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Dislocation and Iatrogenic Dissociation of Bipolar Hip Hemiarthroplasty: A Case Series and Literature Review

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Learning Point of the Article:

Iatrogenic dissociation of bipolar hemiarthroplasty during closed reduction is a rare but serious complication, stressing the need for careful patient assessment and precise technique.

Abstract

Introduction: Bipolar hemiarthroplasty (BHA) is widely used for femoral neck fractures, particularly in elderly patients. However, complications such as the rare dissociation of the bipolar cup can severely impact outcomes. This study aims to investigate iatrogenic BHA dissociation following closed reduction, identify risk factors, and discuss preventive strategies.

Material and Methods: A retrospective study was conducted on patients who underwent BHA for femoral neck fractures at our institution between 2019 and 2024. Included patients had a minimum post-operative survival of 3 months. Parameters analyzed included demographics, comorbidities, implant design, dislocation characteristics, and revision procedures.

Results: Among 490 patients who underwent BHA, 64 dislocation episodes were identified. The incidence of component dissociation related to closed reduction was 20.3%, representing 13 iatrogenic cases. One patient experienced two episodes of dissociation. The mean Charlson comorbidity index was 6.0, indicating a high comorbidity burden. All dissociations involved implants with a single circumferential polyethylene locking ring. The "O-shape sign" was evident in nine cases. Revision procedures included total hip arthroplasty, open reduction with component replacement, or Girdlestone resection arthroplasty.

Conclusion: Iatrogenic dissociation of BHA following closed reduction, though rare, represents a serious complication with significant clinical implications. This study highlights the critical role of implant design, particularly single locking mechanisms, in increasing dissociation risk. Careful pre-reduction assessment, use of fluoroscopic guidance, and awareness of radiographic risk signs are vital to prevention. Multidisciplinary management addressing frailty and comorbidities is essential for optimizing outcomes.

Keywords: Bipolar hemiarthroplasty, dissociation, dislocation, closed reduction, polyethylene locking ring.

Introduction

Hip hemiarthroplasty (HA) is a well-established surgical treatment for femoral neck fractures, particularly in the elderly. Despite evolving articles that increasingly favor total hip arthroplasty (THA) for more active patients [1,2], HA remains a preferred option for those with lower functional demands. While HA is associated with a higher reoperation rate, it offers a lower reported risk of dislocation compared to THA [3]. Among HA complications, dislocation is uncommon but significantly impacts morbidity, quality of life, and mortality. Higher dislocation rates have been observed in patients with pre-operative acetabular dysplasia, suggesting they may be better

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candidates for THA [4].

The debate between unipolar and bipolar HA (BHA) remains unresolved, with some evidence suggesting that bipolar implants may offer advantages in delaying acetabular wear and improving quality of life beyond the first 2 years after surgery [5, 6, 7], whereas others have shown no differences in hip function, complications, and dislocation risk [8, 9]. Notably, BHA designs have been associated with a lower revision rate than unipolar implants, though unipolar HA may be justified for patients with a limited life expectancy (<2.5 years) [10]. A rare but serious complication is dissociative BHA dislocation, where the inner femoral head separates from the outer acetabular cup. The most common cause reported is spontaneous dissociation (48.6%) without preceding trauma. However, trauma-related cases (18.1%) have also been noted, as well as iatrogenic cases (26.4%) following closed reduction maneuvers [11]. The consequences of this complication can be severe, often requiring revision surgery and substantially affecting patient outcomes.

Given the rarity and clinical significance of this complication, this study aims to contribute to the existing literature by presenting thirteen cases of bipolar cup dissociation occurring after closed reduction of a dislocated prosthesis, in the absence of mechanical failures. In addition, we provide a comprehensive literature review to enhance understanding of this uncommon yet critical issue.

Materials and Methods

The study protocol was approved by the institutional ethics committee (IEC No. 23/2025; approval date: June 25, 2025), and the requirement for informed consent was waived.

We conducted a retrospective descriptive review of all patients who underwent BHA for femoral neck fractures at our institution between 2019 and 2024. Inclusion criteria encompassed patients with a minimum post-operative survival of 3 months and documented post-operative dislocation followed by closed reduction attempts complicated by implant component dissociation. Exclusion criteria included prosthetic mechanical failures unrelated to reduction maneuvers and incomplete clinical records.

Data collected comprised demographics, comorbidities, implant design details, time to dislocation, mechanism of injury leading to dislocation, radiographic characteristics focusing on dislocation morphology, and details of revision surgeries.

Descriptive statistics were applied to clinical and radiological data.

Results

During the study period, a total of 514 BHA were performed. After applying the inclusion criteria, 490 BHAs were included in our analysis. Hip dislocation occurred in 33 patients (6.7%), some of whom experienced multiple episodes, resulting in 64 dislocation events (13.1%). The mean time to first dislocation

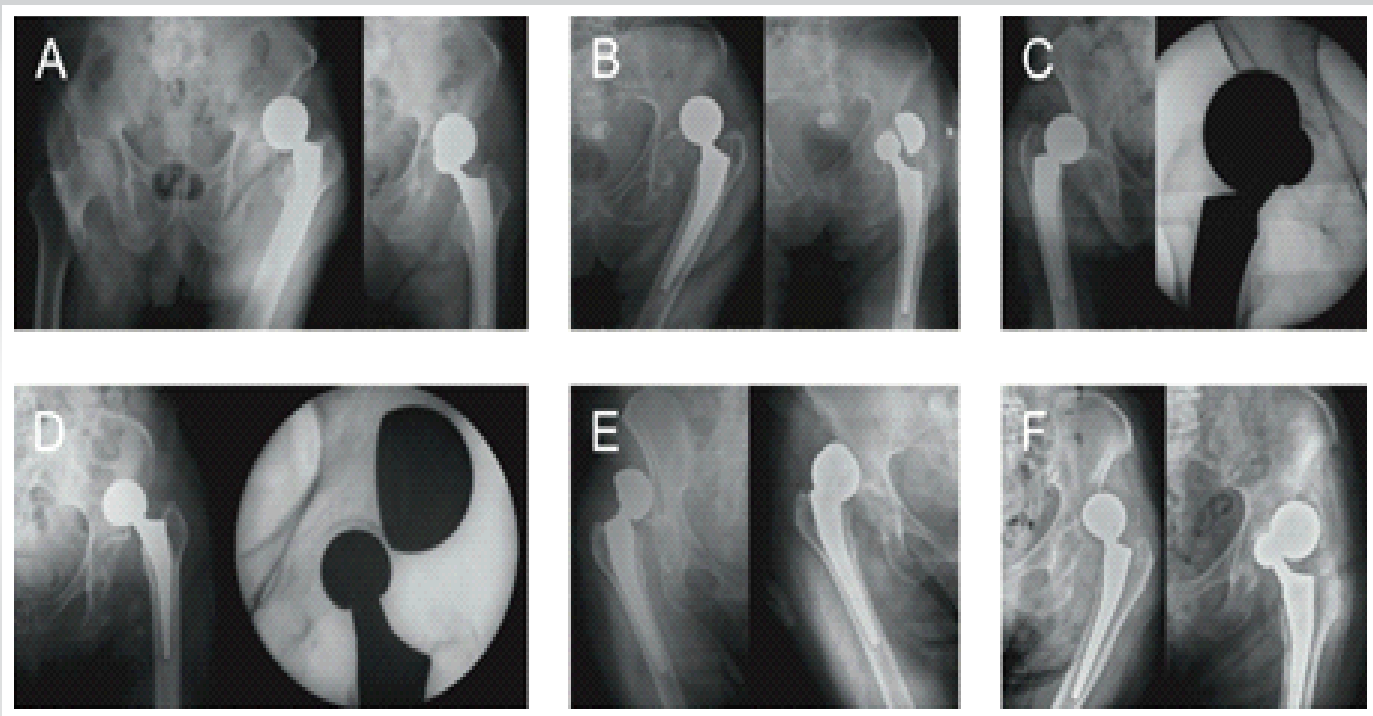

Figure 1: Pre-reduction dislocation and associated dissociation after closed reduction. (a, b, c) The spherical shape of the acetabular cup, the "O-Shaped" sign. (d, e, f) The elliptical shape of the acetabular cup.

was 19 days postoperatively. Among these, 13 cases (20.3%) developed iatrogenic dissociation of the acetabular cup following the close reduction. One patient had two episodes of dissociation. Table 1 summarizes the patient demographics, comorbidities, prosthetic details, dislocation characteristics, and management strategies.

Analysis of the clinical backgrounds of patients experiencing BHA dissociation revealed common demographic and medical traits linked with increased risk. The cohort consisted mainly of elderly patients (mean age 78.4 years), most of whom had significant functional dependence and resided in long-term care facilities. Cardiovascular comorbidities – including hypertension, ischemic heart disease, and congestive heart failure – were highly prevalent, and advanced respiratory disease, such as chronic obstructive pulmonary disease, was present in four patients. Neurological impairments were frequent, with Parkinson's disease diagnosed in 5 patients (45%), dementia in 4 (36%), and prior cerebrovascular accidents resulting in residual hemiparesis in two. The mean Charlson comorbidity index (CCI) of 6.0 indicates a high burden of chronic conditions.

All cases were performed using a posterolateral surgical approach and involved bipolar head prostheses with a single circumferential polyethylene locking ring. The femoral head was 28 mm, and the bipolar acetabular cup diameter ranged from 42 to 52 mm, with the neck length ranging from S to L.

The mean time to dislocation was 4 weeks post-surgery, with 12 cases showing posterior-up dislocations. Notably, in nine patients, dissociation occurred during the first episode of dislocation. Pre-reduction radiographs exhibited a spherical or "O-shaped" acetabular cup in nine cases (Fig. 1), previously thought to predict successful closed reductions. No fluoroscopic imaging was utilized during closed reduction procedures, which were performed using conventional maneuvers under sedation and muscle relaxation.

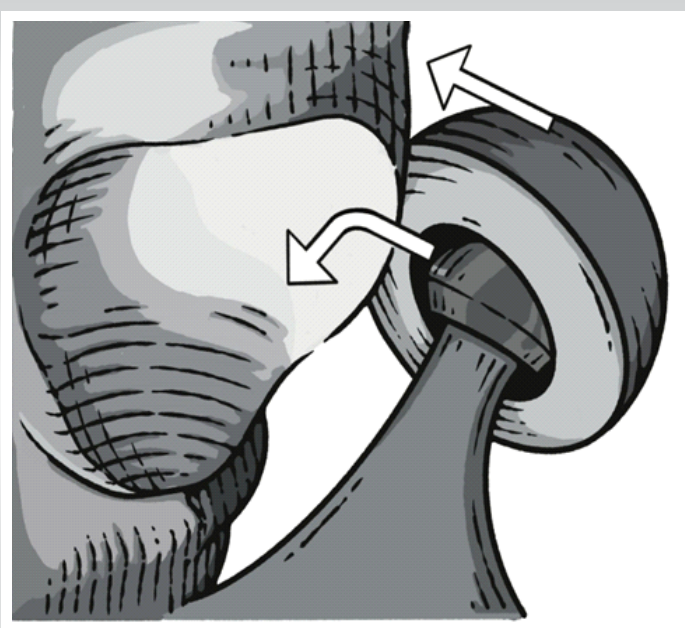

Figure 2: "Bottle opener effect" illustration. The posterior acetabular rim acts as a fulcrum during traction, locking the cup and levering it away from the femoral head, which predisposes to component dissociation.

Revision procedures included constrained or semi-constrained THA (five cases), open reduction and replacement with the same size acetabular cup and femoral head ± a longer femoral neck (six cases), and Girdlestone resection arthroplasty (one case). Functional outcomes varied, with some patients regaining functional mobility while others required prolonged rehabilitation.

Discussion

Guo et al. classified BHA dissociation into three types based on etiology. Type I, iatrogenic dissociation, occurs during closed reduction due to mechanical failure – commonly described as the "bottle opener effect," in which the posterior acetabular rim acts as a fulcrum, forcing the cup away from the femoral head (Fig. 2). Type II, polyethylene insert erosion, results from chronic wear that weakens the locking ring. Type III, spontaneous dissociation, arises from progressive intra-acetabular dislocation [12].

This study highlights iatrogenic BHA dissociation (Type I) following closed reduction and presents, to date, the largest number of reported cases of iatrogenic dissociation (Table 2), surpassing prior reports such as Lee et al. 13% (7/55 dislocations) [13]. Our findings emphasize the critical role of patient comorbidities, implant design, reduction techniques, and radiographic predictors in preventing dissociation and improving patient outcomes.

Patient comorbidities

Our findings highlight that patients experiencing BHA dissociation form a highly vulnerable group characterized by advanced age and significant functional dependence, frequently living in long-term care facilities. The mean CCI score of 6.0 in our cohort reflects a substantial burden of comorbidities.

Neurological disorders, such as Parkinson's disease, dementia, previous cerebrovascular events with residual impairments, and cognitive dysfunction, are increasingly recognized as independent and potent predictors of BHA instability, as evidenced by recent multivariate analyses [27,28]. These neurological deficits impair motor coordination and amplify fall risk, thereby contributing crucially to the mechanical instability that predisposes to implant dislocation.

Table 1 : Detailed clinical and surgical data of patients who experienced dissociation after bipolar hip hemiarthroplasty

Sex	Age (years)	CCI scale	Cup size (mm)	Femoral head size (mm)	Neck length	Number of dislocations	Time after BHA	Dislocation type	Shape of cup in RX	Treatment after dissociation	Status after revision
M	86	9	52	28	L	1°	2 weeks	Posterior	Elliptical	Conversion to THA with a constrained acetabulum	Walking with support
M	91	5	52	28	L	1°	2 weeks	Posterior-up	Spherical	Conversion to THA	Walking with support
F	79	5	44	28	S	2°	5 days	Posterior-up	Elliptical	Conversion to semi-constrained THA	Independent ambulation
F	87	8	42	28	M	1°	4 weeks	Posterior-up	Spherical	Open reduction	Walking with support
F	68	8	45	28	S	1°	3 weeks	Posterior-up	Elliptical	Girdlestone operation	Walking with support
F	87	5	48	28	S	1°	2 weeks	Posterior-up	Spherical	Open reduction with a longer femoral neck	Walking with support
			48	28	M	2°	2 weeks from 2º surgery	Posterior-up	Spherical	Dead before revision surgery	-
F	84	5	47	28	M	3°	6 weeks	Posterior-up	Elliptical	Open reduction	Walking with support
M	91	7	51	28	L	1°	3 days	Posterior-up	Spherical	Conversion to THA with dysplastic polyethylene liner	Walking with support
M	79	5	47	28	S	1°	1 week	Posterior-up	Spherical	Open reduction with a longer femoral neck	Fully dependent
M	83	5	54	28	M	1°	6 months	Posterior-up	Spherical	Open reduction	Independent ambulation
F	80	6	46	28	M	2°	2 weeks	Posterior-up	Spherical	Conversion to semi-constrained THA	Walking with support
M	80	5	48	28	M	1°	1 week	Posterior-up	Spherical	Open reduction	Periprosthetic Infection with BHA extraction

The columns include patient demographics (patient number, sex, and age), CCI: Charlson comorbidity index, implant characteristics (bipolar cup size, femoral head size, neck length), number of dislocation episodes, time elapsed since BHA, shape of bipolar cup in RX before reduction, treatment, and functional status after revision surgery. One patient had two episodes of dissociation. THA: Total hip arthroplasty, BHA: Bipolar hemiarthroplasty, Sex: M: Male, F: Female, Neck Length: L: Long, S: Short, M: Medium

Role of implant design

Bipolar implants utilize either single or dual locking mechanisms to secure the femoral head within the outer metal shell. Single-lock designs rely on a polyethylene ring that expands into a groove within the polyethylene liner, whereas dual-lock designs incorporate an additional metal locking ring for enhanced stability.

Our study exclusively involved prostheses featuring a single circumferential polyethylene locking ring. Although somewhat outdated, these implant designs remain clinically relevant as they are still widely implanted globally, particularly in regions with limited access to newer prosthetic technologies. Lee et al. previously highlighted this single locking mechanism as a factor potentially increasing dissociation risk during closed reduction by concentrating stress on the polyethylene ring instead of distributing it across a dual locking system [13].

Ozan et al. classified BHA cups into three design types. Type 1 features a polyethylene insert integrated with the metal acetabular shell; Type 2 includes a single circumferential polyethylene locking ring, as used in our cases; and Type 3 combines a polyethylene locking ring with a conical metal shell. Their study used cam-out and pull-out tests to simulate forces that might cause dissociation during clinical procedures. The cam-out test measures how rotational and axial forces can displace components, whereas the pull-out test assesses the force needed to separate the femoral head from the acetabular component [26].

Type 2 implants showed greater vertical displacement before release in cam-out tests compared to Types 1 and 3, suggesting better resistance during closed reduction maneuvers. However, despite this biomechanical strength, clinical dissociations still occurred in our study, likely because of additional levering

forces during closed reductions – known as the "bottle opener" effect – which are not replicated in static tests. Therefore, although Type 2 implants show superior vertical displacement resistance in controlled testing, they remain vulnerable under the complex dynamic forces involved in actual reduction maneuvers.

Radiographic predictors of dissociation

The "O-shape sign" on pre-reduction radiographs has been suggested as an important predictor of closed reduction success. Sim et al. reported that a concentric "O"-shaped femoral head and cup on anteroposterior views correlates with successful closed reduction, whereas an elliptical appearance is associated with dissociation risk [24].

In our study, however, nine out of thirteen cases displayed spherical form or the "O-shape sign" yet still experienced dissociation, indicating that while this radiographic finding may suggest an optimal reduction trajectory, it is not a fail-proof predictor of stability.

Alternative reduction techniques

To minimize the risk of iatrogenic dissociation, Bian et al. proposed a modified reduction technique known as the "Push-Turnover-Pull" maneuver. This approach helps prevent excessive leveraging forces on the polyethylene ring, thereby reducing the likelihood of dissociation. In addition, in cases where resistance is encountered, dynamic fluoroscopic imaging should be utilized to guide reduction and confirm the integrity of the components [20].

Once dissociation occurs, management must be tailored to the patient's specific needs, considering acetabular integrity, functional status, and the surgeon's expertise. In our study, revision strategies included open reduction and component replacement, where the acetabular cup and femoral head were replaced with components of the same size to ensure proper engagement of the locking mechanism. In cases requiring additional stability, a longer femoral neck was used to improve joint mechanics. Conversion to THA was preferred for patients at high risk of recurrent instability, with both constrained and non-constrained liners considered based on the individual patient's needs. Girdlestone resection arthroplasty was reserved for low-demand patients with limited mobility, severe comorbidities, or cases deemed non-reconstructable, offering pain relief at the expense of hip function.

Cases of failed BHA converted to THA demonstrated improved pain relief and function, with perioperative complications comparable to standard revision THA procedures [29, 30]. In addition, optimizing soft-tissue tension and, when necessary, utilizing a longer femoral neck (offset) contributed to joint

Table 2: Case reports in the literature of BHA iatrogenic dissociation secondary to close reduction after dislocation

Study	Number of cases	Mechanism of dislocation	Time from BHA
Georgiou *et al* . (2006) [14]	2	Sitting up, kneeling, mobilization out of bed	Ranging from weeks to years
Figved *et al* . (2006) [15]	1	-	-
Salvi (2014) [16]	1	-	-
Moriarity *et al* . (2015) [17]	1	Falls from standing height	4 weeks
Lee *et al* . (2016) [18]	2	Standing from a low seat	3–5 weeks
Uruç *et al.* (2017) [19]	2	Daily activities	6 weeks to 3 months
Lee *et al* . (2018) [13]	7	-	2 weeks to nearly 3 years
Bian *et al* . (2019) [20]	4	Falls from bed, sitting up, standing height	2 days to 6 weeks
Fan *et al* . (2020) [21]	2	-	3 months
Saini *et al* . (2020) [22]	1	Mobilization out of bed	3 weeks post-surgery
Sevinç (2021) [23]	1 (Alzheimer's disease)	-	Nearly a year post-surgery
Sim *et al* . (2023) [24]	1	Mobilization out of bed	3 months post-surgery
Mitchell *et al* . (2024) [25]	1 (Parkinson's disease)	Standing from a low seat	2 months
Ozan *et al* . (2025) [26]	4	Falls from standing height	1 month to 20 years

BHA: Bipolar hemiarthroplasty

stability and helped reduce the risk of further dislocations.

The use of unipolar HA remains a topic of discussion, particularly considering the risk of dissociation associated with BHA. While bipolar prostheses may offer reduced acetabular wear, the need for surgical intervention in cases of dissociation can offset this advantage. Given this risk, some authors suggest opting for unipolar prostheses in certain cases to minimize future complications [25].

Conclusion

This study highlights the significant clinical issue of iatrogenic dissociation following closed reduction of dislocated BHA, with an incidence of 20.3% in a cohort of 64 BHA dislocations. The vulnerability of patients with multiple comorbidities, advanced age, and neurological impairments must be recognized as a key contributor to prosthetic instability.

All of the cases involved prostheses with a single circumferential polyethylene locking ring, underscoring the critical influence of implant design on dissociation risk. While biomechanical testing suggests Type 2 prostheses (single locking ring) demonstrate superior resistance to simple cam-out forces compared to other designs, clinical evidence may reveal vulnerability to levering forces described as the "bottle opener" effect during dynamic reduction maneuvers.

To minimize dissociation risk, surgeons should employ gentle, controlled reduction techniques such as the Push-Turnover-Pull maneuver and use dynamic fluoroscopic imaging for real-time guidance. Radiographic predictors such as the O-shape sign may guide reduction attempts but are insufficient alone to guarantee stability. In instances where resistance is encountered during reduction, proceeding directly to open reduction may be the safest approach.

Pre-operative comprehensive assessments of frailty, comorbid diseases, and neurological status are paramount for optimizing outcomes.

Further research is warranted to refine prosthetic designs and reduction techniques, focusing on enhancing patient safety and minimizing complications in this fragile population.

Limitations

This retrospective single-center study has limitations, including: No control group, descriptive statistics only, heterogeneous unstratified comorbidities, non-standardized reductions or surgeon experience, single polyethylene locking rings (no dual-locking comparison), absent biomechanical/radiographic analyses, no validated long-term functional/patient-reported outcome measures, and limited external validity for modern bipolar systems with improved locking mechanisms. Although our series represents one of the larger cohorts of iatrogenic bipolar dissociations reported to date, the absolute number of dissociation events (13 cases) remains relatively small and precludes more definitive conclusions or robust hypothesis testing.

Clinical Message

When reducing a dislocated BHA in high-risk patients, clinicians should avoid forceful traction and use fluoroscopic or modified maneuvers to limit the "bottle opener effect" to minimize the risk of catastrophic component dissociation and the need for complex revision surgery.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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