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Authors

Ordaz, Angel
Schirmers, Joseph
Bini, Stefano

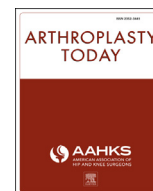
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Case report

Invagination of elevated lip liner preventing reduction of dislocated total hip

Angel Ordaz, BS^{*}, Joseph Schirmers, MD, Stefano Bini, MD

Department of Orthopaedic Surgery, University of California, San Francisco, San Francisco, CA, USA

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ABSTRACT

Instability is the most common indication for revision total hip arthroplasty in the United States. Elevated-rim acetabular liners were introduced to minimize the risk of posterior instability. We describe a patient with multiple total hip arthroplasty dislocations secondary to component subsidence leading to instability. As the patient initially refused revision of his femoral component, he was treated with an elevated-rim acetabular liner. When this too dislocated, the hip could not be reduced concentrically. During operative exposure for a stem revision, the lipped aspect of the liner was found to have folded into the acetabulum thus preventing concentric reduction of the head. We conclude that invagination of the elevated lip of a polyethylene liner should be considered when concentric reduction of a dislocated hip proves difficult.

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Introduction

Total hip arthroplasty (THA) is one of the most successful and cost-effective interventions in orthopedics [1]. Despite its clinical reliability, hip arthroplasty is not without serious complications, one of which being endoprosthesis instability. The dislocation rate of primary THA has ranged from 0.2% to 10% in the literature, with dislocation rates of revision THA being cited as high as 28% [2]. In fact, Bozic et al. [3] retrospectively reported instability and dislocation as the most common cause of THA revision in their study of 51,345 inpatients across the United States. Although contested in the literature, the posterior approach to THA may have the disadvantage of posterior instability secondary to posterior capsule and short external rotator incompetence [4]. In a meta-analysis of studies analyzing the posterior approach with and without posterior soft tissue repair, procedures without the repair had 8 times the risk of posterior dislocation [4]. The elevated-rim acetabular liner

was introduced as a separate biomechanical intervention to reduce the risk of posterior dislocation, with its first use being documented by Sir John Charnley in the 1970s [5]. Theoretically, the augmented segment of the acetabular liner is individually positioned to increase the distance allowed before hip dislocation in the direction prone to instability. Various complications regarding the use of elevated-rim acetabular liners have been described: increased risk of impingement, increased component wear, and an increased risk of component loosening [6,7]. To our knowledge, invagination of a lip-liner precluding closed reduction has yet to be reported in the literature.

Case history

Our patient is a 57-year-old man with a past medical history of morbid obesity, schizophrenia, and polysubstance abuse, who presented to the emergency department with a right prosthetic hip dislocation. Seven months prior to his presentation to the emergency department, this patient had undergone a right THA via a posterior approach for osteoarthritis of the hip (Fig. 1) with a standard 56-mm acetabular cup and 36-mm liner with a 36 mm + 1.5 mm ceramic femoral head (Pinnacle; DePuy, Warsaw, IN) (Fig. 2). The patient was thought to be mentally competent enough to adhere to the posterior hip precautions that were discussed at his index surgery. Although the patient's preoperative body mass index was 43, the increased risk of complications with this weight was

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^{*} Corresponding author. 500 Parnassus Avenue, San Francisco, CA 94142, USA. Tel.: +1 925 207 7213.

E-mail address: angel.ordaz@ucsf.edu

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Figure 1. Preoperative anteroposterior pelvis radiograph demonstrating osteoarthritis of the right hip.

extensively discussed with the patient, and he had followed through with encouragement to lose weight throughout his preoperative appointments. Furthermore, his schizophrenia and drug use were thought to be well controlled preoperatively, and his primary care provider was appropriately managing him with pharmacological treatment. His immediate postoperative course was unremarkable.

Two months postoperatively, he presented for follow-up in the arthroplasty clinic following 3 dislocations and falls in the setting of an exacerbation of his paranoid schizophrenia. The cause of his instability was thought to be associated with subsidence of his stem (Summit; DePuy) that was identified on radiograph. Although the ultimate cause of his subsidence is unknown, we presumed it to be secondary to trauma from multiple ground level mechanical falls the patient had suffered following his surgery. There were no unrecognized fractures that could have contributed to the subsidence and the stem had an excellent press-fit at the index procedure. In retrospect, a lack of sufficient cup anteversion was likely a

significant contributor to this patient's instability, which can be seen in the original postoperative radiograph (Fig. 1). The patient consented to a revision with or without femoral stem exchange depending on our intraoperative findings. Intraoperatively, the stem was found to be stable without evidence of motion even in the setting of instrumentation with a backslapper, and so a limited revision procedure using a longer modular +12 × 40 mm head and an elevated-rim acetabular liner was performed. These revisions were sufficient in restoring the length of the right hip that had been lost with stem subsidence, while avoiding a more extensive femoral stem revision. We considered revising the cup, given its inadequate anteversion, but it was fully ingrown and fixed with a screw with a head that had been sheared off during the index surgery, which would have required burring to remove. Although increasing the anteversion of the cup may have increased stability, an elevated liner was thought to have provided an acceptable hip stability for this patient at the time of the procedure. With the new components, the hip could be ranged to past 90° of flexion with 30° of internal rotation as well as the sleep position without evidence of instability. Although we felt this level of stability to be sufficient for the patient's limited physical needs, we acknowledge that this could have been more fully optimized with increased cup anteversion.

One month later, the patient presented to the emergency department with another right prosthetic hip dislocation. Two days prior to admission, he reported feeling a "pop" associated with pain in his right hip while getting into his car. Clinically, the patient's right leg was shortened and externally rotated. Imaging demonstrated superior lateral dislocation of the right THA (Fig. 3). After multiple failed attempts at closed reduction of the hip in the emergency room, the patient underwent manipulation under anesthesia, but the hip could only be partially reduced (Fig. 4). Furthermore, minimal internal rotation lead to subluxation and the hip was felt to be clinically unstable. The patient was consented for an open reduction and revision surgery and was taken to the operating room the following day.

Intraoperatively, the elevated lip of the acetabular liner was found to have folded into the acetabulum thus precluding a successful closed reduction (Figs. 5 and 6). The stem was revised and the cup was replaced with a modular dual mobility cup and liner (MDM; Stryker, Mahwah NJ). Leg-length equality was established along with soft tissue tension. Intraoperative stability was excellent. No further dislocations have been recorded (Fig. 7). The patient was ultimately discharged to a skilled nursing facility.

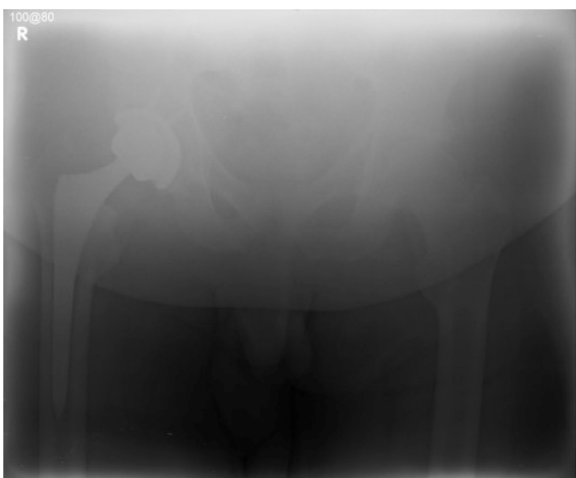


Figure 2. Immediate postoperative anteroposterior pelvis radiograph following initial surgery.

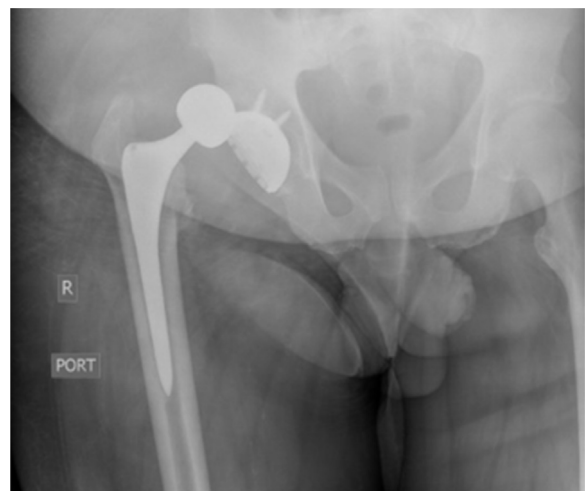


Figure 3. Anteroposterior pelvis radiograph demonstrating lateral superior dislocation of right revision THA.



Figure 4. C-arm film of pelvis following closed reduction under anesthesia demonstrating incomplete radiographic reduction. Clinically, the patient's hip was very unstable necessitating second revision.

Informed consent was obtained from the patient for publication of this case report.

Discussion

Instability of THA results in higher cost and patient morbidity. An inflation-adjusted cost analysis of THA performed at Mayo Clinic from 1997 to 2002 demonstrated that hospital costs of THA that eventually required closed reduction for dislocation were 19% greater than the cost of THA alone, whereas THA requiring revision surgery for instability was 148% greater than the cost of uncomplicated THA [8]. A similar cost analysis of THA in Italy demonstrated that early dislocations after THA were 342% more expensive than THA alone [9]. Although the cost-effectiveness of THA may be offset by the costs associated with complications, the traumatic clinical effect of dislocation on the patient is of equal importance. Multiple dislocations following THA have been shown to be associated with slower gait, decreased single limb support time, and higher mean Western Ontario and McMaster Universities Osteoarthritis Index and 12 Item Short Form Survey scores [10,11]. This detriment to patient functioning was evident in our patient's case, who was afraid to walk during the time of his instability, and will now require more involved therapy to achieve baseline functional status.

Various techniques exist to circumvent or treat instability following THA or revision THA, including an array of acetabular liners with different levels of constraint. Elevated-rim acetabular liners achieved widespread use given their theoretical aid in

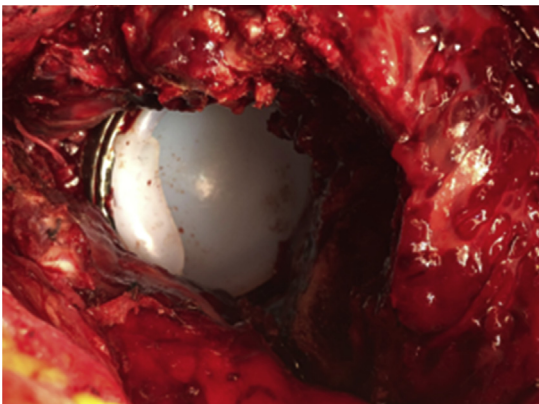


Figure 5. Intraoperative exposure of elevated-rim acetabular liner.

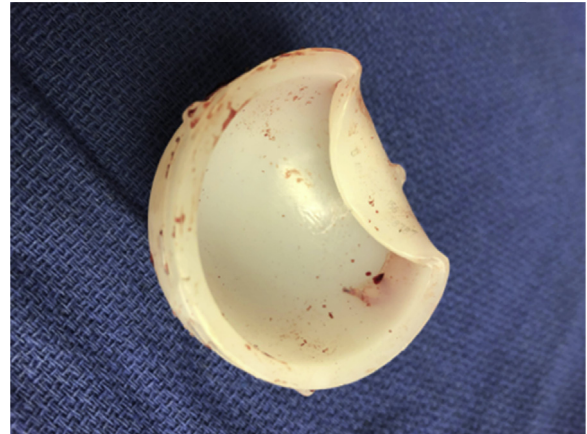


Figure 6. The explanted elevated-rim acetabular liner had folded over on itself, presumably secondary to attempted closed reduction.

decreasing the risk of dislocation. Although such liners biomechanically provide an increase in jump distance in one direction, there is a paucity of high-level prospective evidence establishing clinical benefit. Retrospective evidence does demonstrate some statistically significant associations with a decrease in dislocations. In 1996, Cobb et al. [12] were the first group to critically analyze the relationship between elevated-rim liners and dislocation. Retrospective review of 5167 primary and revision THAs showed the 2-year probability of dislocation to be 2.19% for hips with elevated-rim liner and 3.85% for those without ($P = .001$). A larger difference of 10.03% vs 5.02% ($P = .005$) was seen in revision THAs when analyzed separately from primary THAs. Alberton et al. [13] retrospectively found similar results in an analysis of 1548 revision THAs. In their review, elevated rims decreased the risk of dislocation by 4.6%, which approached statistical significance ($P = .07$). Furthermore, the relative risk for dislocation associated with the nonelevated inserts was 2.2 times that associated with elevated liners. In the 662 revision THAs that required both combined acetabular and femoral revisions, 2.3% of THAs with elevated-rim liners dislocated vs 8% of THAs without elevated-rim liners ($P = .05$). In cases where both acetabular and femoral components are revised, there is additional exposure required which may lead to muscle weakness that would benefit from having an elevated-rim liner in place. Further evidence favoring the benefits of elevated liners was shown by Insull et al.



Figure 7. Postoperative anteroposterior pelvis radiograph of second revision THA with modular stem, and modular dual mobility acetabular cup.

[14] in 2014, when the group analyzed 84,430 primary THAs using the New Zealand Joint Registry. Using a cox regression model, revision for both instability and all other indications was found to be significantly lower in elevated liners, with nonelevated liners being 2.4 times more likely to undergo revision THA for instability. This was true after adjusting for femoral head size, surgical approach, age, and gender. On the contrary, a prospective multicenter comparison of 2107 THA revision hips showed that elevated rims had a higher risk of additional revision for dislocation [15]. This finding may be confounded by the fact that these THA revisions for instability were more likely to dislocate regardless of the liner used. Finally, a meta-analysis on the evidence of risk factors for dislocation after revision THA included 3 studies that analyzed the use of elevated-rim liners and dislocation risk, 2 of which were prospective and failed to show any significant association individually, but had a combinable odds ratio of dislocating of 0.611 (95% confidence interval 0.415–0.898) [16]. Thus, these authors concluded that elevated-rim acetabular liners may decrease dislocation after revision, with the risk of implant dislocation being 1.8 times higher in the nonelevated rim liner groups in this meta-analysis.

Although the retrospective data presented above might suggest a possible association between elevated liners and decreased dislocation rates following primary and revision THA, well-established conclusions cannot be made with this level of evidence given the multiple confounding variables which are unaccounted for. True isolation of the potential benefit of elevated-rim liners would require well-designed prospective controlled trials. In the patient presented in this case, the elevated-rim did not help prevent further dislocation although the primary cause of dislocation may have been inadequate soft tissue tension from a subsided stem in a very large male.

The purpose of the report is to document the invagination of the raised lip as a cause for incomplete reduction of a dislocated total hip. This case presents a unique failure mechanism of elevated-rim acetabular liners. Other concerns about the use of elevated-liners include increased wear rates of components secondary to biomechanical impingement of the neck on the elevated segment. Although a 1993 case report concluded that femoral stem loosening may be due to polyethylene wear debris resulting from impingement on an extended-lip acetabular cup [6], Cobb et al. [17] did not find such a trend in a review of THAs with elevated liners over 5 years. A final concern with elevated lipped liners is the difficulty in reducing a dislocated hip if the head must be pulled the extra distance over the posterior lip. Outside of these practical concerns, there is little literature regarding the negative effects of elevated-rim liners on THA outcomes, and to our knowledge, there is no literature describing the effects of elevated-rim liners on the ability to perform closed prosthetic hip reduction due to an invagination of the elevated segment. The possibility that the elevated lip of such liners may invaginate into

the acetabulum during closed reduction, thus precluding successful reduction, needs to be known and considered.

Summary

To our knowledge, a case of an elevated-rim acetabular liner precluding successful closed reduction and folding over on itself has yet to be reported in the literature. Although the use of acetabular liners is loosely supported by retrospective data, the possible complications associated with their use are poorly reported. Invagination of the lip of the liner needs to be considered when the reduction of a dislocated total hip with a raised liner is being attempted.

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