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Dual mobility acetabular construct with freedom constrained liner for treatment of recurrent dislocations after total hip arthroplasty: A case report and literature review

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ABSTRACT

INTRODUCTION: Recurrent dislocation after total hip arthroplasty (THA) using the dual mobility cup system can present challenges, while dual-mobility THA bearings can improve stability in both primary and revision total hip arthroplasties.
PRESENTATION OF CASE: A 72-year-old woman with a history of schizophrenia underwent a left primary THA using the G7 dual mobility system. Two postoperative posterior dislocations occurred within 2 months post-surgery. The patient underwent revision surgery in which the metal liner and dual mobility head were exchanged using the Freedom constrained liner system without revision of the cup and stem. As of this writing, 28 months after the revision surgery, no further dislocations have occurred. The implants are stable, and the patient has good range of motion.
DISCUSSION: Dual-mobility bearings are utilized to improve stability in both primary and revision total hip arthroplasties, but even if the dual mobility system is chosen, it sometimes fails to prevent postoperative dislocation. Although a relatively high failure rate has been reported in THA using the constrained liner system, this patient's clinical course suggests that the G7 Freedom constrained liner system can be an efficacious option for some patients with unstable hip joints who undergo THA using the dual mobility system.
CONCLUSION: A modern constrained liner system such as the G7 Freedom liner may provide an improved salvage solution for joint instability in dual mobility THA.

1. Introduction

Dislocation is one of the most common complications of total hip arthroplasty (THA) and revision surgeries [1]. A previous survey of more than 250,000 revision cases between 2009 and 2013 in the United States showed that postoperative dislocation had become a significant problem, surpassing aseptic loosening [2]. In particular, patients with altered mental status or neuromuscular disease are at increased risk of dislocation [3]. The dislocation rate can also be related to the surgical approach, component positioning, and type of implant used [4–6]. Revision surgery is usually required after recurrent dislocation. Surgical options to treat instability include inserting a femoral head with a longer neck or larger diameter, repositioning components, adding a dual mobility device, or implanting a constrained liner. Unfortunately, studies have shown recurrence rates of 2%–55% after revision surgery [7,8]. To increase THA implant stability, Bousquet et al. developed the dual mobility (DM) socket in 1974 [9]. The DM socket provides dual articulation, larger jump distance, and greater range of motion before impingement, which significantly reduce the rate of dislocation [10,11]. The rate of dislocation after revision arthroplasties is higher than that for primary THAs, suggesting the potential utility of a DM socket in THA revision surgery for treatment of instability [11], and DM implants are currently selected particularly often for patients at high risk of postoperative instability. Here we report a case of dry revision THA using a constrained liner to treat recurrent dislocation after primary dual mobility THA. The patient was informed that data concerning the case would be submitted for publication, and she provided consent. This work has been reported in line with the SCARE criteria [12].

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Fig. 1. (**A**) The G7 dual mobility acetabular system (ZimmerBiomet, Inc, Warsaw, IN) device includes a vitamin-E infused highly crosslinked polyethylene outer head and Delta ceramic inner femoral head. The titanium alloy acetabular cup is a 3D porous cup with a mean pore size of 475 microns, 70% porosity, and a coefficient of friction of 1.25. A multi-hole design for the acetabular cup was used in this case.

2. Case history

A 72-year-old woman with a history of schizophrenia underwent left primary THA (posterior approach) to treat a subchondral insufficiency fracture of the left femoral head by the senior author (KF). She had previously undergone right THA 8 years previously and right total knee arthroplasty 2 years previously. Her past medical, drug and social history was unremarkable.

Studies have shown a higher-than-average risk of postoperative dislocation in patients with psychiatric disease [13,14]. To reduce this risk, we selected a G7 dual mobility system (50 mm multi-hole cup, 40 mm outer-head; vitamin-E infused crosslinked polyethylene, 28 mm inner-head; Delta ceramic, Taperloc 123° #11 cementless stem, ZimmerBiomet, Warsaw, IN, USA) (Figs. 1 and 2A).

At the time of the patient's right THA, the dual mobility system was not yet available in Japan, and a conventional liner was used. Unfortunately, postoperative dislocation occurred twice within 2 months after that surgery (Fig. 2B). Both posterior postoperative dislocations occurred when the patient moved her hip toward deep flexion and internal rotation in the process of getting up from her futon bed on the floor. In both cases, the patient received conscious sedation, and the dislocation was reduced by manipulation. Post-reduction fluoroscopy showed successful concentric reduction without complications each time. However, after the second occurrence, revision surgery was scheduled to prevent a potential third dislocation.

Implant alignment was acceptable, with the cup showing radiographic anteversion of 31°, radiographic inclination of 41°, anatomical anteversion of 45°, operative anteversion of 44°, and stem anteversion of 19° (Fig. 3A–E). We planned dry revision surgery to exchange both the liner and head. No stem replacement was required because the G7 Freedom constrained liner was compatible with the previously implanted Taperloc cementless stem.

During surgery, the metal liner of the G7 dual mobility construct was easily removed by tapping on the edge of the cup (Fig. 4A, B), and the G7 cup and the Taperloc stem were well fixed to the bone. We inserted two additional screws into the empty holes of the G7 cup to reinforce the cup and reduce the risk of cup loosening during movements that increased torque applied by the constrained liner system. We then embedded the Freedom constrained liner in the G7 cup and placed the uniquely shaped Co-Cr metal head on the femoral neck of the original stem (Fig. 4C–F). The neck length of the stem was extended by 7 mm. The surgery lasted 75 min and involved intraoperative blood loss of 120 mL. Postoperative radiographs obtained 28 months after the revision surgery showed the implants were stable (Fig. 2C). The patient recovered without incident, and remained asymptomatic with no further episodes of instability as of 28 months after the revision surgery. The range of motion (ROM) in her left hip was good: flexion 110°, abduction: 30°, external rotation 30°, internal rotation 15° (Fig. 5A–D).

3. Discussion

Post-THA dislocation is a challenging multifactorial complication with multiple treatment options [15,16]. One such option involves the use of dual-mobility bearings, which are known to improve stability in both primary and revision THA [17–19]. Terrier et al. suggested that dual mobility implants provided the greatest ROM before the risk of impingement and had a lower risk of subluxation and dislocation than standard and constrained implants in finite element analysis [20]. A literature review has shown 1.1% incidence of intra-prosthetic dislocation, 0.46% incidence of extra-articular dislocation, 98.0% survivorship for the dual mobility acetabular components, and mean time before revision of 8.5 years (2–16.5) after primary THA [21]. That review concluded that dual mobility articulations are excellent alternatives to traditional bearing surfaces because the dual mobility articulations provide less instability and better overall survivorship in primary and revision THA. The dual mobility cup has also shown satisfactory long-term results [22]; the Dutch arthroplasty register shows a 3-fold increase in use of the dual-mobility cup from 2010 to 2016, with 8 different

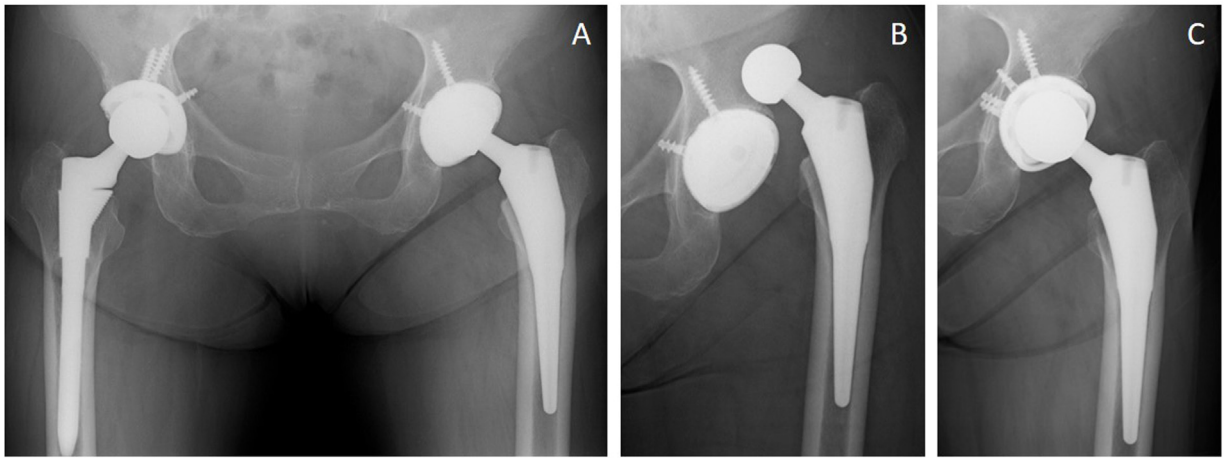

Fig. 2. (**A**) Postoperative radiographs obtained immediate after left total hip arthroplasty. (**B**) Plain radiograph showing postoperative posterior dislocation just one month after surgery. (**C**) Postoperative radiographs obtained 28 months after dry revision hip arthroplasty. Both retaining cup and stem remained stable.

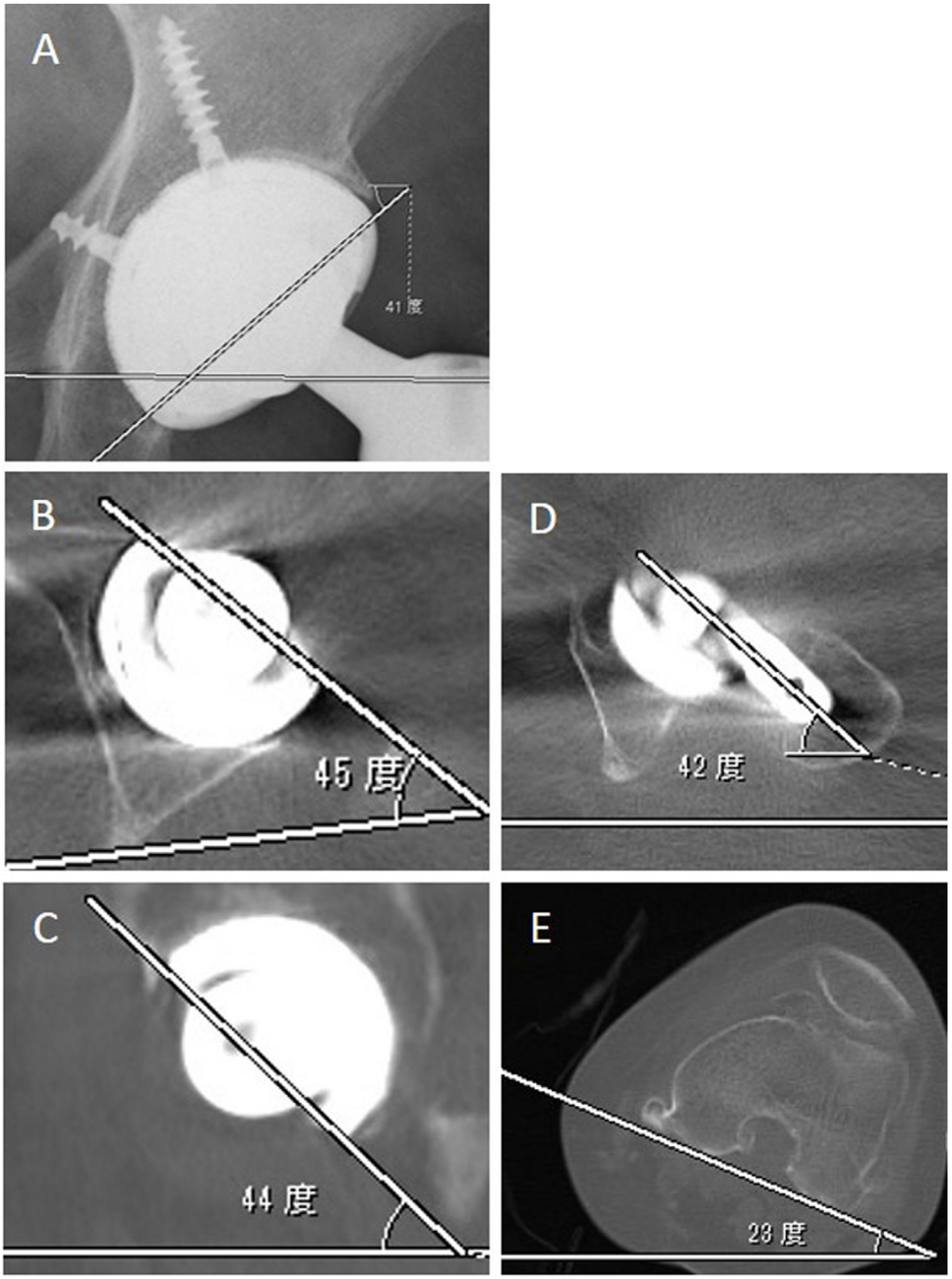

Fig. 3. Evaluation of the implant alignment (**A**) Radiographic inclination of the cup (**B**) Anatomical anteversion of the cup (**C**) Operative anteversion of the cup (**D,E**) Anteversion of the stem.

types of dual mobility cup commercially available [23]. Recurrent extra-articular dislocation without dissociation of the polyethylene outer head from the inner femoral head is relatively rare because the large femoral head increases the primary arc range and lever range by providing a maximized head-neck ratio and considerable excursion distance, which protect from dislocation [24]. However, Addona et al. reported a relatively high rate of postoperative dislocation (4.55%) in patients who were treated with the G7 dual mobility system, although these findings may reflect a particularly high risk of postoperative dislocation in the patients participating in that study [25]. Hernigou et al. suggested treating recurrent extra-articular dislocation without dissociation of the polyethylene outer head from the inner femoral head with iterative dual-mobility arthroplasties or constrained liners [24]. Fortunately, our patient showed good alignment of the G7 cup and the TaperLoc stem, and the Freedom liner was compatible with the Taperloc stem, possibly because both components were manufactured by the same company. We thus chose a dry revision with the Freedom constrained liner.

A number of constrained implants have been designed to increase ROM without component impingement. The constrained Longevity (Zimmer Biomet) liner improves ROM in areas of impingement by placing liner cut-outs in focal areas of constraint. This design has a dislocation failure rate between 3% and 19% [26,27]. Other promising types of constrained implant use a bipolar or tripolar articulation to improve ROM before impingement. Shrader et al. used a bipolar constrained mechanism in 110 hips with no dislocation failures within 2.9 years, on average, after the revision THA [28]. Long-term studies of that same device revealed a dislocation rate of 2.4% and a revision rate of 8.2% after an average of

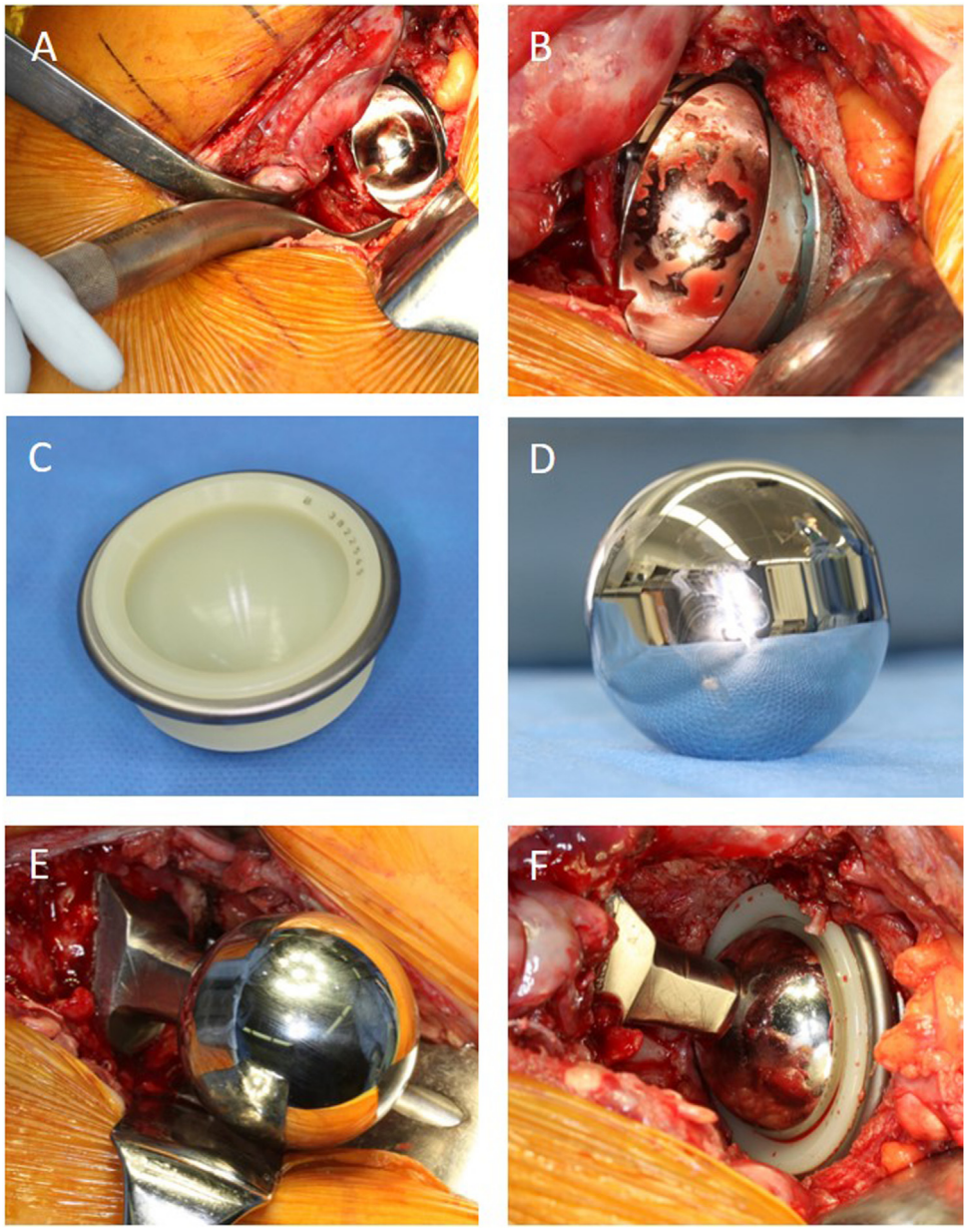

Fig. 4. (**A**) Intraoperative image showing removal of the metal liner by tapping the edge of the cup. (**B**) The metal liner was easily removed from the cup. (**C**) The Freedom constrained liner (Zimmer Biomet, Inc, Warsaw, IN) system comprises a highly crosslinked polyethylene liner and (**D**) 36-mm cobalt chromium modular femoral head. The unit has a flat equatorial section at 15° to the vertical axis along the sides. (**E**) The unique 36-mm cobalt chromium head was compatible with the retaining stem; both stem and head were manufactured by the same manufacturer. (**F**) Intraoperative image after reduction.

58 months [29]. Overall, a relatively high failure rate was reported for constrained liners [30–33]. Therefore, we have not considered a constrained liner as a first choice for unstable hip in primary and revision THA.

The Freedom constrained liner system is intended to be used specifically in patients at high risk for dislocation because of localized muscle weakness, hip joint structure, or previous dislocations. The system has a flat equatorial section 15 degrees from the vertical axis, along the sides of the Freedom liner and the 36-mm modular chrome–cobalt head (Fig. 3D). The acetabular liner is used with both primary and revision acetabular components because it can be locked into a standard locking mechanism.

In one of the few studies available on the Freedom constrained liner system 105 patients were treated with the Freedom liner: dislocation failure occurred in 0% of primary preventive hip replacements, 7.7% of preventive revisions, and 4.8% of patients treated for a history of dislocation, and a 5.7% mechanical failure rate was noted overall at 2.5-year follow-up [34]. Another study of 177 hips treated with the Freedom liner showed dislocations in 6.2% of hips and revision for aseptic acetabular loosening at 7.1-year follow-up in 7.3% [35].

Our patient experienced no further dislocation and no implant loosening, and ROM was satisfactory at 28-month follow-up.

One limitation of the Freedom system is that its unique metal head is only compatible with the stem manufactured by ZimmerBiomet company, so primary THA well-fixed stems that are manufactured by other companies cannot be used with the Freedom system. Given that limitation, however, our findings suggest that dry revision using the G7 constrained liner may be a good salvage option for instability after dual-mobility total hip arthroplasty.

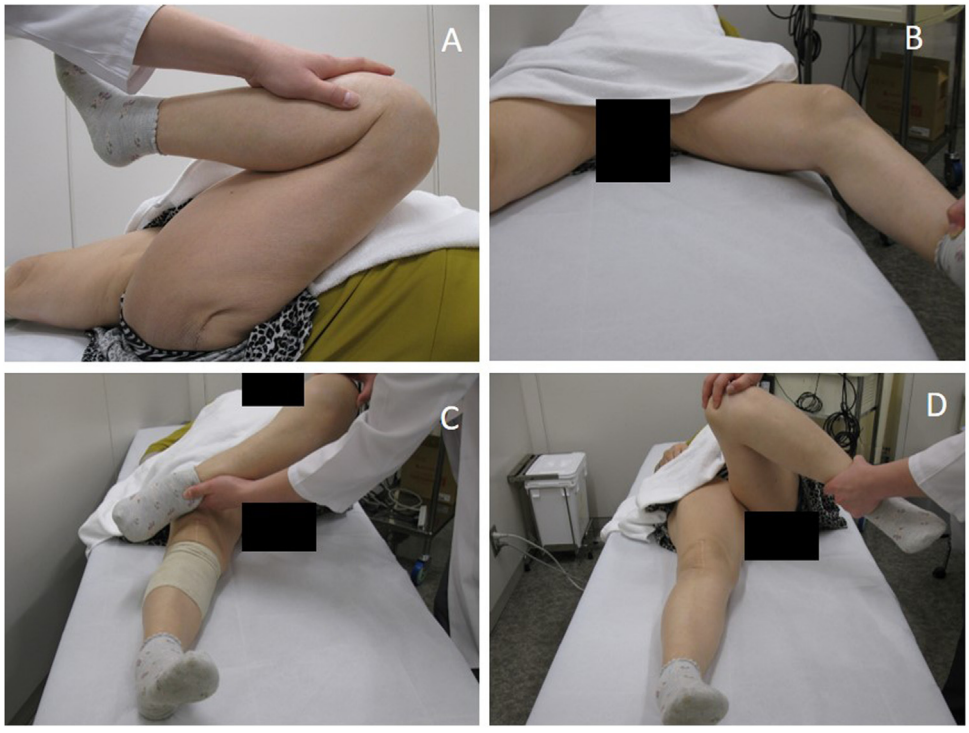

Fig. 5. Range of motion of the left hip at most recent follow-up **(A)** Flexion (**B**) Abduction (**C**) External rotation (**D**) Internal rotation.

Declaration of Competing Interest

The authors report no declarations of interest.

Sources of funding

None.

Ethical approval

Case reports are exempt from the need of IRB approval in our institute.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Conceptualization, Writing of manuscript, Literature review: Kiyokazu Fukui, Yuuki Onochi.
Data collections: Kiyokazu Fukui, Yuuki Onochi, Xipeng Wang.
Data analysis: Kiyokazu Fukui, Yuuki Onochi.
Reviewing of the final version of the manuscript: Kiyokazu Fukui, Ayumi Kaneuji, Toru Ichiseki, Norio Kawahara.

Registration of research studies

NA.

Guarantor

Kiyokazu Fukui.

Note

Each author certifies that he has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements) that might pose a conflict of interest in connection with the submitted article. Each author certifies that his institution approved the reporting of this case and that all investigations were conducted in conformity with ethical principles of research.

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