, 1990; Beaver *et al.* 1991; Star *et al.* 1992). But dissociation of components is unique to the modular system (Star *et al.* 1992). We report five cases of late dissociation of the polyethylene liner from an acetabular metal shell without a preceding dislocation of the femoral head or any trauma. In each instance, the locking mechanism of the acetabular component was broken or bent. The purpose of this report was to describe the diagnosis of such failures, to infer the causes of the dissociation of the polyethylene liner, and to establish the proper management for each patient.

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CASE REPORT

Case 1

A 41-year-old man with idiopathic avascular necrosis of the right femoral head was treated with a total hip arthroplasty 5 years previously. A Harris-Galante II porous acetabular metal shell (54-mm outer diameter and standard polyethylene liner) and Anatomic porous femoral stem (14-mm diameter and 144-mm length) with a short-neck and 28 mm diameter modular head (Zimmer, Warsaw, IN, U.S.A.) were used. He obtained complete relief of his hip pain and resumed his work. Six months before admission he had felt pain and instability in the right hip and had a limping gait. On roentgenogram, the metal head was displaced superiorly within the acetabular metal shell and a semilunar radiolucent shadow was found under the acetabular metal shell. A small piece of metal was found, which suggested that it had been broken off from the superolateral locking mechanism (Fig. 1). Revision procedure was per-

formed. The polyethylene liner was lying free and worn away and frayed at its rim. The metal head was in contact with the dome of the metal shell. The locking mechanism was slightly turned outward. The acetabular metal shell and femoral stem had stable bone ingrowth. Definite osteolysis was not observed. The worn polyethylene liner was removed and three of four screws in the dome were backed out. One remaining rack of the superolateral locking mechanism was reverted and repaired. The metal head was replaced by a new component with a medium-neck and a new polyethylene liner was inserted and held securely by the remaining intact locking mechanism. The patient returned to work and was periodically followed up.

Case 2

A 56-year-old man underwent a total hip arthroplasty 6 years before for idiopathic avascular necrosis of the right hip. A Harris-Galante II porous acetabular metal shell (52-mm outer diameter and standard polyethylene liner) and Anatomic porous femoral stem (16-mm diameter, 148-mm length) with a short-neck and 28-mm diameter modular head were used (Zimmer, Warsaw, IN, U.S.A.). The postoperative course was uneventful and the patient was followed up periodically. Three weeks prior to admission he had heard a loud pop when he got up from a seat and felt acute pain in the hip. The hip felt unstable and the feeling of roughness became more evident. On physical examination, he had a limping gait of the right lower extremity and a metal-on-metal squeak was audible from the hip. On roentgenograms, the metal head was shown to be eccentrically located in a superolateral direction within the acetabular metal shell, and the radiolucent shadow of the polyethylene liner could be seen lying medially under the acetabular metal shell. As well, the superolateral locking mechanism of the acetabular metal shell had been pushed by the metal head and was deformed. A revision procedure was done. The femoral metal head was riding on the superolateral edge of the acetabular metal shell. The polyethylene liner was dislodged posteroinferiorly and was worn away, particularly severely at the superolateral portion. However, the anteroinferior surface of the liner did not have any fitting marks made by the locking

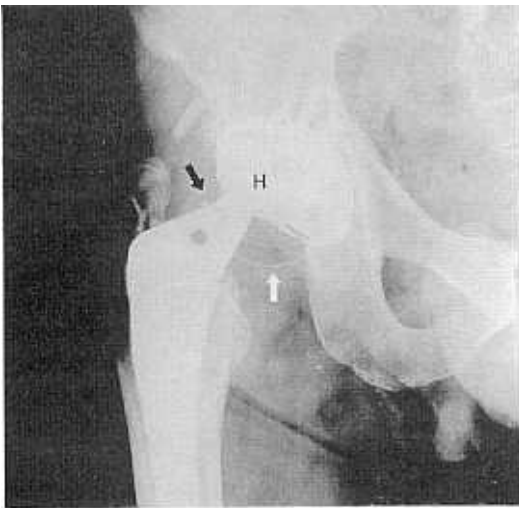


Fig. 1. Preoperative anteroposterior roentgenogram of the right hip. The prosthetic metal head ("H") was located eccentrically within the acetabular metal shell. The radiolucent shadow was found under the acetabular metal shell, which indicated the dislodged polyethylene liner (white arrow and white drawn lines). A small piece of metal was found, which suggested that it had broken off from the superolateral locking mechanism (black arrow).

mechanism, which indicated a failure of the initial fitting of the liner into the acetabular metal shell and locking mechanism. The titanium acetabular component had been significantly worn by the cobalt chrome head of the femoral component. The dark-stained capsule contained titanium debris and polyethylene fragments. The metal shell and femoral stem were found to be securely fixed to the bone. The deformed locking mechanism was reverted inward and repaired and a new liner was inserted. Metal debris and polyethylene particles were removed and cleaned. The postoperative course progressed routinely. The patient has since done well.

Case 3

A 64-year-old man had a total hip arthroplasty for non-union of a fracture of the right femoral neck 5 years before. A Harris-Galante II porous acetabular metal shell (52-mm outer diameter and standard polyethylene liner) and Anatomic porous femoral stem (13-mm diameter, 135-mm length) with a short-neck and 28-mm diameter modular head (Zimmer, Warsaw, IN, U.S.A.) had been implanted. The patient was asymptomatic and did well. Three weeks prior to admission he was unable to bear full weight on the right hip and he heard a metal-on-metal noise while walking and felt a dull ache in the right hip. Physical examination showed a limping gait of the right lower extremity. Any motion of the hip elicited crunching crepitus and pain. Roentgenograms showed the metal head to be eccentrically located in the acetabular metal shell. A radiolucent arc was found medially to the femoral neck under the acetabular metal shell, which suggested a displaced polyethylene liner. Amorphous radio-opacity was found in the hip joint, which suggested metallosis. The hip was opened through the original posterolateral incision. The polyethylene liner was seen to be completely disengaged and subluxated posteroinferiorly while the femoral metal head was riding on the superolateral rim of the acetabular metal shell and it had pushed out the superolateral locking mechanism, which was deformed and turned outward (Fig. 2). The polyethylene liner was found to have marked wear on the rim. Polyethylene fragments and metal dust were widespread. The liner was removed and the wound was debrided. The acetabular dome screws

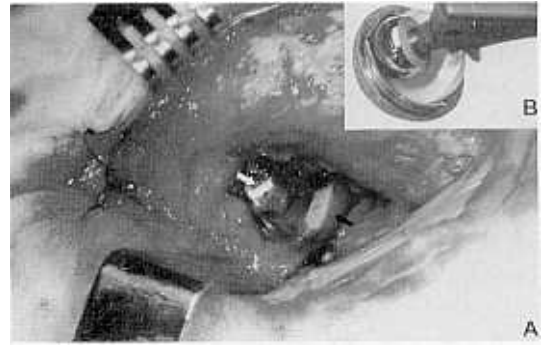


Fig. 2. Photographs of the dissociation of the polyethylene liner from the acetabular metal shell. The prosthetic metal head (white arrow) was located eccentrically and was riding on the superolateral edge of the acetabular metal shell and it pushed out the locking mechanism. The polyethylene liner was dissociated and dislodged (black arrow). (a) Photograph made intraoperatively. (b) Photograph showing what the actual state of operation field would be like.

were backed out and the metal shell was found to be well fixed with no motion to manual or instrumental testing. The deformed locking mechanism was reverted inward and repaired. A new polyethylene liner was inserted and the modular femoral head was replaced with a new one. The patient was rehabilitated and returned home. He has had no further problems with this hip.

Case 4

A 40-year-old man had two total hip arthroplasties 5 years before for idiopathic avascular necrosis of both hips. A Harris-Galante II porous acetabular metal shell (54 mm outer diameter and standard polyethylene liner) and porous Multi-lock femoral stem (152 mm length) with a long-neck and 28 mm diameter modular head (Zimmer, Warsaw, IN, U.S.A.) had been implanted in the right hip. The left hip was operated on using the same design as that of the right hip. The patient did well and followed up annually. Five months prior to admission he had suffered from an audible friction sound and pain in the right hip. A roentgenogram showed large osteolytic lesions in the proximal femur and acetabulum, superolateral displacement of the metal head, a radiolucent shadow lying under the acetabular metal

shell, and a radio-opaque curvilinear shadow. A surgical exploration revealed metallosis in the hip. The polyethylene liner was found to be displaced posteroinferiorly. It was worn at the superolateral portion and had a discolored and irregularly eroded rim at the inferomedial portion which was in contact with the prosthetic neck on hip adduction. The metal head was overriding the superolateral metal shell. One rack of the locking mechanism was broken off and not repairable. As a result, the locking mechanism was unable to hold the polyethylene liner. The metal shell and femoral stem were found to be securely fixed to the bone. The acetabular metal shell and screws were removed with difficulty. The osteolytic lesions in the acetabular wall and proximal femur were curetted and cleaned. The acetabular bed was prepared with allogeneous cancellous bone and was implanted with a bipolar prosthesis. One year later, the pain had resolved completely.

Case 5

A 55-year-old man had total hip arthroplasties five and one-half years before for idiopathic avascular necrosis of the right hip. A Harris-Galante II porous acetabular metal shell (54 mm outer diameter and standard polyethylene liner) and porous Multi-lock femoral stem (13 mm diameter, 152 mm length) with a medium-neck and 28 mm diameter modular head (Zimmer, Warsaw, IN, U.S.A.) had been implanted in the right hip. He returned home and visited our hospital periodically. Ten days prior to admission he had slipped down and felt a pop in his left hip with acute pain. On physical examination, movement in the hip was restricted and any motion of the hip caused pain. Roentgenograms showed that the prosthetic femoral head was positioned eccentrically within the acetabular metal shell. Also, a radiolucent arc shadow was found under the acetabular metal shell. There was no evidence of osteolysis or loosening in the femur and acetabulum. At revision operation, the polyethylene liner was seen to be completely disengaged from the acetabular metal shell. The prosthetic metal head was riding on the superolateral portion of the polyethylene liner and acetabular metal shell. The polyethylene liner was eroded in the superolateral direction and the superolateral flange was torn off in the pattern of

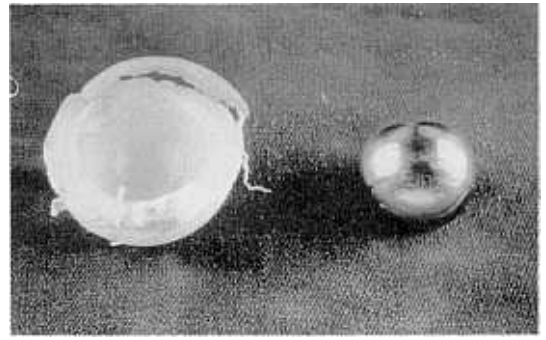


Fig. 3. Retrieved polyethylene liner and metal head. The polyethylene liner was eroded in the superolateral direction and the superolateral flange was torn off in the pattern of a bucket handle. The metal head was abraded and darkly discolored. The neck of the femoral stem impinged on the inferomedial portion of the liner, which was also eroded and deformed.

a bucket handle (Fig. 3). The metal head was abraded and darkly discolored. The neck of the femoral stem impinged on the inferomedial portion of the liner, which was also eroded and deformed. The inferomedial locking mechanism was turned outward. Metal dust or polyethylene fragments were found sparsely scattered. The acetabular metal shell and femoral stem were found to be solidly fixed to the host bone in a good position. A new polyethylene liner was snapped in place and the metal head changed to a new component. The patient made an uneventful recovery and regained excellent function with no further episodes of painful limitation of the hip.

DISCUSSION

Total hip arthroplasty evolved as a result of the many improvements in prosthetic design, the availability of suitable component materials and manufacturing techniques, and a better understanding of hip mechanics. In 1971, Harris introduced a metal-backed acetabular component to allow replacement of worn polyethylene cups, leaving the metal firmly cemented in place (Bueche *et al.* 1989). In recent years, modular total hip arthroplasty systems have become increasingly popular whether off-the-shelf

or customized, cemented or noncemented (Star *et al.* 1992). Modular total hip implants have given the total hip surgeon a wide range of implant selection to restore anatomy and function in arthrosis: variable choice of head size, adjustment of neck length, allowance for placement of fixation screws, and additional femoral head coverage with a hooded or elevated rim polyethylene liner (Star *et al.* 1992; Fisher and Kiley, 1994). However, along with complications inherent with all hip arthroplasty systems, modular systems have the additional potential for dissociation of components that requires surgical intervention to correct (Star *et al.* 1992; Fisher and Kiley, 1994). Disassembly of the components of bipolar endoprostheses of the Bateman and Christensen designs have been reported previously (Anderson and Milgram, 1978; Barnada and Mess, 1987; Miller, 1983; Woolson and Pottorff, 1990; Beaver *et al.* 1991). Also, disassembly of a one-piece metal-backed acetabular component was reported (Brien *et al.* 1990; Beaver *et al.* 1991). However, dissociation of components is unique to modular system (Star *et al.* 1992).

There are several case reports in the literature of dissociation of polyethylene liners from acetabular metal shells (Fisher and Kiley, 1994). Most dissociations of modular hip arthroplasty components occurred on dislocation or at attempted closed reduction after dislocation. However, in all of the our cases, polyethylene liners were worn and dissociated from acetabular metal shells without preceding trauma or dislocation after a long period had elapsed postoperatively.

Theoretically modular component dissociation may occur at two differing levels: (1) acetabular polyethylene liner from the acetabular metal shell, and (2) modular femoral head from the tapered neck of the femoral stem (Star *et al.* 1992). Although Star *et al.* and Woolson and Pottorff, each reported one case of dissociation at the femoral head-neck interface (Star *et al.* 1992), most dissociations of modular hip arthroplasty components have occurred between the acetabular metal shell and the polyethylene liner, as were all of our cases. Component dissociation necessitated open reduction. Although the potential disadvantage of modular hip arthroplasty systems indicated here does not outweigh the advantages discussed above, it does warrant that certain precau-

tions be followed when using modular components (Star *et al.* 1992).

Dissociation and dislodgement of the polyethylene liner from the acetabular metal shell can be predicted from clinical symptoms and signs, as well as from roentgenograms. It can also be confirmed at the revision operation. The patient usually has a dull ache and discomfort of the affected hip and walks with a limp in the affected leg. Any motion of the affected hip causes a metal-on-metal friction sound. The roentgenograms must be taken and carefully compared to the previous roentgenograms. The metal head can be eccentrically located within the acetabular metal shell and the radiolucent shadow of the polyethylene liner can be seen lying under the acetabular metal shell. Either sign is evidence of dissociation of the polyethylene liner (Kitzinger *et al.* 1990). As well, the superolateral locking mechanism of the acetabular metal shell can be deformed or broken. Hazy mist-like irregular shadows were found in the joint which were considered metal debris.

We postulated two causes for the dissociation. First, the polyethylene liner was not fixed securely within the acetabular metal shell at the operation. Second, the locking mechanism of the acetabular metal shell was not strong enough to firmly hold the polyethylene liner within the acetabular metal shell. The acetabular polyethylene liner should be flush within the metal shell after impaction. Any space between the liner and shell indicates inadequate or asymmetric seating that warrants correction. The impacted liner should resist a reasonable intraoperative test effort to pry it away from the metal shell (Star *et al.* 1992). The posterolateral approach of the arthroplasty makes it difficult for a surgeon to confirm by the naked eye whether the polyethylene liner is securely fixed in the anterior or inferior direction. Thus, the anterior or inferior portions of the polyethylene liner are first snapped into the acetabular metal shell, followed by fitting of the posterior or superior portion. If special attention is not paid, the impaction force may also be distributed in a posterior and superior direction, resulting in unstable seating of the liner. Occasionally, soft tissue may be caught between the liner and the shell. Strict adherence to surgical technique during the initial procedure may aid in the prevention of dissociation of modular components (Star *et al.* 1992).



Fig. 4. (A) Intraoperative photograph showing that the locking mechanism was everted outward and deformed (white arrows). (B) Close-up photograph of the locking mechanism of the Harris-Galante II porous acetabular metal shell. The racks of the locking mechanism were weak, pliable and easily broken. They were subject to deformation and fatigue failure.

The Harris-Galante II acetabular metal shell has five or six racks on its inner edge which provide the locking mechanism for the polyethylene liner. Both tips of these racks are bent slightly inwards at their tips. The polyethylene liner is locked in these racks in a snap-fit fashion. These racks are weak, pliable and easily broken, so that they may be subject to deformation, fatigue failure, or breakage, followed by dissociation of the polyethylene liner (Fig. 4). The acetabular metal shell and its locking mechanism is composed of titanium, which is a relatively soft metal (Cameron, 1993). We think that the dissociation resulted from repeated episodes of impingement between the femoral neck and the edge of the polyethylene liner. As a result, this produced failure of the locking mechanism and tear and destruction of the polyethylene flange which held the liner within the acetabular metal shell, allowing motion between the liner and metal shell. More and more the locking mechanism and polyethylene liner were worn down and broken out, which eventually led to the liner being levered out of the metal shell completely (Wilson *et al.* 1988; Beaver *et al.* 1991; Fisher and Kiley, 1994). We believe that the locking

mechanism of a Harris-Galante II porous acetabular component is mechanically weak and fails easily, therefore its design must be improved in an attempt to prevent postoperative dissociation of the polyethylene liner. Recently the manufacturer designed a new model of hip prosthesis.

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