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Outcome and risk factors of failures associated with revision total hip arthroplasty for recurrent dislocation

Christian Klemt[1] · Wenhao Chen[1] · Georges Bounajem[1] · Venkatsaiakhil Tirumala[1] · Liang Xiong[1] · Young-Min Kwon[1]

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Abstract

Introduction Recurrent dislocation represents the third most common cause of revision surgery after total hip arthroplasty (THA). However, there is a paucity of information on the outcome of revision total hip arthroplasty for recurrent dislocation. In this study, we investigated (1) clinical outcomes of patients that underwent revision THA for recurrent dislocation, and (2) potential risk factors associated with treatment failure in patients who underwent revision total hip arthroplasty for recurrent dislocation.

Methods We retrospectively reviewed 211 consecutive cases of revision total hip arthroplasty for recurrent dislocation, 81 implanted with a constrained liner and 130 with a non-constrained liner with a large-diameter femoral head (> 32 mm). Patient- and implant-related risk factors were analyzed in multivariate regression analysis.

Results At 4.6-year follow-up, 32 of 211 patients (15.1%) underwent re-revision surgery. The most common causes for re-revision included infection (14 patients) and dislocation (10 patients). Kaplan–Meier analysis demonstrates a 5-year survival probability of 77% for patients that underwent revision THA for recurrent dislocation. Osteoporosis, obesity (BMI ≥ 40), spine disease and abductor deficiency are independent risk factors for failure of revision surgery for recurrent dislocation. Liner type (constrained vs. non-constrained) was found not to be associated with failure of revision THA for recurrent dislocation ($p = 0.44$).

Conclusion This study suggests that THA revision for recurrent dislocation is associated with a high re-revision rate of 15% at mid-term follow-up. Osteoporosis, obesity (BMI ≥ 40) spine disease and abductor deficiency were demonstrated to be independent risk factors for failure of revision THA for recurrent dislocation.

Level of evidence Level III, case–control retrospective analysis.

Keywords Revision · Total hip arthroplasty · Constrained liner · Outcome · Dislocation

Introduction

Dislocation is one of the most common complications after total hip arthroplasty (THA), often requiring additional revision surgery. The reported rate of hip dislocation ranges from 0.5 to 3% in primary surgery and to up to 11% in revision total hip surgery [1]. Therefore, managing recurrent dislocations, defined as 2 or more episodes of dislocation, remains a notable clinical challenge [2]. Additionally, recurrent dislocation represents the most common cause of early revision surgery. Prior literature has identified numerous risk factors for recurrent dislocation to include: component malpositioning, soft-tissue imbalance, surgical approach, surgeon volume, implant design, bone loss of the proximal femur or the acetabulum, as well as abductor insufficiency [3–5]. Additionally, a prior study showed an increased risk of dislocation following isolated exchange of the polyethylene liner due to wear [6].

There are several surgical options for addressing instability in revision THA, including revision of a mal-positioned component [7], use of a larger femoral head [8], the advancement of the trochanter and abductor complex [9], and acetabular conversion to a constrained cup or dual mobility design [10, 11]. The use of a constrained liner is thought to be one of the established methods to improve stability in revision THA [12]. These liners maintain the femoral head within the

✉ Young-Min Kwon
ymkwon@mgh.harvard.edu

[1] Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, 55 Fruit Street, Boston, MA 02114, USA

acetabular component via a locking mechanism. However, potential disadvantages of constrained liners include reduced range of motion and increased stress on the bone-implant interface leading to early aseptic loosening [13]. Numerous studies have also demonstrated that non-constrained liners with large-diameter femoral head have the potential to improve stability in revision THA [2]. This is mainly due to the improvement in head-to-neck ratio as well as the greater amount of femoral head translation (jump distance) that is provided prior to dislocation [14].

Despite the availability of multiple surgical treatment options, recurrent dislocation after primary THA remains a challenging clinical issue. Poor outcomes have been reported after a single dislocation following primary and revision THA, with previous studies demonstrating variable dislocation rates of up to 11% [1]. As recurrent dislocation is likely to further increase complication rates and as revision surgery is associated with increased morbidity and mortality, the outcomes of patients with recurrent dislocation following revision surgery are likely to be inferior, when compared to those reported in the literature for patients with a single dislocation following primary THA. This study aimed to report the outcome and risk factors of failures associated with revision total hip arthroplasty for recurrent dislocation.

Materials and methods

Patients

The study was approved by the institution's Internal Review Board. Patients were identified from a prospectively-maintained institutional database. Exclusion criteria were as follows: revision for reasons other than recurrent dislocation, multiple indications for revision surgery, implantation with a megaprosthesis at the index surgery, hemiarthroplasty, prior revision THA at another institution, incomplete clinical information, and less than 1-year follow-up. There were 211 consecutive cases of revision total hip arthroplasty for dislocation that fulfilled our inclusion and exclusion criteria, with 81 cases involving the use of a constrained liner and 130 cases involving the use of a non-constrained liner. The non-constrained liner cohort included only hips with a large-diameter head (> 32 mm).

Demographic characteristics included gender, age at revision surgery, laterality, BMI, and ASA scores. We subclassified primary reasons for recurrent dislocation, including mal-positioning of the implants, trauma, abductor deficiency, component loosening, impingement, acetabular liner dislodgement, liner wear. Mal-positioning of the cup was defined as 10° of variation from the Lewinnek "safe zone" of 40–45° of abduction and 10–15° of anteversion [15]. Abductor deficiency was defined as loss or detachment of the abductor muscles. Spine disease was defined as a prior lumbar spinal fusion and this was obtained through manual review of surgical data for each patient. Osteoporosis was obtained through manual chart review and confirmed through a bone density test with T-score smaller than − 2.5. Component loosening was identified with preoperative radiographs and confirmed by intraoperative testing of component instability. Impingement was identified by testing the full range of motion in the revision THA. Liner dislodgement and liner wear were identified with preoperative radiographs and confirmed by intraoperative findings. Additional clinical data, such as medical comorbidities, and implant manufacturer in revision THA, were also collected for survival analyses.

Revision THA for recurrent dislocation

All revision surgeries were performed by fellowship-trained arthroplasty surgeons at our institution, using a posterolateral approach in all cases. The positioning of the components was evaluated both preoperatively using radiographs and intraoperatively. The existing acetabular and femoral components were examined for stability. Impingement was tested intraoperatively with the hip flexed to approximately 90 degrees (adduction was zero degrees) and internally rotated, as well as with the hip hyper-extended and externally rotated. 40 of 211 stems (18.9%) were revised and 121 of 211 cups (57.3%) were revised in our cohort. 81 cases were implanted with constrained liners while 130 cases were implanted with non-constrained liners. After the components were revised and the liners were changed, testing of range of motion was performed and documented to ensure that there was no obvious intra-articular or extra-articular impingement and that soft tissue tension was adequate. The mean length of stay in the hospital for revision THA was 5.5 days (range: 2–17). In concordance with previous literature [16], the general indications for constrained liners included patients with poor hip musculature and specific medical conditions such as dementia or alcohol abuse. Constrained liners were used in patients with well-positioned acetabular and femoral components and with hip instability.

Clinical follow-up

Routine clinical and radiographic follow-up was scheduled at 3 months, 1 year, 2 years, 5 years, and every 5 years after surgery. In our cohort, all patients were followed clinically for a minimum of 3 years, until failure of the revision surgery (re-revision), or until death. The mean follow-up time was 4.6 years (range 3.1–5). Failure of revision surgery was defined as recurrent dislocation, liner dissociation, component loosening, periprosthetic fracture, adverse local tissue reaction or periprosthetic joint infection (PJI). Patients meeting the Musculoskeletal Infection Society (MSIS) criteria were diagnosed with PJI. The lower limb length discrepancy was obtained through radiographic analysis and this was defined as the length change of bilateral distance between bi-ischial line and the centers of the lesser trochanters at the femurs [17].

Statistical analysis

All analysis was performed with R software for Windows version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria; www.R-project.org). The outcomes and re-revision rates of patients following revision THA due to recurrent dislocation were analysed. The survival probability of the prosthesis in 5 years after revision THA was investigated using the Kaplan–Meier method. Patient and implant-related risk factors for failure of revision THA for recurrent dislocation were analysed in univariate analysis. Body mass index (BMI) was classified in concordance with the World Health Organization classification of obesity [18]. Multivariate Cox proportional hazard analysis was performed to establish independent risk factors associated with failure of revision THA for recurrent dislocation ($p < 0.05$) [19].

Results

This study included 211 consecutive cases of revision total hip arthroplasty for recurrent dislocation. The mean age of the cohort was 86.1 ± 13.3 years, with a mean BMI of 28.5 ± 5.4 kg/m^2 (Table 1). The anterolateral approach at index THA was used in 39 patients (18.4%), while the posterior approach was used in 172 patients (81.6%; Table 1). The most common causes of revision surgery included impingement (30.3%), malpositioning (19.4%) as well as abductor deficiency (17.1%; Table 2).

At a mean of 4.6-years of follow-up, 32 of 211 patients (15.1%) underwent re-revision surgery. There were 14 re-revisions for periprosthetic joint infections, 10 re-revisions for dislocation, 3 re-revisions for periprosthetic fractures, 3 re-revisions for dislocation due to liner dissociation, and 2 re-revisions due to aseptic loosening (Table 3). The results of the Kaplan–Meier analysis demonstrate a 5-year survival probability of 77% for patients that underwent revision THA for recurrent dislocation (Fig. 1).

Univariate analysis demonstrates that obesity (BMI ≥ 40), osteoporosis (T score: − 2.9 ± 0.8), spine disease (1–2 spinal levels fused in 42 patients; 3–4 spinal levels fused in 27 patients) and abductor deficiency were associated with an increased risk of failure for patients following revision THA due to recurrent dislocation (Table 4). Multivariate Cox regression analysis confirmed obesity ($p = 0.01$), osteoporosis ($p = 0.03$), spine disease ($p = 0.03$) and abductor deficiency ($p < 0.01$) as independent risk factors for failure of revision THA for recurrent dislocation (Table 5).

Multivariate Cox regression analysis demonstrated that constrained liner type was a confounding factor for the survival profile of patients who underwent revision THA for recurrent dislocation, confirming that constrained liner type was not a risk factor for failure ($p = 0.63$; Table 5). For matched constrained liner and non-constrained liner

Table 1 Patient demographics for revision total hip arthroplasty due to recurrent dislocation

	Revision THA for recurrent dislocation (211)
Gender (male/female)	74/134
Age (mean ± SD)	68.1 ± 13.3
Laterality (right/left)	115/96
BMI (mean ± SD)	28.5 ± 5.4
ASA (≥ 3/ < 3)	156/55
Surgical approach at primary THA	
Anterolateral	18.4%
Posterior	81.6%
Radiographic analysis	
Limb length discrepancy (mm)	3.7 ± 4.3
Femoral offset (mm)	37.1 ± 7.5
Head skirts	57 (27.0%)
Spine disease	48 (22.7%)

Table 2 Reasons for revision THA

	Revision THA for recurrent dislocation (211)
Impingement	64 (30.3%)
Malposition	41 (19.4%)
Abductor deficiency	36 (17.1%)
Component loosening	32 (15.2%)
Acetabular Liner wear	20 (9.4%)
Trauma	8 (3.7%)
Unidentified	4 (5.6%)

Table 3 Reasons for re-revision THA

	Revision THA for recurrent dislocation (211)
Dislocation	10
Dislocation due to liner dissociation	3
Infection	14
Others	5

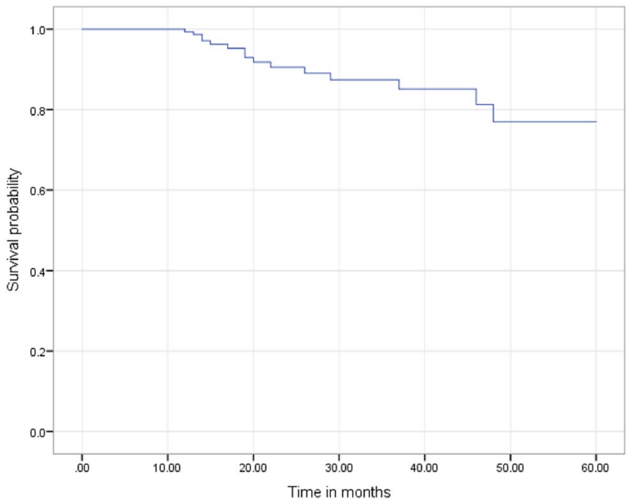

Fig. 1 Kaplan–Meier curve for the failure of revision THA due to recurrent dislocation

cohorts, there was no significant difference in re-revision rates (17.0% vs. 14.1%, $p=0.44$). Among the re-revisions in the constrained liner group, 3 of 12 (25%) re-revised constrained liner hips failed due to recurrent dislocation, while 7 of 20 (35%) non-constrained liner hips failed underwent re-revision because of recurrent dislocation. Among the re-revisions in the constrained liner group, 3 of 12 (25%) re-revised constrained liner hips failed due to constrained liner dissociation, while there was no failure (0%) due to liner dissociation observed in the non-constrained liner cohort. 6 of 12 (50%) re-revised constrained liner hips underwent re-revision because of infection, while 8 of 20 (40%) non-constrained liner hips failed underwent re-revision because of infection.

Discussion

Periprosthetic hip dislocation remains one of the most common and challenging complications after total hip arthroplasty, as well as one of the leading causes of failure following revision THA [20]. Poor outcomes have been reported in patients with a single dislocation following primary and revision THA, with dislocation rates as high as 11% [21]. As recurrent dislocation is likely to further increase complication rates and as revision surgery is associated with increased morbidity and mortality, the outcomes of patients with recurrent dislocation following revision surgery are likely to be inferior, when compared to those reported in the literature for patients with a single dislocation following primary THA. However, there is a paucity of data on outcomes for patients with revision THA due to recurrent dislocation. The findings of this study demonstrate a high re-revision rate at 4.6 years follow-up with 32 of 211 patients (15.1%) undergoing revision surgery. Obesity (BMI ≥ 40), osteoporosis, spine disease, and abductor deficiency were found to be independent risk factors of failure for patients following revision THA due to recurrent dislocation.

At a mean follow-up of 4.6-years, this present study demonstrates that 32 of 211 patients (15.1%) underwent re-revision surgery, predominantly due to dislocation and infection. This is in concordance with previous literature, also demonstrating high complication rates for patients that underwent revision THA for recurrent dislocation. In a retrospective study with 38 patients following revision THA, Mehta et al. reported a re-revision rate of 29% at 8 years of follow-up [21]. The main modes of failure included infection, followed by dislocation. Similarly, Herman et al. studies 379 revision THA patients that underwent revision surgery for recurrent dislocation, demonstrating that 78 patients (21%) underwent re-revision within 5 years, with 66 of those patients being revised for dislocation [22]. In a different study with 148 patients following revision THA for recurrent dislocation, Biviji et al. reported a re-revision rate of 20% [23], reporting dislocation and infection as the main modes of failure. These studies illustrate that re-revision rates are high at mid-term follow-up for patients that underwent revision surgery for recurrent dislocation. These failure rates are higher compared to patients with a single dislocation following primary and revision THA, with a reported failure rate of up to 11% [21], illustrating the clinical challenges associated with revision surgery for recurrent dislocation.

This study also demonstrates several risk factors associated with the failure of patients that underwent revision THA for recurrent dislocation. Univariate regression analysis demonstrated that obesity (BMI ≥ 40), osteoporosis, spine disease, and abductor deficiency were associated with an increased risk of failure following revision THA for recurrent dislocation. Patients with higher BMI apply greater stress on the bone-implant and implant-implant interfaces, as well as the constrained liner locking mechanism, which may contribute to a higher rate of failure in revision THA. Another potential contributor to a higher rate of failure in revision THA for patients with obesity may involve dislocation due to soft tissue impingement. Hernigou et al. found that the risk of dislocation is increased in patients with obesity, without providing an explanation for this observation [24]. A lower bone mineral density in patients with osteoporosis may contribute to increased stresses on the bone-implant interfaces [25]. Increased stressed on the bone-implant interfaces may also be due to diminished bone stock quality and poorly positioned implants; however, there was no significant difference between both cohorts with regards to implant malpositioning. Moreover, infection is one of the most common reasons for failure in revision THA for recurrent dislocation; medical problems including a high BMI and

Table 4 Risk factors for failure of patients following revision THA due to recurrent dislocation

Variables	Stratification	Number of cases (re-revision)	*p* value
Age	≤ 60	10/50	0.831
	60 ~ 70	11/49	
	70 ~ 80	7/65	
	≥ 80	4/47	
BMI	≤ 18.5—Underweight	1/3	**< 0.001**
	18.5–24.9—Normal weight	9/91	
	25.0–29.9 Overweight	10/77	
	30.0–34.9—Class I Obesity	10/31	
	35.0–39.9—Class II Obesity	2/7	
	> 40—Class III Obesity	0/2	
Smoking	Smoke	3/14	0.723
	Non-smoke	29/196	
Drug abuse	Abuse	1/2	0.449
	Non-abuse	31/209	
Alcohol	Alcohol	12/79	0.643
	Non-alcohol	20/132	
Renal failure	Renal failure	4/26	0.231
	Non renal failure	28/185	
Depression	Depression	4/50	0.743
	Non-depression	28/161	
Diabetes mellitus	DM	4/39	0.487
	Non-DM	27/172	
Osteoporosis	Osteoporosis	3/20	**< 0.001**
	Non- Osteoporosis	29/191	
	No Spine Disease	21/142	
Liner type	Constrained	12/81	0.446
	Non-constrained	20/131	
Implant positioning	Malpositioned	7/38	0.336
	Well-positioned	25/173	
Revision type	Cup	16/121	
	Stem	6/40	0.37
	Liner	10/66	
Use of head skirts	Head Skirts	14/67	0.176
	No Head Skirts	18/144	
Spine disease	Spine Disease	14/69	**< 0.01**
	No Spine Disease	18/142	
Abductor Deficiency	Abductor Deficiency	8/36	**< 0.001**
	No Abductor Deficiency	25/175	

Bold values indicate statistical significance ($p < 0.05$)

Table 5 Multivariate Cox regression analysis

Variables	HR	Lower 95% CI	Upper 95% CI	*p* value
Abductor deficiency	2.465	1.223	3.704	**< 0.01**
Spine disease	2.138	0.994	2.971	**0.03**
Liner type	1.174	0.602	2.291	0.637
Osteoporosis	2.014	1.056	3.838	**0.03**
BMI	2.204	0.761	6.385	**0.01**

Bold values indicate statistical significance ($p < 0.05$)

osteoporosis are likely proxies for greater overall medical comorbidity burden and may be associated with greater rates of PJI. Gill et al. also found that a high comorbidity score is associated with an increased risk for THA failure [26].

The present study demonstrated spine disease to be a risk factor for failure of patients that underwent revision THA due to recurrent dislocation. This observation was made in previous studies on patients following primary THA. In a study with patients following primary THA, Malkani et al. demonstrated that patients that underwent primary THA with concomitant spinal pathology had a dislocation rate of 7.4%, which was almost double that for patients without spinal pathology (4.8%) [27]. Spinal pathology was shown to lead to a loss in spine mobility, thereby potentially affecting normal compensatory pelvic parameters including tilt and version during sitting and standing which leads to instability, impingement, and thus increased dislocation rates [28–30]. The findings of the present study also report abductor deficiency as a risk factor for failure of patients following revision THA due to recurrent dislocation. Abductor deficiency was reported in previous studies to be strongly associated with an increased risk of dislocation following primary and revision surgery due to the loss of stabilization at the hip joint. Bonner et al. reported a abductor deficiency as a risk factor for dislocation following revision surgery for adverse local tissue reactions (ALTR) in a study with 252 consecutive THA patients [3]. This is in agreement with Waterson et al. [31], who reported that 18.2% of 69 patients with MoP THA following revision surgery required further surgical interventions to treat dislocated arthroplasties, indicating that abductor deficiency is strongly associated with an increased risk of dislocation.

The high prevalence of re-revision following revision THA for recurrent dislocation in this study suggests that dual mobility construct use may be a viable alternative option. Dual mobility design is an option for patients with recurrent dislocation after THA. Many studies have demonstrated that the dual mobility construct reduces dislocation rate at long-term follow-up [10, 32, 33]. However, there are potential disadvantages associated with the use of dual mobility arthroplasty including intra-prosthetic dislocations [34, 35]. Long-term outcome studies of first-generation dual mobility cups showed significant rates of polyethylene wear due to liner material and design issues [36, 37]. Implant manufacturers may also lack modular dual mobility options for implanted acetabular cups encountered during revision surgery, whereas constrained liners may be available.

There are several potential limitations of this study. First, it is a retrospective study, and there are inherent biases in the study design and possible inaccuracies in clinical information. Second, there are additional confounding variables that we did not account for in the final model of regression. These include, but are not limited to, revision surgery component positioning and bone loss, which has been demonstrated to be important in THA stability. However, due to the complexity of revision THA, it is challenging to account for these confounding variables [16]. Additionally, although the study utilized radiographic analysis to compare limb length discrepancy and femoral offset between both study cohorts, there was no comparison of the femoral version as this requires cross-sectional imaging, which was beyond the scope of this retrospective study. Furthermore, although indications for the use of constrained liners are detailed in this manuscript, it remains unclear how much weight and emphasis the operating surgeons put on each criteria including soft tissue quality, bone stock or patients medical comorbidities.

In conclusion, recurrent dislocation is one of the most common reasons for revision THA. This study demonstrates a high re-revision rate of 15.1% at a mean of 4.6-years of follow-up for patients that underwent revision THA for recurrent dislocation. This study also identified osteoporosis, obesity (BMI ≥ 40), spine disease and abductor deficiency as independent risk factors for the failure of revision THA due to recurrent dislocation.

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Compliance with ethical standards

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. The authors have no conflicts of interest to declare that are relevant to the content of this article. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained for the retrospective patient chart review.

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