



## Failure mechanism of a constrained liner : A case report

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**Instability after primary and revision total hip arthroplasty continues to be a problem. The use of a constrained system helps manage this problem. A new constrained total hip arthroplasty, Trilogy constrained liner (Zimmer, Warsaw, IN), is currently in use. We report a case showing dislocation following a Trilogy constrained total hip arthroplasty. In this case, when an impingement between the femoral neck and the anterior part of the polyethylene liner occurred, the hip dislocated easily although both polyethylene and reinforcing ring were properly positioned. The lever-out test showed that the Trilogy constrained liner is safe and compares favourably with other implants. Surgeons should be aware that constrained acetabular systems are not infallible and they should pay attention to place implants in good position even when constrained THA is performed.**

**Keywords :** total hip arthroplasty ; constrained liner ; dislocation.

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### INTRODUCTION

Instability after primary and revision THA can be a clinical and technical challenge for the surgeon. In primary hip arthroplasty, its incidence has been reported to be between 0.5% and 10% (2,6). With

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revision surgery, it can be as high as 25% (6). The increased risk of dislocation in the setting of revision surgery may be due to trochanteric nonunion, soft tissue laxity, abductor deficiency, improper component position, operative approach, and the need for increased operative exposure. Most dislocations occur in the early postoperative period, and many are successfully treated in a conservative fashion. However, recurrent instability is a difficult problem to overcome despite traditional methods, including reorientation of the implants, use of elevated rim liners, removal of sources of impingement, trochanteric advancement, and abductor repair. Surgical stabilization using these traditional methods is also unpredictable, with success rates ranging from 60% to 80% depending on the series, aetiology of dislocation, and surgical technique used (3). Daly *et al* also reported that even when multiple modalities were used to treat postoperative instability, subsequent dislocation was prevented in only 61% of cases (4).

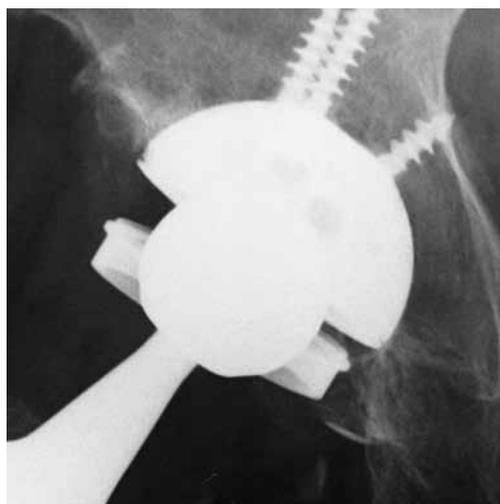
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As a result, constrained acetabular systems were developed to improve the outcome of stabilization procedures. The Trilogy constrained liner is a partially slit design with an uninterrupted inner diameter and a metal alloy reinforcing ring. To the best of our knowledge, there has been only one previously published case of a patient with a failed Trilogy constrained acetabular liner (13). We report one more patient with a failed Trilogy constrained acetabular liner. Trilogy constrained acetabular liner showed specific forms of dislocation. The head dislocated easily with both polyethylene and reinforcing ring properly positioned when an impingement between the femoral neck and the anterior part of the polyethylene liner occurred, although there was no breakage of the reinforcing ring. In addition, we investigated the dislocation strength of the Trilogy constrained liner system and concluded that the the Trilogy constrained system is a good replacement system.

### CASE REPORT

A 61-year-old woman underwent hybrid THA for osteoarthritis of the right hip at another hospital (uncemented cup/cemented stem). The operation was performed via the posterior approach. The postoperative radiographic position of the cup was 41° of inclination. Computed tomography showed that the anteversion angle of the cup was -1°. The postoperative course was uneventful until 5 years after surgery when she began to develop progressive right hip pain on weight bearing. Radiographs revealed sinking of the femoral component. The patient was referred to our institution, and revision surgery via the posterior approach was performed 74 months after the initial THA. The loose stem was exchanged for an uncemented stem (TL stem, JMM, Osaka, Japan). The shell was not replaced because the shell was well fixed in the acetabulum. A 26-mm Trilogy liner (Zimmer, Warsaw, IN) was inserted into the shell. A 26-mm-diameter head was used. Since a femoral shaft fracture occurred during surgery, open reduction and internal fixation using a cable plate was performed.

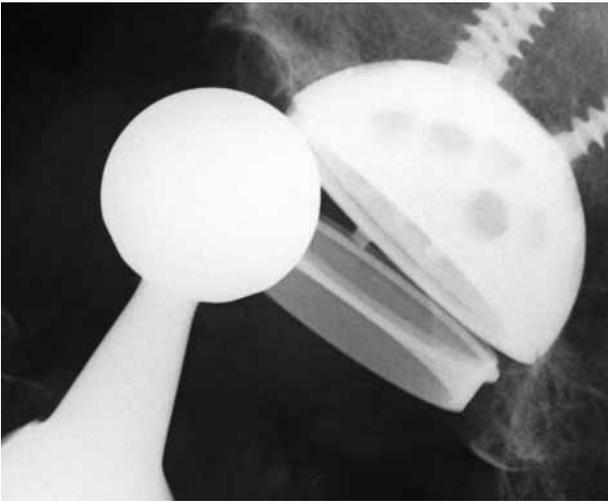
Five days after the revision THA, dislocation occurred when she stooped down. As she experi-



*Fig. 1.* — Radiograph after constrained THA

enced dislocations several times thereafter, liner and head exchange re-revision surgery was performed 3 months after the revision surgery. At the re-revision surgery, a 32-mm Trilogy constrained liner was inserted into the metal shell that was inserted at the first operation (Fig. 1). A 32-mm-diameter head was also used.

Unfortunately, 3 months later, the THA dislocated when she was sitting. Radiographs showed posterior dislocation, although the polyethylene and reinforcing ring were properly positioned in a solidly fixed metal shell (Fig. 2). Closed reduction failed, so open reduction was performed. At surgery, the polyethylene was found properly secured in the metal shell, but an impression was noted along the anterior part of the rim of the polyethylene caused by impingement of the femoral neck. The polyethylene prongs that lock the metal reinforcing ring in place were not fractured. Intraoperative examination revealed that when an impingement between the femoral neck and the anterior part of the polyethylene liner occurred at 40° of flexion, the head dislocated easily with both polyethylene and reinforcing ring properly positioned. Neither laxity of the soft tissue nor impingement of soft tissue was found. Since malalignment of the metal shell was a cause of dislocation, the metal shell was exchanged. A 58-mm Trilogy cup



**Fig. 2.** — The dislocated hip with the constrained liner ring still correctly in place.

with a 32-mm Trilogy constrained liner and a 32-mm head was used. Twelve months after surgery, the patient had a good postoperative recovery, and the radiographs were satisfactory. Computed tomography showed that the anteversion angle of the cup was 39°.

Next, we investigated the dislocation strength of the Trilogy constrained liner system because we were concerned that the Trilogy constrained liner might not properly restrain the head. The lever-out test was performed using a Shimadzu AG-IS (Shimadzu Rika Corporation, Tokyo, Japan). A 50-mm acetabular cup with a constrained liner was secured to a holding fixture. The distance from the 32-mm head center to the load point was 10 cm (Fig. 3). Dislocation occurred at 39.7 Nm. Dislocation for the S-ROM 28-mm constrained liner (DePuy, a Johnson and Johnson Company, Warsaw, IN, USA) and the Osteonics bipolar system (26-mm head) Stryker-Howmedica-Osteonics, Rutherford, NJ, USA) occurred at 45.2 Nm and 33.8 Nm, respectively.

## DISCUSSION

In the present case, the main causes for dislocation after THA were malposition of the prosthesis and, subsequently, impingement between the



**Fig. 3.** — Lever-out test simulated femoral neck impingement with the liner lip acting as the fulcrum.

femoral neck and the anterior part of the polyethylene liner, with both polyethylene and reinforcing ring properly positioned. Treatment of postoperative dislocation after THA has been a challenge for surgeons. Many surgeons use a constrained THA to improve stability in patients with a history of hip dislocation. Although constrained liners are felt by some surgeons to be the most definitive form of management for patients with recurrent instability, various designs made by multiple manufacturers are presently available, and these different designs may yield varying success rates in preventing recurrent instability.

Berry *et al* outlined the indications for appropriate usage in patients who are low-demand or without a clear aetiology of the dislocation, in patients who have exhausted other alternatives, and in patients with cognitive or abductor deficiencies (2). The use of constrained components, which use a locking mechanism to capture the femoral head, has increased to help manage this problem. There are two prevailing designs of constrained acetabular systems that have been tested and reviewed in the literature: the ring-lock design by DePuy (S-ROM, DePuy, a Johnson and Johnson Company, Warsaw, IN, USA) (1,5,10) and the tripolar design by Stryker (Omnifit, Stryker-Howmedica-Osteonics, Rutherford, NJ, USA) (7,8,11,12).

Lombardi *et al* (10) used the S-ROM constrained liner in primary and revision THA with a 91% stability rate at 3-year follow-up. Della Valle (5) reported that 9 of 55 hips (16%) sustained a dislocation after S-ROM constrained THA with a mean follow-up of 74 months. Unfortunately, a longer 10-year minimum follow-up of a substantially larger cohort of 755 consecutive cases showed

that the recurrent dislocation rate was 17.5% (1). The Ominifit® constrained acetabular bearing insert has demonstrated excellent results, with a 0-4% dislocation rate and an 8% revision rate reported at up to 5 years (7,8,11,12).

In the present case, the Zimmer Trilogy constrained liner was used. The Trilogy constrained liner is a partially slit design with an uninterrupted inner diameter and a metal alloy reinforcing ring. The inner diameter is 32 mm, and there is a built-in, 10° oblique face. Tufescu and Dust (13) reported 2 failures of a Trilogy constrained acetabular liner due to impingement of the modular femoral head skirt causing disengagement of the reinforcing ring and subsequent dislocation. After the ring had disengaged, the femoral component then dislocated through a lever-out mechanism. A lever-out mechanism has been found to decrease the force necessary to dislocate a similar component to a quarter of that needed for a direct outward pull. The authors recommended avoiding the use of skirted femoral heads with that implant. To the best of our knowledge, no other failure has been reported with this component. In the present study, we investigated the dislocation strength of the Trilogy constrained liner system. The lever-out test showed that the Trilogy constrained liner system is superior to the excellent bipolar Osteonics system. Therefore, the cause of dislocation was probably not implant failure.

In the present case, the ring did not disengage from the polyethylene. As evidenced by the impression on the inner rim of the polyethylene, forces caused by impingement were the main cause for dislocation. Our previous study (9) revealed that the implant should be placed approximately at a 50° angle, the sum of cup and stem anteversion. We also showed that, even if the cup alone or the stem alone is in a proper position, dislocation might occur. In this case, the sum of cup and stem anteversion at the first revision surgery with the Trilogy constrained acetabular liner might have been inadequate, although we could not measure the sum of cup and stem anteversion due to lack of a postoperative CT. However, the sum of cup and stem anteversion at the second operation with the Trilogy constrained acetabular liner was 38°, which was significantly

better than the earlier operation. The improvement of the position of implants is associated with a good clinical course.

In conclusion, forces caused by impingement of the skirt transmitted through the polyethylene probably led to disengagement of the ring in this case, which is similar to the report by Tufescu *et al* (13). The unique aspect of this case is that dislocation occurred even though the polyethylene and reinforcing ring were properly positioned in a solidly fixed metal shell. We concluded that the position of the implant is very important even when the Trilogy constrained liner is used, because neck impingement will result in failure of the component via dislocation of the femoral head. The biomechanical study showed that the Trilogy constrained system is a good replacement system. Surgeons must be aware that constrained acetabular systems are not infallible, and they should pay special attention to place implants in a good position.

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