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Original article

# DUAL MOBILITY CUP CEMENTED INTO POROUS TRABECULAR METAL SHELL DURING REVISION TOTAL HIP ARTHROPLASTY

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**SUMMARY**

Revision total hip arthroplasty (RTHA) is a challenging procedure when we speak about acetabular defects and recurrent instability. There are multiple reasons like the number of previous revisions, implant position, bone quality, patient characteristics and etc. Managing acetabular defects with porous trabecular metal augments has excellent survivorship, but when addressing instability, there are some unsolved issues. Management options include the use of large femoral heads, constrained acetabular liners, and dual mobility cups (DMC). These cups have increased jump distance and reduced likelihood of dislocation while not relying on locking mechanisms, therefore are the preferred option in RTHA.

We present single-center series of 13 patients undergoing revision THA with a specific DMC cemented into a newly implanted or well-fixed trabecular metal (TM) revision shell. All patients underwent cementation of a single specific cemented DMC design (Novae Stick, SERF, Decines, France) in a Trabecular Metal Revision Shell (Zimmer Biomet, Warsaw, IN, US). The mean follow-up is 15,2 months, and there were no dislocations of the implanted DM cups. The mean HHS improved significantly from 35.9 (range 15–80) preoperatively to 80.1 (range 64-93) postoperatively (p = 0.001).

The results of this small clinical series demonstrate that cementing a DMC in a well-fixed TM revision shell leads to no dislocation or dissociation of the cement interface and acetabular construct loosening in the short term.

**Keywords:** porous trabecular metal, dual mobility cup, revision THA,

**INTRODUCTION**

The ideal acetabular reconstruction in revision total hip arthroplasty (RTHA) should achieve good primary stability of the cup as a prerequisite for osseous integration with the restoration of the center of rotation and stability of the arthroplasty. Instability is a major issue in RTHA, with dislocation rate reportedly ranging from 5% to 28% and with 35% of the re-revisions in the first two years performed for instability [1, 2]. The cause of dislocation after revision is related to multiple factors such as patient characteristics, revision etiology, previous surgeries, component orientation and location of the hip center of rotation in the setting of various bone defects, limb length and status of the hip abductor mechanism [2-5 ].

Porous trabecular metal (TM) cups perform well in hip revision surgery both with and without TM augments, with a low risk of re-revision due to aseptic loosening in the long term, but dislocation seems to be an issue with the traditional use of a cemented or snap-fit polyethylene (PE) liner [6-11].

Management options include the use of large femoral heads, constrained ace tabular liners, and dual mobility cups (DMC). Utilization of large femoral heads improves stability by increasing the head-to-neck ratio, range of motion and head jump distance after impingement occurs [12]. Despite the improvements in highly cross-linked PE (XLPE), large heads raise some concerns related to accelerated wear or mechanical failure of the thinner PE liner and a higher incidence of adverse local tissue reactions (ALTR) [13-15]. Furthermore, the stabilizing effect of larger heads can diminish with suboptimal cup placement and change in center of rotation due to acetabular bone defects [7]. Constrained liners prevent instability by locking the femoral head into a PE liner and restricting the hip range of motion. However, such a mechanism results in inevitable repeating impingement at the PE liner rim, leading to locking mechanism damage and subsequent dislocation or in high stress applied to the bone–implant interface leading to loosening [17,18]. With unacceptably high rates of mechanical failure and dislocations, including early loosening of freshly implanted revision cups, many authors recommend limiting their use to salvage situation of recurrent instability [16].

More recently, DMC are gaining popularity with a design concept that addresses instability, avoiding the pitfalls of large femoral heads and constrained liners [6]. In a DMC system, a small diameter femoral head articulates in a constrained manner with a PE liner and together form a large femoral head construct which in turn articulates articulate with the inner surface of the metal acetabular shell [14]. At the extremes of ROM of the inner joint, the stem engages the edge of the PE liner resulting in motion in the outer joint. Therefore, DMC are characterized by a large effective femoral head to increase the impingement free arc of motion and a larger head-to-neck ratio, resulting in increased jump distance and reduced likelihood of dislocation while not relying on locking mechanisms.

In the settings of complex acetabular reconstructions, DMC may as well provide an option to improve stability without adding stress on the bone-implant interface. The current generation of DMC has shown remarkably low dislocation rates following RTHA. Furthermore, DMC was proven as an effective tool to address recurrent dislocation during RTHA for instability in clinical studies and national joint registry reports [11-14]. A recent large systematic review including 3008 revisions with DMC revealed just a 2,2% dislocation rate at 3 to 8 yrs. follow-up. Previous concerns over excessive PE wear of the mobile liner have been denied with an aseptic survivorship rate of 96,6% at mid-term and intraprosthetic dislocation (IPD) 0,3% and 0% in the cases operated with modern DMCs after 2007 [14].

Although cementation of dedicated cemented DMC into a well-fixed metal shell during RTHA has been biomechanically validated by Wegrzyn et al. showing failure at significantly higher moment in lever out testing than cemented PE liner, there have been few clinical studies evaluating outcomes of this construct in patients with complex acetabular reconstructions using TM revision cups with or without TM augments [4-7].

The goal of this study is to analyze the short term outcomes of a single design dual mobility cup meant for cementation cemented into a newly implanted or well-fixed trabecular metal revision shell (Zimmer Biomet, Warsaw, IN, US). Specifically, we sought to analyze the rates of dislocation and other complications, reoperations, re-revisions and clinical outcomes.

## MATERIALS AND METHODS:

### Patients

A single-center series of 13 patients undergoing revision THA with a specific DMC cemented into a newly implanted or well-fixed TM revision shell between 01.2019 and 03.2021 were retrospectively reviewed. A new TM revision cup was implanted in 12 cases, and in 1 case, a well-fixed and well-positioned TM revision shell was retained. There were 5 men and 8 women. The mean age was 67,9 yrs. (48-77). Mean follow-up 15,2 months (3-25). There were 2 or more than 2 previous surgeries in 6 cases (46,1%). 4 (30,7%) of the revisions were isolated acetabular revisions, and 9 (69,3%) were total revisions. Indications for revision THA included the following: aseptic loosening in 8 cases (61,5%), 2$^{nd}$ stage reimplantation for deep infection in 4 cases (30,7%) and recurrent dislocation in 1 case (7,8%.)

Surgical procedure characteristics are listed in Table 1.

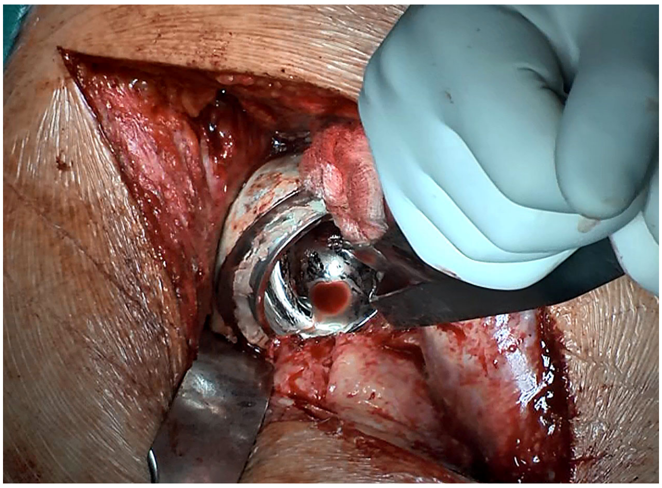
| Surgical procedure characteristics | Number of patients (n) |
|---|---|
| Acetabular bone defect (Paprosky) | |
| II A | 1 |
| II B | 1 |
| II C | 1 |
| III A | 5 |
| III B | 4 |
| Indication for revision | |
| Aseptic loosening | 8 |
| Infection (reimplantation) | 4 |
| Recurrent dislocation | 1 |
| Number of previous surgeries (incl primary THA) | |
| 1 | 6 |
| 2 | 3 |
| >2 | 4 |
| Type of revision | |
| Isolated acetabular revision | 4 |
| Total hip revision | 9 |
| TM augments | |
| No | 4 |
| Yes (1) | 8 |
| Bone grafting | |
| No | 11 |
| Yes | 2 |
| Extended trochanteric osteotomy (ETO) | |
| No | 6 |
| Yes | 6 |

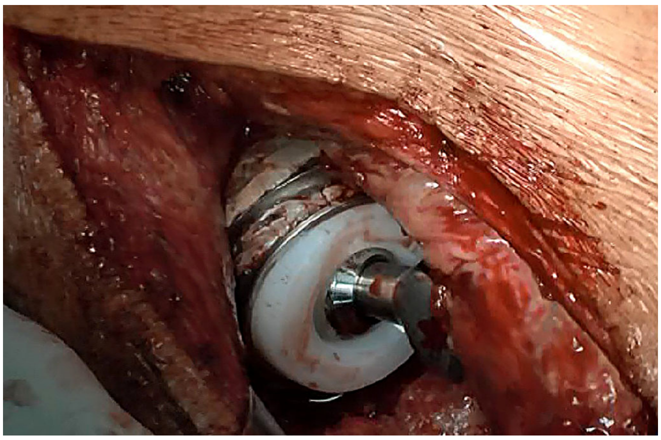
### Surgical technique

The posterolateral approach was used in all cases. All patients underwent cementation of a single specific cemented DMC design (Novae Stick, SERF, Decines, France) in a Trabecular Metal Revision Shell (Zimmer Biomet, Warsaw, IN, US), which has a highly porous tantalum biologic ingrowth surface but does not have a modular liner. In 12 cases, the TM shell was newly implanted, and in 1 case, revised for recurrent instability, the TM revision cup was well fixed from previous revision surgery in a good position and included cemented PE liner. The median outer diameter of the TM shell was 63 mm (58-72 mm). When cementing the DMC into the revision cup, a minimum 13mm difference is needed between the outer diameter of the acetabular shell and the outer diameter of the DMC. Accordingly, the median size of the DMC was 49,7 mm (45-59). The inner femoral head size was 22 mm in 3 hips and 28mm in 10 hips.

When implanting a new TM revision cup after reaming for the TM shell, morselized bone graft (2) or augments (8) were used when necessary to fill acetabular defects, a TM revision shell with appropriate dimensions was impacted into the acetabulum, and this was fixed with additional screws in all cases (mean 2,85 screws). In the single case, where a previously implanted and well-fixed TM revision shell was revised for recurrent instability, the present cemented PE liner was reamed away until easily removed, and a cemented DMC was inserted in a cement-in-cement fashion. In all cases, after choosing the proper size and position of the trial DMC, antibiotic loaded cement (Palacos R+G; Heraeus Medical, Wehrheim, Germany)) was placed into the acetabular component circumferentially, covering the entire surface and all screw heads. The cemented DMC (Novae Stick, Serf, Décines, France) was then placed into the acetabular component at the desired inclination and anteversion angle and held in place with a liner inserter until the cement cures. After completing the femoral reconstruction, a trial femoral head and dual mobility liner are utilized to assess intraoperative stability, and the head length is adjusted as needed. The final components are impacted onto the femoral component, and the hip is reduced. Patients were advised to partially weight bear for 6 weeks. ( Fig.1)

**Fig. 1.** Intraoperative corrected position of the DMC into TM shell and final DM articulation





**Evaluation**

Patients returned for postoperative follow-up visits at 3 months, 6 months, 1 year, and at 6 months interval thereafter. Patients underwent a physical examination, and clinical outcome was evaluated with the Harris Hip Score (HHS). Acetabular defect size prior to the index procedure was assessed using the Paprosky classification. The patient's medical records and radiographic images were retrospectively reviewed and assessed for any postoperative complications, specifically dislocation, dissociation of the cemented DMC at the metal shell/cement interface or acetabular implant loosening or failure. At the final follow, acetabular components were considered loose if they had migrated or if there was a circumferential lucency of at least 2 mm in all zones.

**Statistics**

Data are presented as means with ranges. A comparison of the preoperative to postoperative HHS was performed using a 2-sample t-test. Statistical analysis was performed using IBM SPSS for Windows v.25 with p values $< 0.05$ considered significant.

**RESULTS:**

There were no dislocations of the DMC.No dissociations at the cement-cup interface were observed. In the 12 patients with newly implanted TM revision shells, no acetabular components showed signs of loosening or component migration at the final radiographic follow-up. In the single patient with DMC cemented into the existing TM revision cup, there was no change in component position or biologic ingrowth at final radiographic follow-up. No breakage of screws was recorded. At the final radiographic follow-up, no intraprosthetic dislocation of the DMC was detected. No revisions were performed. There were no reported cases of infection. One patient (7.6%) sustained an intraoperative greater trochanter fracture that was fixed with cerclage wire and finally healed with fibrous union. No other complications were recorded. At final radiographic follow up, 6 cases of heterotopic ossification (46.1%) were recorded: Brooker grade I in 3 patients and Brooker grade II in 3 patients. The mean HHS improved significantly from 35.9 (range 15–80) preoperatively to 80.1 (range 64-93) postoperatively ($p = 0.001$).

**DISCUSSION**

Instability is a common problem in hip revision surgery, with dislocation rates 3 times higher than in primary hip replacement [2]. Poor bone stock and disrupted soft tissues from previous surgeries contribute to suboptimal cup placement with changes in COR and soft tissue envelope insufficiency. Prosthetic options that reduce the risk of dislocation and avoid early fixation failure may help the surgeon in the acetabular reconstruction [18].12 out of 13 of the cases in the present series required an acetabular shell revision with tantalum porous revision shell (TM Revision shell, Zimmer Biomet, Warsaw, Indiana, US) combined with TM augments in 8 cases. This implant allows for good primary stability and multiple screw fixation in the best reconstruction position possible according to the available host bone contact and the need for augment use. However, this may not be the best position for hip instability. Trabecular metal cups have demonstrated a 96% survival rate at 10 yrs. in RTHA with Paprosky type II and III defects [9]and 92,5 % at 10 yrs. in severe acetabular defects when TM cups used in combination with TM augments [12]. However, a major issue in RTHA using TM cups is the risk of instability. Analysis of the Finnish arthroplasty register, including 827 revisions using TM revision cups, concluded that 60 % of the revisions were performed for instability while only 2% for aseptic loosening at 3 years [11]. Another registry study comparing the performance of porous tantalum cups to Muller reinforcement rings in RTHA showed that the main reason for re-revision in the TM group was dislocation [8].

Cementing a DMC inside of TM revision shell is an attractive option as the large effective femoral head increases the impingement-free range of motion and the jump distance to dislocation but also does not lead to higher contact stresses on a newly implanted complex acetabular reconstruction [4,9-11]. Furthermore, it can be implanted within the shell in a better “safe-zone” position. DMC have demonstrated lower dislocation risk than large femoral heads (40mm) in revision surgery [12]. A great advantage over constrained liners is that no constraint is added in the bone/acetabular implant interface [18]. Impressively, DMC were demonstrated to successfully address recurrent dislocation during revision THA for instability in many clinical series and national joint registry reports [16,20].

The main finding of this study is that no dislocation occurred after the use of a cemented DMC in conjunction with a TM revision shell, demonstrating that cementing DMC into TM shells may be an adequate way to address joint instability after complex acetabular reconstruction in RTHA. Accordingly, no re-revision was performed due to instability. All patients included in this series were considered to be of high risk for dislocation because of multiple surgeries, complex acetabular reconstructions with high-grade acetabular defects and a substantial part of the indications being second-stage reimplantation in infection cases (4 patients, 30%) and recurrent instability (1 patient, 7.7%) where usually the soft tissue envelope of the hip is compromised. Also, it has been reported that isolated acetabular revision (4 cases, 30%) are associated with a higher risk of dislocation than procedures where the cup and stem revision are combined [7-9].

In one patient of this series, a DMC was cemented inside a previously implanted and well-integrated TM revision shell as a revision procedure due to multiple dislocations after the previous second reimplantation for deep THA infection. Despite the 36 mm head of the previous construct (TM revision shell with cemented PE liner with elevated rim), the patient has suffered over 10 dislocations after the index revision surgery. The PE liner was gradually reamed away without disturbing the cement mantle, and a DMC was cemented in a safer position in a “cement-in-cement” fashion with the longest head possible. The patient had no further episodes of instability during the 12 months of follow-up.

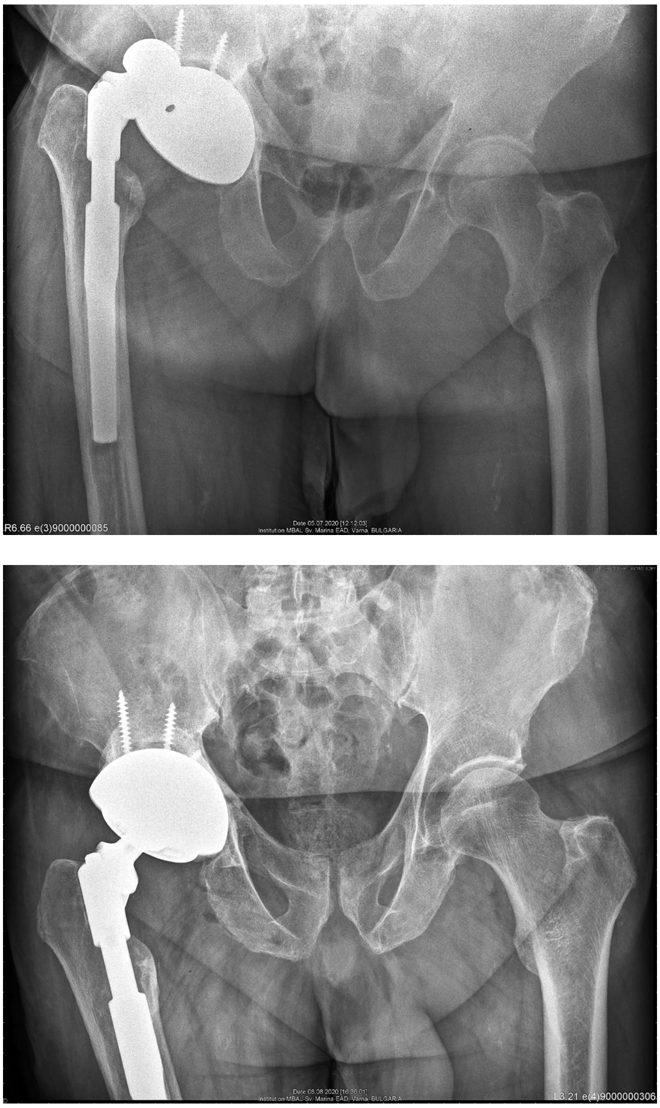
Dual mobility cups cemented into TM shells have occasionally been used in an attempt to reduce the risk of dislocation after hip revision surgery, with good results. Chalmers et al. reviewed the results of 18 patients who had undergone RTHA with a DMC cemented into a well-fixed or new acetabular component. At a mean follow-up of 3 years, 3 patients (17%) experienced postoperative dislocations, and no cups failed at the DMC-cement interface. The dislocations occurred at a mean of 4 months postoperatively [3-6]. A multicenter study including 38 RTHA in which a DMC was cemented in a newly implanted porous revision cup reported a single dislocation (2,6%) that was close reduced with no further complications [10]. Evangelista et al. assessed the outcomes of 18 patients who underwent implantation of a DMC, designed for cementation, into a well-fixed or new revision acetabular cup. At a mean follow-up of 36 months, there were no cases of hip dislocation nor any dissociation at the DMC-cement interface [19].

Our results indicate a satisfactory clinical outcome, having in mind multiple previous surgeries and etiology for revision, and they are similar to those described by other authors [8-11].

Another major finding of this study was that at 15 months, implanting a cemented DMC into the TM revision shell results in a stable construct with no cases of dissociation of the DMC cup or aseptic loosening of the TM shell in the newly implanted cases. The motion within the DMC occurs mainly at the small articulation, with the large articulation being fully unconstrained, leading to limited mechanical stress with no pull-out forces applied onto the cemented interface when compared to constrained acetabular components [5-7,13,17]. With no mechanical failures seen in the short term, similar to the findings of Evangelista et al., Chalmers et al., and Gabor et al. [18-20], this small clinical series supports the biomechanical work of Wegrzyn et al., who suggested that cementing a DMC in a well-fixed metal shell is strong enough to withstand physiologic loading [1].

Minimizing stresses at the bone-acetabular component interface is of great importance in complex acetabular reconstruction with porous cups, augments and bone grafting [3,5]. DMCs do not markedly increase constraint at a newly placed acetabular component. Currently, there is no mid- or long-term data supporting the beneficial effect of the unconstrained DMC on aseptic survivorship of complex acetabular reconstructions using TM cups. However, in an analysis of 96 RTHAs with acetabular cages and cemented dual mobility cup, Schneider et al. reported a 99% survival free of aseptic acetabular revision at 8 years [17]. Some authors have even proposed the rationale of cementing a DMC in revision TM shell in patients at the highest risk for instability and eventually replacing the DMC with a constrained liner after bone ingrowth if instability occurs [13]. Cases of early failure where a modular dual-mobility liner was roughened with a burr and then cemented into a shell were reported by Plummer et al. [12]. We used a DMC dedicated for cemented use. This stainless-steel metallic shell has an inner surface that is highly polished and an outer surface with circumferential and transverse grooves to increase contact between the implant and the cement and oppose torsion and lever loading. This technique allows for placing the DMC in a corrected inclination and anteversion related to the TM shell to achieve a more safe position ( Fig.2). Accordingly, some technical issues should be considered. The smallest size available of the cemented DMC we used in this series is 45mm, so with a minimal size difference of 13 mm, the smallest TM revision cup that allows for the described technique is 58mm.

**Fig. 2.** Radiologic preoperative dislocated revision jumbo cup and postoperative corrected position.



So can really the cemented DMC replace the use of cemented PE in the TM revision cup during RTHA to reduce the dislocation risk without compromising aseptic survivorship? Despite the lack of randomized studies, a large comparative study by Bruggeman et al. reports 99% survivorship regarding dislocation and 96% aseptic survivorship of a TM revision shell/cemented DMC construct compared to 88% survivorship concerning dislocation and 98% aseptic survivorship in the group of TM shells with cemented or snap fit PE liner [20].

Although the concerns of elevated PE wear of the DMC have been alleviated, the potentially enhanced risk of aseptic loosening with the use of DMC and long-term wear of the mobile liner must be considered when implanting the DMC in younger and active patients. We did not encounter any IPD specific to the DMC systems. Darrith et al. observed that the rate of IPD of DMC was three times lower in RTHA compared to primary THA, but caution should be paid, especially in isolated acetabular revisions when the cup can be combined with stems with inappropriate neck design and skirted heads [13-15].

To summarize, in this report, we describe no dislocations or mechanical complications in a series of RTHA using a DMC cemented inside a newly implanted or retained revision TM shell.

This study has some limitations. Since it is a retrospective one, we faced the usual problems of underreporting data. Furthermore, we may have been biased in the indication for the use of cemented DMC since the operating surgeon chose that option over cementation of PE liner in revision patients that were considered to be at higher risk for dislocation (isolated cup revision, complex acetabular reconstruction, multiple previous surgeries, revision for instability etc.)

The series volume was small but comparative to other single center series using the same technique in RTHA [9-11, 15]. A single design cemented DMC and a single design revision TM shell was used, and therefore the results may not be generalizable to other designs and combinations.

The follow-up period was limited. Despite this, the rate of dislocation in RTHA remains elevated throughout the first 3 postoperative months, and most of the dislocations and mechanical failures after RTHA occur in the first postoperative year, which is adequately covered in our study [1,6]. Further follow-up will be required to ensure the long-term durability of this construct.

In **conclusion**, the results of this small clinical series demonstrate that cementing a DMC in a well-fixed TM revision shell leads to no dislocation or dissociation of the cement interface and acetabular construct loosening in the short term. This technique seems promising as an alternative for the prevention and treatment of instability in RTHA with complex acetabular reconstructions.

**REFERENCES:**


1. Batuyong ED, Brock HS, Thiruvengadam N, Maloney WJ, Goodman SB, Huddleston JI. Outcome of porous tantalum acetabular components for Paprosky type 3 and 4 acetabular defects. *J Arthroplasty.* 2014; Jun;29(6):1318-22. [PubMed]

2. Beckmann NA, Weiss S, Klotz MC, Gondan M, Jaeger S, Bitsch RG. Loosening after acetabular revision: Comparison of trabecular metal and reinforcement rings. A systematic review. *J Arthroplasty.* 2014 Jan;29(1): 229-35. [PubMed]

3. Brüggemann A, Fredlund E, Mallmin H, Hailer NP. Are porous tantalum cups superior to conventional reinforcement rings? *Acta Orthop.* 2017

Feb;88(1):35-40. [PubMed]

4. Konan S, Duncan CP, Masri BA, Garbuz DS. Porous tantalum uncemented acetabular components in revision total hip arthroplasty: a minimum ten-year clinical, radiological and quality of life outcome study. *Bone Joint J.* 2016 Jun;98-B(6):767-71. [PubMed]

5. Lachiewicz PF, Soileau ES, Martell JM. Wear and osteolysis of highly cross-linked polyethylene at 10 to 14 years: the effect of femoral head size. *Clin Orthop Relat Res.* 2016 Feb; 474(2):365-71. [PubMed]

6. Jauregui JJ, Pierce TP, Elmallah RK, Cherian JJ, Delanois RE, Mont MA. Dual mobility cups: an effective prosthesis in revision total hip arthroplasties for preventing dislocations. *Hip Int.* 2016 Jan-Feb;26(1):57-61. [PubMed]

7. Harwin SF, Sultan AA, Khlopas A, Chughtai M, Sodhi N, Piuzzi NS, et al. Mid-Term Outcomes of Dual Mobility Acetabular Cups for Revision Total Hip Arthroplasty. *J Arthroplasty.* 2018 May;33(5):1494-1500. [PubMed]

8. 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 May;42(5):1015-1020., [PubMed]

9. Chalmers BP, Pallante GD, Taunton MJ, Sierra RJ, Trousdale RT. Can dislocation of a constrained liner be salvaged with dual-mobility constructs in revision THA? *Clin Orthop Relat Res.* 2018 Feb;476(2):305-312. [PubMed]

10. Mohaddes M, Cnudde P, Rolfson O, Wall A, Karrholm 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.* 2017Mar;41(3):583-588. [PubMed]

11. 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 Jan;100-B(1):11-19. [PubMed]

12. Chalmers BP, Ledford CK, Taunton MJ, Sierra RJ, Lewallen DG, Trousdale RT. Cementation of a Dual Mobility Construct in Recurrently Dislocating and High Risk Patients Undergoing Revision Total Arthroplasty. *J Arthroplasty.* 2018 May; 33(5):1501-1506. [PubMed]

13. Evangelista PJ, Okroj K, Plummer D, Della Valle CJ, Schwarzkopf R. Do Cemented Dual-Mobility Cups Confer Stability for Patients at High Risk of Dislocation in Revision Total Hip Arthroplasty? *J Hip Surg.* 2018 Jun;02(02):088-091. [Crossref ]

14. Gabor JA, Feng JE, Gupta S, Calkins TE, Della Valle CJ, Vigdorchik J, et al. Cementation of a monoblock dual mobility bearing in a newly implanted porous revision acetabular component in patients undergoing revision total hip arthroplasty. *Arthroplast Today.* 2019 Jun 14;5(3):341-347. [PubMed]

15. Löchel J, Janz V, Hipfl C, Perka C, Wassilew GI. Reconstruction of acetabular defects with porous tantalum shells and augments in revision total hip arthroplasty at ten-year follow-up. *Bone Joint J.* 2019 Mar;101-B(3):311-316. [PubMed]

16. 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 Feb;476(2):293-301. [PubMed]

17. Schmidt A, Batailler C, Fary C, Servien E, Lustig S. Dual mobility cups in revision total hip arthroplasty: efficient strategy to decrease dislocation risk. *J Arthroplasty.* 2020 Feb;35(2): 500-507. [PubMed]

18. Brown TS, Tibbo ME, Arsoy D, Lewallen DG, Hanssen AD, Trousdale RT, et al. Long-term outcomes of constrained liners cemented into retained, well-fixed acetabular components. *J Bone Joint Surg Am.* 2019 Apr 3; 101(7):620-627. [PubMed]

19. Jenkins DR, Odland AN, Sierra RJ, Hanssen AD, Lewallen DG. Minimum five year outcomes with porous tantalum acetabular cup and augment construct in complex revision total hip arthroplasty. *J Bone Joint Surg Am.* 2017 May 17;99(10):e49. [PubMed]

20. Brüggemann A, Mallmin H, Hailer NP. Do dual-mobility cups cemented into porous tantalum shells reduce the risk of dislocation after revision surgery? *Acta Orthop.* 2018 Apr;89(2):156162. [PubMed]

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