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Dual-mobility cups in revision acetabular reconstructions: Short-term outcomes in high-risk patients for instability

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ABSTRACT

Objective: The aim of this study was to evaluate the performance of dual-mobility (DM) cup systems for revision total hip arthroplasty (rTHA) in patients who had high risk for instability.
Methods: We prospectively followed up 34 hips of 30 patients (27 females, 3 males; mean age: 66.1 (range: 33 to 89) years) who underwent rTHA with DM cups for aseptic loosening in 23 hips, infection treatment as second or single stage in nine hips, and instability in two hips. Clinical functions of the patients were evaluated using the Harris Hip Score (HHS), and radiological migration or loosening of the DM cups were recorded. The survival of the components was calculated with the Kaplan-Meier survival analysis and failure was defined as any dislocation of the polyethylene (PE) insert, intraprosthetic dislocation (IPD), aseptic loosening of any component or total hip system revision due to any reason.
Results: The mean duration of follow-up was 3.52 (range: 2.05 to 6.26) years. There was one dislocation of PE insert (2.9%), which was treated with closed reduction. There were two (5.8%) re-revisions for cemented DM cup due to migration. There was one PE insert and head change due to subacute infection. The mean HHS increased from 42.8 ± 6.7 (range: 34 to 60) points preoperatively to 87.3 ± 5.8 (range: 75 to 98) points postoperatively. The cumulative survival rate of the DM cup system was 91.2% (95% CI: 81.6 −100%) with any revision, 94.1% (95% CI: 86.2−100%) with aseptic loosening and %97.1 (%95 CI: 91.4 −100%) with dislocation as the end point at 3.5 years.
Conclusion: Dual-mobility cups may provide good stability and represent a good option for revision acetabular reconstruction in patients who have high risk for instability.
Level of evidence: Level IV, therapeutic study.

Introduction

Instability is one of the most challenging complication after revision total hip arthroplasty (rTHA).[1,2] Reported rate of dislocations was up to 28% after rTHA.[3] Multiple surgical constructs can be used to address instability after rTHA, e.g., constrained acetabular implants, large-diameter femoral heads and dual-mobility (DM) cups.[4–6]

The DM system for total hip arthroplasty and rTHA to reduce the risk of THA dislocations was first introduced in the 1970s by Gilles Bousquet.[7,8] The DM concept consists of a mobile polyethylene insert (PE), which articulates freely its metallic acetabular shell. Femoral heads are impacted in force and captured into the mobile PE insert. The PE insert, with its large-diameter head, moves the femoral head of the prosthetic joint closer to the native one and limits dislocation due to the increased jump distance. Despite good to excellent clinical results, instability has been observed to continue in some DM systems, including intraprosthetic dislocation (IPD), which is a unique complication of DM system identified as the separation of the mobile PE insert form the prosthetic femoral head, with an incidence rate ranging from 0% to 8.7% in rTHA.[7,9–11] This is extremely difficult to reduce using closed techniques and requires an open procedure.

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The risk factors for instability after rTHA are multifactorial, e.g., bone defects, inadequate soft tissue envelope, previous surgical applications, patient characteristics (age, gender), alignment of components, impingement, muscle imbalance (cognitive or neuromuscular disorders), hip abductor insufficiency and limb length.[5,12,13] The purpose of this study was to demonstrate the outcome of the same-design DM cups in patients who had high risk for instability before and/or after rTHA.

Patients and methods

We prospectively followed 35 consecutive patients who were considered to have high risk for instability after rTHA and who underwent isolated acetabular and/or rTHA using same-design DM bearings by a single senior surgeon between January 2009 and September 2016, after obtaining the approval of the institutional review board. During the follow up, four patients died of causes unrelated to revision surgery, while one patient was lost to follow-up. Conclusively, we followed up 34 rTHA in a series of 30 patients (27 females, 3 males) with an average of 66.1 (range: 33 to 89) years at the time of revision. The mean follow-up time was 3.52 (range: 2.05 to 6.26) years. The mean BMI of the patients was 26.8 ± 7.2 (range: 19.7 to 36.2). The most common indication for revision included aseptic loosening, single-stage or two-stage periprosthetic joint infection (PJI) treatment and recurrent instability (Table 1). Indications for the DM acetabular cup included revision for instability or a history of dislocation in two patients, abductor deficiency and/or trochanteric non-union in 19 patients, the American Academy of Orthopaedic Surgeons (AAOS) Grade 4 bone defects in seven patients, and inadequate intraoperative stability when trialing in two patients. On average, patients had undergone a hip surgery 2.9 (range: 1 to 13) times.

All revisions were performed using a posterolateral approach by a senior surgeon. Both components were reconstructed in 19 patients (23 hips) and isolated acetabular revision was done in 11 patients. All reconstructions were done with same design stainless-steel DM acetabular cups (POLARCUP™; Smith & Nephew Schweiz AG, Baar, Switzerland). The cup size was selected according to the acetabular reconstruction technique and displayed a range from 43 mm to 61 mm. 28-mm femoral heads of Co–Cr were used in 22 hips, ceramic heads (BIOLOX®delta ceramic; CeramTec GmbH, Plochingen, Germany) were used in four hips, Oxinium heads were used (Smith & Nephew) in two hips, and stainless-steel heads were used in one hip, totaling 29 revisions. 22-mm Co–Cr femoral heads were used in five revisions. We used ultra-high-molecular-weight PE mobile component in 15 revisions and cross-linked PE (XLPE) mobile component in 19 revisions. Cemented femoral components (Echelon™; Smith & Nephew) were used in 11 hips, monoblock cementless femoral components (SLR-R®, Echelon™) in eight hips, and modular cementless reconstruction stem (LINK® MP® Reconstruction Prosthesis; Waldemar LINK GmbH & Co. KG, Hamburg, Germany) in one hip. A mega-tumor prosthesis (Penta-MERS®; TIPSAN, Izmir, Turkey) was used in three hips that needed excessive bone resection for PJI treatment.

Acetabular reconstruction techniques were preferred according to the degree of the acetabular bone defect and acetabular defects were classified according to the AAOS classification system.[14] AAOS Grade 2 and 1 defects were observed in 15 hips (cemented in 11 hips and cementless DM cups in four hips). AAOS Grade 3 defects were recorded in 12 hips and cemented DM cups into acetabular reinforcement rings (Contour Acetabular Reinforcement Ring®; Smith & Nephew) were used with a cancellous femoral head allograft. AAOS Grade 4 defects were observed in seven hips and cemented DM cups were used with acetabular reconstruction ring (Contour Acetabular Reconstruction Ring®; Smith & Nephew). In three patients, a medial wall mesh (X-Change™; Stryker, Sao Paulo, Brazil) was needed with cancellous graft impaction for the medial wall defect (Fig. 1). During revision, we used a trochanteric grip-plate (ACCORD™ Cable System; Smith & Nephew) in 13 hips for the abductor–trochanteric complex.

Clinical and radiological follow-ups were performed at the 3rd, 6th and 12th month and 3rd and 5th year postoperatively. We prospectively checked any evidence of acetabular and femoral component loosening,[15,16] and the clinical outcomes were evaluated using the Harris Hip Score (HSS).[17] Statistical analyses were performed using the MedCalc v.17.9 statistical software (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2017). Kaplan-Meier survival analysis was used to calculate survivorship curves with 95% confidence intervals (CIs) with end points of any revision for dislocation of PE insert and/or IPD and any revision of DM system for any reason.

Table 1
Baseline Demographics and Surgical data.

Gender		
Female	27	(90%)
Male	3	(10%)
Mean age at the time of surgery (range)	66.1 (33–89)	
Indication for rTHA		
Aseptic loosening	23	(67.6%)
Single-stage revision for PJI	4	(11.8%)
Two-stage revision for PJI	5	(14.7%)
Instability	2	(5.9%)
Type of rTHA		
Isolated acetabular revision	11	(32.4%)
Acetabular + Femoral component	23	(67.6%)
Type of DM applications		
Cemented DM	11	(32.4%)
Cementless DM	4	(11.8%)
Cemented ARiR	7	(20.6%)
Cemented ARcR	12 (35.3%)	
DM head size		
22 mm CoCr	5	(14.7%)
28 mm	29	(85.3%)
Co–Cr	22	
Ceramic	4	
Oxinium	2	
Stainless-steel	1	

ARcR: Acetabular Reconstruction Ring, ARiR: Acetabular Reinforcement Ring, Co-Cr: cobalt-chrome, DM: dual mobility, PJI: periprosthetic joint infection, rTHA: revision total hip arthroplasty.

Results

No revision for the PE insert was needed or IPD was observed after a mean follow up of 3.52 (range: 2.05 to 6.26) years. We had one PE insert dislocation in a 63-year-old patient who had an uncontrolled Parkinson's disease and had undergone three surgeries and 14 closed reductions due to recurrent dislocations. This patient had two dislocations; the first due to a fall during mobilization two days after the revision surgery and the second eight weeks after the first closed reduction. Re-revision was scheduled for this patient. However, after replacing the deep brain stimulator battery for muscle imbalance, we did not observe any new re-dislocation of the PE insert or IPD during the 18-month follow-up, so we canceled the revision surgery.

There were 3 (8.8%) re-revisions; two due to aseptic loosening and one due to subacute infection. The reason of aseptic loosening was the migration of the cemented acetabular cups from the acetabulum in patients with severe hip abductor insufficiency after 11 months and 19 months from revision (Fig. 2) In Case #1, we used

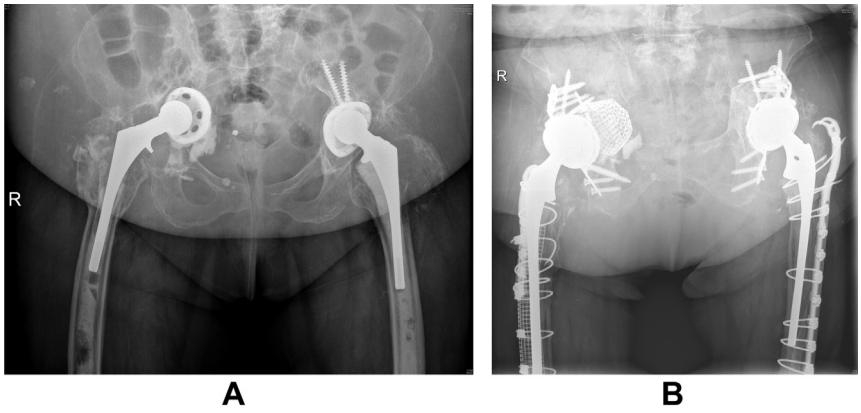

Fig. 1. **(A)** Radiographs of a 74-year-old woman with a failed bilateral rTHA due to aseptic loosening. **(B)** No cup migration or radiolucency is observed at 6 years and 2 months postoperatively.

multi-hole cementless cup and constrained acetabular liner for salvage and did not observe any loosening during her 3.5-year follow-up. In Case #2, the same DM cup was cemented into the acetabular reconstruction ring and the patient completed 5.5 years of follow-up without any sign of loosening. We did not observe any loosening of the other cemented DM cups that were placed into the acetabular reconstruction or reinforcement ring. In Case #3, subacute infection was detected one year after revision. The infection was treated with irrigation and PE insert-femoral head exchange with administration of six weeks of IV antibiotics. No loosening of the femoral components was observed.

The mean preoperative HHS improved from 42.8 ± 6.7 (range: 34 to 60) to 87.3 ± 5.8 (range: 75 to 98) points postoperatively ($p < 0.001$). The cumulative survival rate of the DM cup system was 91.2% (95% CI: 81.6–100%) at 3.5 years, with any revision as the end point. The infection-free survival rate of the DM cups was 94.1% (95% CI: 86.2%–100%). Kaplan-Meier analysis showed 97.1% (95% CI: 91.4–100%) survivorship for dislocation at 3.5 years (Fig. 3).

Discussion

The most important characteristic of DM cups was its ability to provide more stability via increasing the jump distance of the prosthetic femoral head, following total hip arthroplasty and rTHA.[2,10,18,19] Additionally, DM bearings provide more stability than other surgical constructs in patients undergoing rTHA.[20,21] We found out that when the patients, who had a high risk for instability, underwent revision surgery for any reason, the use of a DM construct provided excellent stability with acceptable revision rates in the short term.

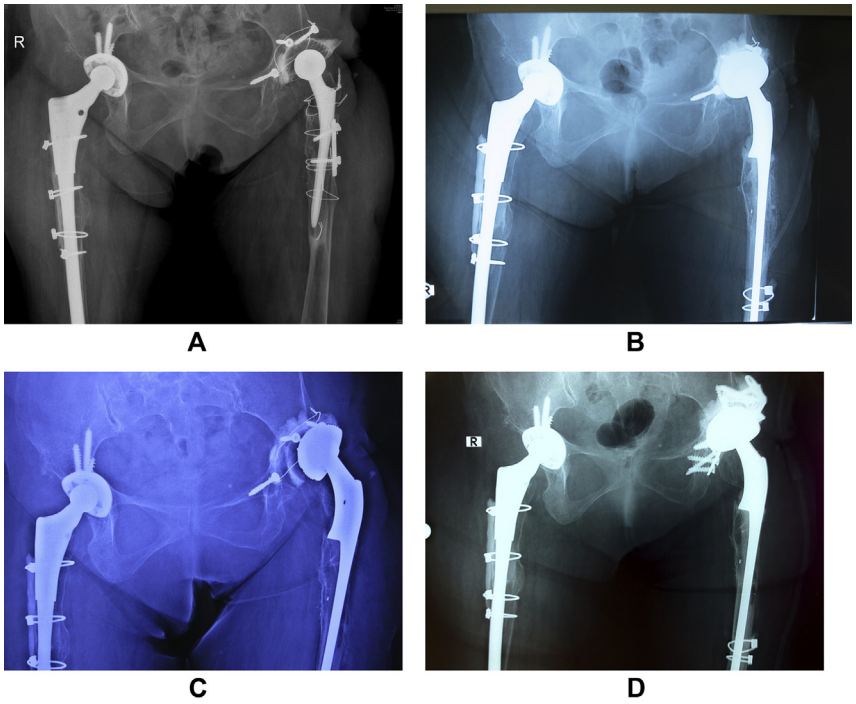

Fig. 2. **(A)** Preoperative view of a 66-year-old woman who underwent multiple revisions due to Crowe Type 4 dysplasia. **(B)** Cemented DM cup was used to prevent the risk of instability. **(C)** The cemented DM cup has migrated from the acetabulum 11 months after revision. **(D)** Same DM cup was cemented into the acetabular reconstruction ring. No loosening was observed at the 66th month follow-up radiograph.

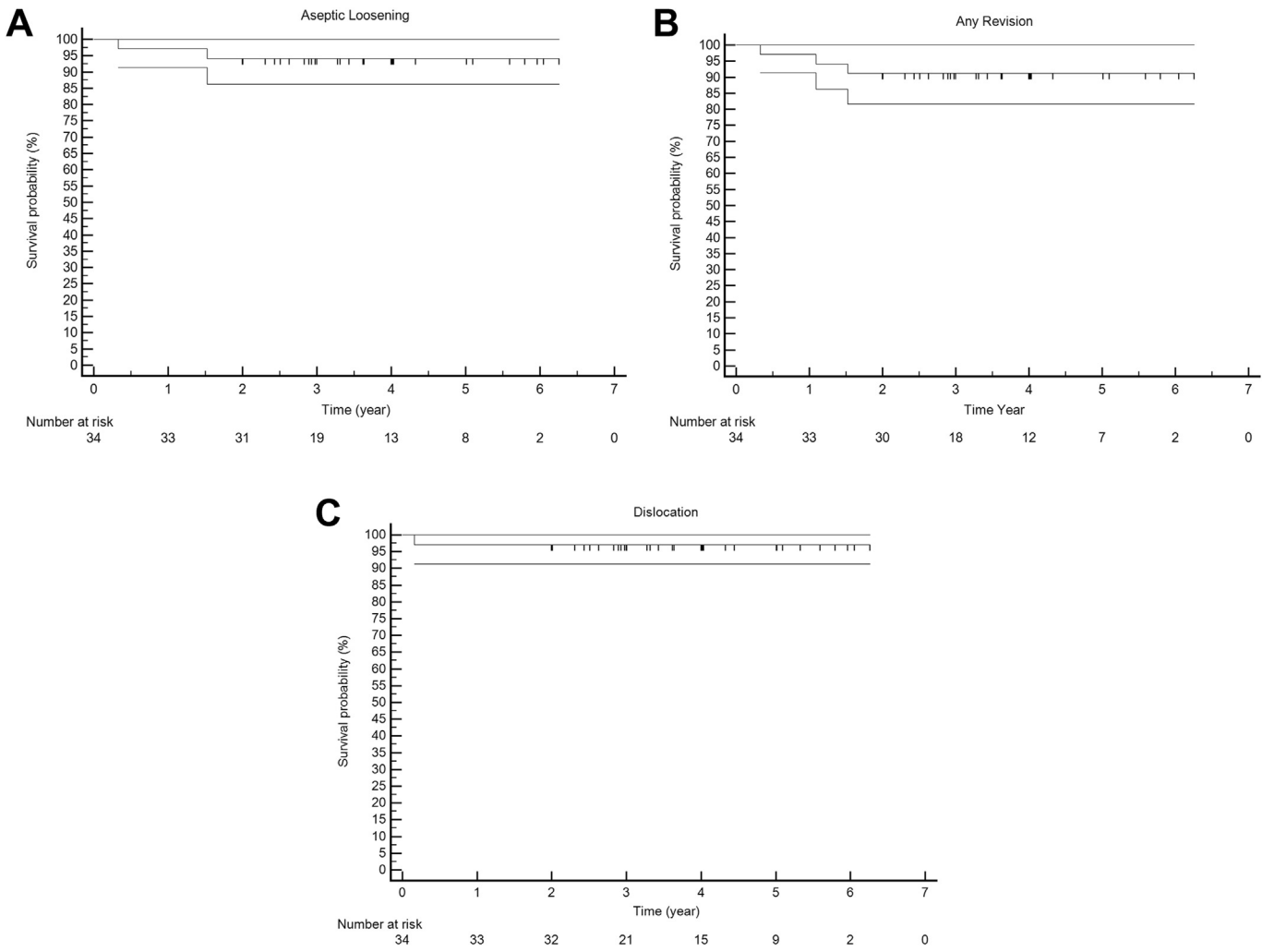

Fig. 3. **(A)** Cumulative survival of the DM cup with aseptic loosening, **(B)** with any revision and **(C)** with dislocation as the end point.

Different dislocation rates were reported with the use of DM cups in rTHA. Wegrzyn et al. reported 1.5% dislocation of PE insert and 0.2% IPD rate in 994 rTHAs during a midterm follow up.[18] Our results had similar dislocation rates (2.4%) with previous series ranging from 0% to 8.7% at 2–8 years of follow-up on average.[11,19,22,23] We had one dislocation of PE insert in extreme patients with a history of uncontrolled Parkinson's disease and multiple previous surgeries due to recurrent instability that was treated with closed reduction and replacement of the deep brain stimulator battery.

Hip abductor insufficiency poses a high risk for instability in patients who had undergone rTHA.[7,24,25] Plummer et al. reported one dislocation in 36 patients (2.7%).[2] In a different study, 6 (0.6%) DM cup dislocations were reported in the context of severe abductor insufficiency.[18] In another recent paper, there was no dislocation of PE insert or IPD during the short-term follow-up of 16 patients who had severe abductor insufficiency.[26] Abductor or muscle insufficiency also have a risk for mechanical failure of DM constructs due to increased forces at the acetabular bone-cement interface. We observed two cemented cup revisions due to mechanical failure in patients with abductor insufficiency. Some surgeons recommend that if the patient has a severe bone loss and muscular insufficiency and/or had undergone a revision surgery with cemented DM cups, the use of a cage or ring may increase the quality of fixation.[24] Our results had similar mechanical failure rates (5.8%) with previous series ranging from 0% to 5.5%.[23,27]

POLARCUP™ has shown a favorable survivorship (97.4%) without any PE insert dislocation or IPD after a midterm follow-up of 150 primary THA patients, but its performance in rTHA is unknown.[28] The overall performances of the DM systems showed that DM bearings are reliable options for rTHA via preventing or treating instability. In a recent review, which evaluated 3008 rTHAs, the incidence of dislocation was 2.2%, the rate of aseptic loosening was 1.4% and the rate of IPD was 0.3% after a mean follow-up of 5.4 (range: 2 to 8) years.[29] According to our results, POLARCUP™ had low rates of instability and a good overall survivorship in rTHAs after 3.5 years of follow-up on average.

Our study had some major limitations. We had a small number of patients with a relatively short period of follow-up after rTHA. A source of bias is the possible nonrandom variation in the senior surgeon's preference to use cemented DM with or without an acetabular ring or cementless DM revision implants. Acetabular defects and abductor status of the patients were not uniform. There was no control group to compare the results of the DM cups with those of conventional constructs, constrained acetabular components or large femoral heads. Finally, further follow-up will be required to assess the implant performance and special complications such as IPD and PE insert wear in the long term.

In conclusion, our results suggest that DM cups may provide good stability and are a good option for patients with high risk for dislocation after rTHA in the short term. In addition, when using cemented DM cups, the status of the abductor–trochanteric complex should be taken into account to prevent a possible mechanical failure.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Springer BD, Fehring TK, Griffin WL, Odum SM, Masonis JL. Why revision total hip arthroplasty fails. *Clin Orthop Relat Res*. 2009;467:166–173.
2. Plummer DR, Christy JM, Sporer SM, Paprosky WG, Della Valle CJ. Dual-mobility articulations for patients at high risk for dislocation. *J Arthroplasty*. 2016;31:131–135.
3. Parvizi J, Picinic E, Sharkey PF. Revision total hip arthroplasty for instability: surgical techniques and principles. *J Bone Joint Surg Am*. 2008;90:1134–1142.
4. Berend KR, Lombardi Jr AV, Mallory TH, Adams JB, Russell JH, Groseth KL. The long-term outcome of 755 consecutive constrained acetabular components in total hip arthroplasty. Examining the successes and failures. *J Arthroplasty*. 2005;20:93–102.
5. Kung PL, Ries MD. Effect of femoral head size and abductors on dislocation after revision THA. *Clin Orthop Relat Res*. 2007;465:170–174.
6. Saadat E, Diekmann G, Takemoto S, Ries MD. Is an algorithmic approach to the treatment of recurrent dislocation after THA effective? *Clin Orthop Relat Res*. 2012;470:482–489.
7. Plummer DR, Haughom BD, Della Valle CJ. Dual mobility in total hip arthroplasty. *Orthop Clin North Am*. 2014;45:1–8.
8. Noyer D, Caton JH. Once upon a time.... Dual mobility: history. *Int Orthop*. 2017;41:611–618.
9. Philippot R, Adam P, Reckhaus M, et al. Prevention of dislocation in total hip revision surgery using a dual mobility design. *Orthop Traumatol Surg Res*. 2009;95:407–413.
10. Guyen O, Pibarot V, Vaz G, Chevillotte C, Béjui-Hugues J. Use of a dual mobility socket to manage total hip arthroplasty instability. *Clin Orthop Relat Res*. 2009;467:465–472.
11. Vasukutty NL, Middleton RG, Matthews EC, Young PS, Uzoigwe CE, Minhas TH. The double-mobility acetabular component in revision total hip replacement: the United Kingdom experience. *J Bone Joint Surg Br*. 2012;94:603–608.
12. Alberton GM, High WA, Morrey BF. Dislocation after revision total hip arthroplasty: an analysis of risk factors and treatment options. *J Bone Joint Surg Am*. 2002;84-A:1788–1792.
13. Bozic KJ, Kurtz SM, Lau E, Ong K, Vail TP, Berry DJ. The epidemiology of revision total hip arthroplasty in the United States. *J Bone Joint Surg Am*. 2009;91:128–133.
14. D'Antonio JA, Capello WN, Borden LS, et al. Classification and management of acetabular abnormalities in total hip arthroplasty. *Clin Orthop Relat Res*. 1989;243:126–137.
15. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. *Clin Orthop Relat Res*. 1976;121:20–32.
16. Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop Relat Res*. 1979;141:17–27.
17. Nilsdotter A, Bremander A. Measures of hip function and symptoms: Harris hip Score (HHS), hip disability and osteoarthritis outcome Score (HOOS), oxford hip Score (OHS), lequesne index of severity for osteoarthritis of the hip (LISOH), and American Academy of orthopedic surgeons (AAOS) hip and knee questionnaire. *Arthritis Care Res*. 2011;63:S200–S207.
18. Wegrzyn J, Tebaa E, Jacquel A, Carret JP, Béjui-Hugues J, Pibarot V. Can dual mobility cups prevent dislocation in all situations after revision total hip arthroplasty? *J Arthroplasty*. 2015;30:631–640.
19. Mohaddes M, Cnudde P, Rolfson O, Wall A, Kärrholm J. Use of dual-mobility cup in revision hip arthroplasty reduces the risk for further dislocation: analysis of seven hundred and ninety one first-time revisions performed due to dislocation, reported to the Swedish Hip Arthroplasty Register. *Int Orthop*. 2017;41:583–588.
20. Stucinskas J, Kalvaitis T, Smailys A, Robertsson O, Tarasevicius S. Comparison of dual mobility cup and other surgical constructs used for three hundred and sixty two first time hip revisions due to recurrent dislocations: five year results from Lithuanian arthroplasty register. *Int Orthop*. 2018;42:1015–1020.
21. Hartzler MA, Abdel MP, Sculco PK, Taunton MJ, Pagnano MW, Hanssen AD. Otto aufranc award: dual-mobility constructs in revision THA reduced dislocation, rerevision, and reoperation compared with large femoral heads. *Clin Orthop Relat Res*. 2018;476:293–301.
22. De Martino I, D'Apolito R, Soranoglou VG, Poultsides LA, Sculco PK, Sculco TP. Dislocation following total hip arthroplasty using dual mobility acetabular components: a systematic review. *Bone Joint J*. 2017;99-B:18–24.
23. Hamadouche M, Ropars M, Rodaix C, et al. Five to thirteen year results of a cemented dual mobility socket to treat recurrent dislocation. *Int Orthop*. 2017;41:513–519.
24. Wetters NG, Murray TG, Moric M, Sporer SM, Paprosky WG, Della Valle CJ. Risk factors for dislocation after revision total hip arthroplasty. *Clin Orthop Relat Res*. 2013;471:410–416.
25. Zywiel MG, Mustafa LH, Bonutti PM, Mont MA. Are abductor muscle quality and previous revision surgery predictors of constrained liner failure in hip arthroplasty? *Int Orthop*. 2011;35:797–802.
26. Ozden VE, Dikmen G, Beksac B, Tozun R. Dual-mobility bearings for patients with abductor-trochanteric complex insufficiency. *Hip Int*. 2018;28:491–497.
27. Mertl P, Combes A, Leiber-Wackenheim F, Fessy MH, Girard J, Migaud H. Recurrence of dislocation following total hip arthroplasty revision using dual mobility cups was rare in 180 hips followed over 7 years. *HSS J*. 2012;8:251–256.
28. Bauchu P, Bonnard O, Cyprès A, Fiquet A, Girardin P, Noyer D. The dual-mobility POLARCUP: first results from a multicenter study. *Orthopedics*. 2008;31:1663–1672.
29. Darrith B, Courtney PM, Della Valle CJ. Outcomes of dual mobility components in total hip arthroplasty: a systematic review of the literature. *Bone Joint J*. 2018;100-B:11–19.