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Incomplete seating of modular dual mobility

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Summary

Objective. Instability is considered a leading cause of early revision in total hip arthroplasty. Dual mobility cup (DMC) has shown to be a good solution for this problem. However, using DMC there is the potential complication of malseating of the liner. The study aims to determine the incidence of DMC malseating in a large volume hospital where different modular constructs are used, and if there is a significant difference in the incidence between the different constructs used.

Methods. In this retrospective study, we included patients admitted at single institution from January 2016 to March 2020. One-hundred-and-one patients were enrolled. Fifty-seven patients were male, the mean age was 61 years, and the mean body mass index was 25.9 kg/m^2.

Results. Three patients had radiographic evidence of liner malseating. In one patient, the radiological divergence disappeared at one-year follow-up. One patient showed an unfavorable evolution with a progressive increase of the divergence of the shell line associated with a painful noise. He eventually underwent revision surgery.

Conclusions. In high-risk patients, DMC component provided a low risk of dislocation and good overall survival.

Key words: incomplete, seating, dual mobility, malseating, modular

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Introduction

Instability is considered a leading cause of early revision in total hip arthroplasty [1]. Since it was developed in the late seventies, the dual mobility cup (DMC) has shown to be a good solution for this problem [2-4], leading to a significant reduction of the instability rate.

The reported clinical data have recently been confirmed by European Registers [5-8]. In France, the country where the DMC was developed, the dislocation rate has globally decreased from 9.06% in 2005 to 6.10% in 2014 [9] and dual mobility constructs are nowadays estimated to be used in 62% of all revision hip procedures [10] with substantial cost savings [11].

Two options for DMC implants are currently available: monoblock or modular [12]. The monoblock design consists of a one-piece steel or cobalt chrome acetabular shell. Some implants also have two pegs at the bottom (in correspondence of the pubis and ischium) and one screw on the top of the cup. Furthermore, a hook for obturator anchorage and one or more plates can be used with some implants for ilium screw fixation. The monoblock component does not permit screw fixation through the shell, and this option is usually preferred in revision settings.

Modular Dual Mobility Cup (modular DMC) cups were introduced during the last

decade in order to overcome this limitation. The use of modular DMC components during primary and revision total hip arthroplasty (THA) has been progressively growing during the last years. Modular DMC differ from the original monoblock DM for the material of construction and possibility to additional fixation. Indeed, the modular construct utilizes titanium alloy instead of stainless-steel or cobalt chromium alloy. With respect of original construct which lack of holes, the modular implants allow for supplemental screw fixation or attachment of an insertion handle, making the implantation easier. Contemporary modular DMC designs consist of a standard titanium acetabular component and a modular cobalt-chromium articular liner which articulate with the polyethylene. A possible drawback of modular DMC is represented by liner miseating, which has high propensity to micromotion and corrosion. Malseating was initially described for ceramic-on-ceramic bearing with an incidence of 7.2% [13]. Malseated metal-backed liners in acetabular shells have been reported with variable incidence from 1.3 to 16.4% [14-16].

All these cases were reported using a single modular DM construct. Given the increasing use of modular DMC and the appearance of different models by different companies, we sought to answering the following questions:

1. what is the incidence the modular DM malseating in a large volume hospital where different modular constructs are used?
2. it is possible to find a significant difference in the incidence between the different constructs?

Materials and methods

This is a retrospective review performed at Maggiore Hospital of primary and revision THAs performed with a modular dual mobility bearing between January 2016 and March 2020.

A total of 101 patients who underwent primary or revision THAs using a modular DMC construct were identified. The cohort include 20 Integra cups (Groupe Lepine®), 42 Traser (Permedica®), 25 Tritanium MDM (Stryker®) and 14 to Lima implants Delta TT or Delta Revision. The Devane score, ASA scores and the Charnley classification are presented in Table I. The cohort comprised 57 men and 44 women, aged 60.9 ± 15.8 years (range 19-93), with body mass index (BMI) of 25.9 ± 4.1, ASA 1: 6 patients (6%); ASA 2: 31 patients (30%); ASA 3: 52 (51%); ASA 4: 12 patients (12%).

Pre-operative walking ability was assessed with the Charnely classification [7]: it stratifies patients into three categories to quantified walking ability and levels of activity. Patients are assigned to Class A if they have single joint arthropathy and no significant medical comorbidity. Class B patients have one other joint in need of an arthroplasty, or an unsuccessful or failing arthroplasty in another joint, while Class C patients have multiple joints in need of arthroplasty, multiple failing arthroplasties or significant medical or psychological impairment. For all ambulant patients, excluding patients with femoral neck fractures, the pre-operative evaluation was completed using the Harris Hip Score (HHS) [8]. The same score was then used at each and last follow-up.

Eighty-four patients (83%) underwent a primary THA and 17 patients (17%) revision procedures. For primary THA: 23 patients (27%) were fractures, 35 patients (42%) were osteoarthritis, 16 patients (19%) femoral head necrosis and 10 patients (12%) osteosynthesis failures. For the revisions: 6 patients (36%) were

Table I. Patient characteristics and baseline variables.

	INTEGRA Groupe Lépine®	TRASER Permedica®	TT or Revision LIMA®	Tritanium MDM Stryker®	Tot.	p value
No. of patients	20	42	14	25	101	
Age at surgery	71.5 ± 15.1	62.8 ± 15.9	60.1 ± 10.3	49.8 ± 11.6	60.9 ± 15.8	0.00003
Right/left	7/13	20/22	9/5	16/9	52/49	0.178
Male/female	9/11	22/20	9/5	17/8	57/44	0.383
BMI	25.1 ± 4.8	25.8 ± 3.9	26.3 ± 5.2	26.2 ± 3.5	25.9 ± 4.1	0.013
ASA (1/2/3/4)	0/1/13/6	5/12/20/5	0/6/7/1	1/12/12/0	6/31/52/12	0.065
Charnley classification (A/B1/B2/C)	6/8/1/5	10/26/4/2	3/9/2/0	17/5/3/0	36/48/10/7	0.003
Devane activity score (D2/D3/D4/D5)	0/5/12/3	4/9/26/3	0/2/11/1	0/8/17/0	4/24/66/7	0.887
Acetabular cup size, mean (min-max)	54.4 (48-62)	53.4 (48-60)	55.4 (50-60)	53.4 (48-60)	53.9 (48-66)	

All results are expressed as variables and as mean ± standard deviation for continuous variables. Statistical significance was set at $p < 0.05$.

treated for periprosthetic infection, 7 patients (41%) were treated for aseptic loosening of prosthetic components and 4 patients (23%) were treated for periprosthetic fractures.
Clinical and radiographic follow up was performed at one, three and six months after surgery and then every year. Patients who were unable to return for follow-up were mailed a questionnaire and were asked to return radiographic images.
The primary outcome was post-operative dislocation requiring closed reduction, open reduction, or revision THA. Secondary reoperation for any cause, and overall complications where reported. Finally, clinical and radiological evaluation was performed for each patient.

Radiographic assessment

Plain pelvic X-rays were evaluated at every pre-established follow-up. The measurements were manually performed by two operators (SS and MP), using Carestream Vue Pacs (Rochester, NY,). The immediate post-operative standardized anteroposterior and lateral view radiographs were compared to the radiographs taken at each following control.

According to prior works, the modular liner was considered malseated if there was either a visible gap between the back of the liner and the rim of the acetabular shell, or if there was any angulation between the liner and the shell, in case where the liner exceeds the shell, like for MDM of Stryker® and Lima®. For Integra (Groupe Lepine®) and Traser (Permedica®) which modular liners sit flush with the rim of the acetabular shell. The liner was considered malseated in cases with a distinct gap seen on the otherwise flush implant surface on AP or cross table lateral radiographs.

Statistical analysis

Quantitative data were reported as means ± standard deviation (SD) or medians (range). Differences between the groups were assessed using the One-Way ONAVA including Turkey HSD test for parametric data. The Chi-Square test (APA) was adopted for categorical variables (osseointegration parameters). SPSS software (version 14.0.1; Chicago, IL, USA) was used for statistical analyses. $p < 0.05$ was considered statistically significant.

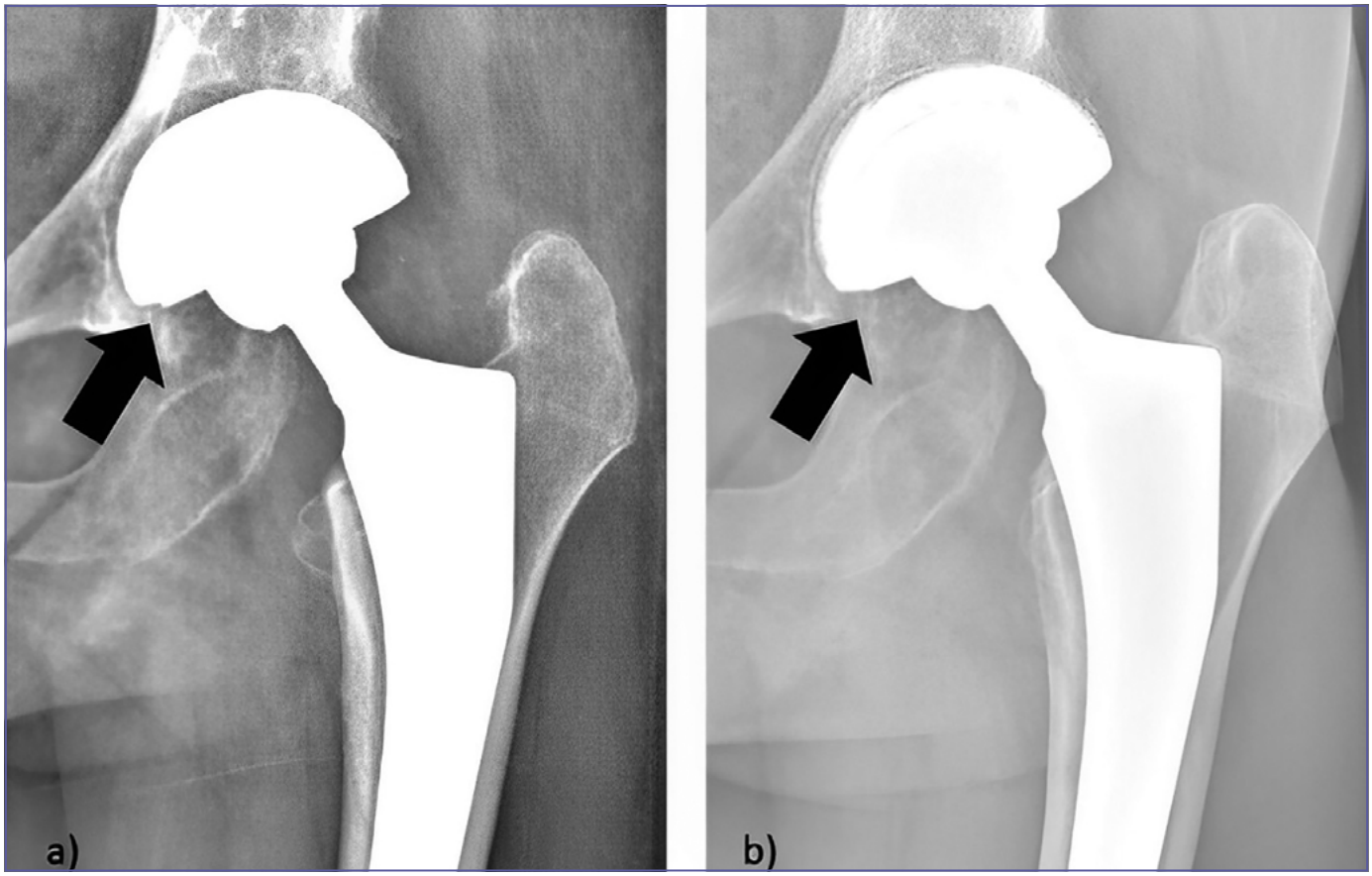

Figure 1. Seventy-five-year-old woman treated with total hip arthroplasty. A) at the post-operative X-ray is possible to see a radiological divergence of the shell line indicative of mispositioning (black arrow); B) at 1 year follow-up the divergence disappeared.

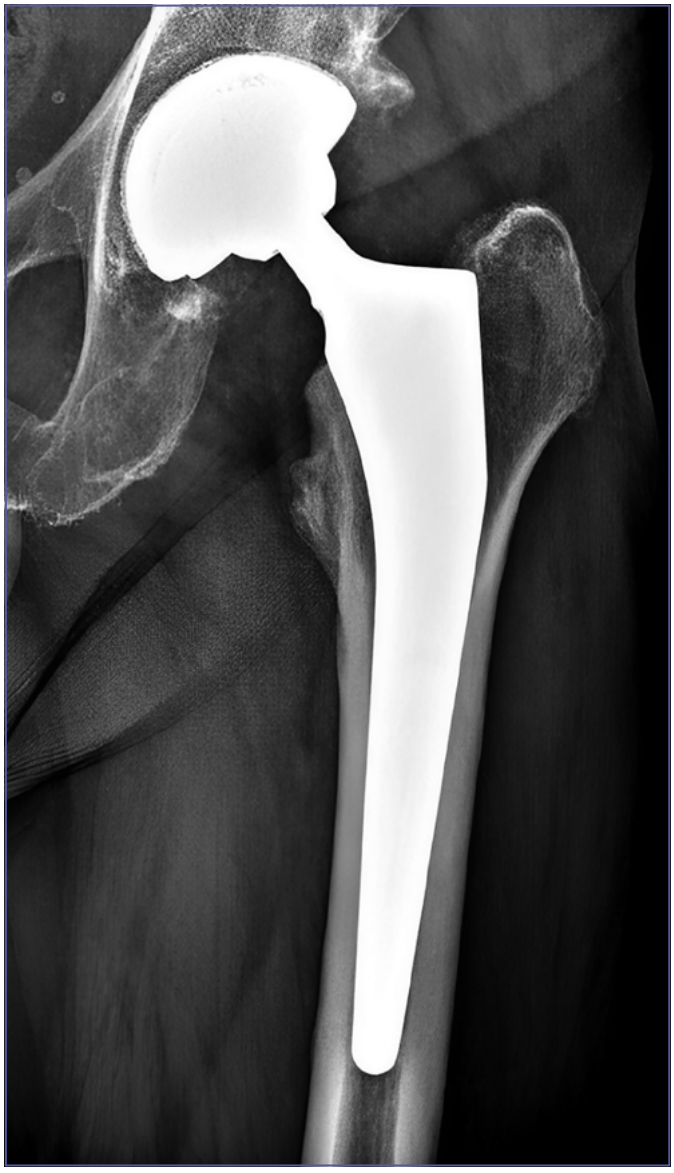

Figure 2. Fifty-eight-year-old man treated with total hip arthroplasty. Radiological divergence of the shell is visible at one-year follow-up. The patient showed no pain in weight-bearing or hip motion.

Results

Three patients had radiographic evidence of liner mispositioning, two cases in the Permedica group and one in the Stryker MDM group®. In one of the two patients, radiological divergence of the shell line indicative of mispositioning, clearly identified on post-operative CT and radiography, disappeared at one-year follow-up, while in the other patient the radiographic divergence was observed at all subsequent follow-ups even if still in the short term (48 months). Both patients had excellent clinical evaluation (mean HHS at month 6: 89.9 ± 2.3; mean HHS at one year 95.6 ± 1.6) (Figs. 1 and 2). The third patient, from the Tritanium MDM Stryker group®, had an unfavorable evolution with a progressive increase of the divergence of the shell line associated with a painful noise The patient therefore underwent revision surgery and after the operation the HHS had a remarkable improvement (Fig. 3).

Discussion

The use of modular DMC involves more potential complications than conventional DMC. The modular DMC is a prosthetic construct which adds one liner, cobalt-chromium liner. The possibility of fretting corrosion at the non-articulating metal-on-metal interface between the modular liner and the titanium socket may cause metal release [17,18]. In the literature several studies have reported uniformly low blood metal ion concentrations in patients undergoing DMC primary or revision THA, which were found to be acceptable for the safety of patients [19,20]. However, all these studies have short follow-ups and the possible adverse biological effects of metal release in the long-term are unknown. Recently. Chalmers et al. reported that no patient with a modular dual-mobility construct and ceramic femoral head had elevated cobalt levels. That series also included patients revised specifically for adverse local tissue

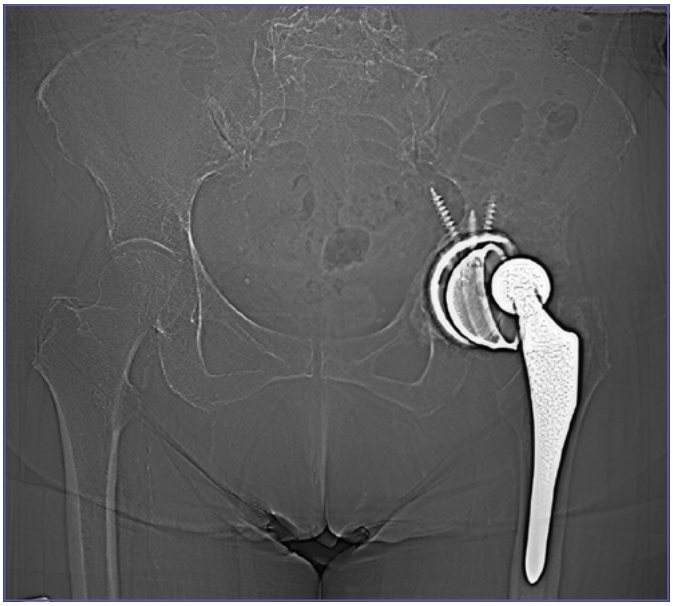

Figure 3. Sixty-one-year-old woman treated with total hip arthroplasty. The patient showed a progressive increase in the divergence of the shell line until subluxation of the implant head, with pain and a squeaking noise during motion. She eventually underwent revision surgery.

reactions to metal. Three patients had radiographic evidence of incomplete seating of the liner. Two cases occurred in the group of Permedica® and one in the Stryker® series. Only the latter needed to be submitted to revision. The notion that a stiff cobalt-chrome liner has a potentially higher risk of malseating because of less-conforming tolerance than that of polyethylene has been supported by experiences with incomplete seating of the liner with metal-backed ceramic liners [21]. This complication can be caused by interposition of soft tissue or bone and plastic deformation of acetabular shell during impaction. Cadaveric studies, using the press fit technique with Trident acetabular shells, have actually shown constant compression deformation preventing complete seating of the liner [13]. Two papers [15,22] have reported incomplete seating using MDM Stryker® modular DMC. The incidence was, respectively, 5.8 and 1.3% lower than that reported in similarly hard and inelastic metal-backed ceramic liners and significantly higher with low-volume MDM surgeons than high-volume MDM surgeons [22]. Another paper recently has reported an incidence of liner malseating of 5.0% with both Stryker® and Zimmer Biomet® constructs [14]. According to this study, a component size of 50 mm or smaller was identified as a risk factor for malseating.

Our study has several limitations. First, it is a retrospective review with a relatively small number of patients. Secondly, it is a heterogeneous study that includes primary and revision and conversion THAs. Finally, none of our cases were submitted to serum ion evaluation. Nevertheless, is the only report where four different modular MDC implants have been studied in a high-risk population in a single institution.

Conclusions

Our study suggests that, in high-risk patients, a DMC component provided a low risk of dislocation and good overall survival. Longer follow-up is obviously required to determine the prevalence of late complications and the limitations of these components in patients with a high risk of dislocation and revisions for recurrent dislocation.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

DT, GM: participated in conceptualization, development of study design, data collection and curation and writing of the original draft; SS, MP: performed formal analysis, participated in writing the original draft; CP, AP: participated in review and editing of data and final draft. DT, GM: provide study materials, patients, and settings. They participated in oversight and leadership responsibility for the research activity, planning and execution; EC: participated in project administration, management and coordination responsibility for the research activity. All authors have read and agreed to the published version of the manuscript.

Ethical consideration

No Ethical approval was needed, since this is a retrospective study. The study was conducted in accordance with the Helsinki declaration and all patients gave informed consent in writing to participate.

References

1 Romagnoli M, Grassi A, Costa GG, et al. The efficacy of dual-mobility cup in preventing dislocation after total hip arthroplasty: a systematic review and meta-analysis of comparative studies. Int Orthop 2019;43:1071-1082. https://doi.org/10.1007/S00264-018-4062-0

2 Massin P, Orain V, Philippot R, et al. Fixation failures of dual mobility cups: a mid-term study of 2601 hip replacements. Clin Orthop Relat Res 2012;470:1932-1940. https://doi.org/10.1007/S11999-011-2213-3

3 Lecuire F, Benareau I, Rubini J, et al. Intra-prosthetic dislocation of the Bousquet dual mobility socket. Rev Chir Orthop Reparatrice Appar Mot 2004;90:249-255. https://doi.org/10.1016/S0035-1040(04)70101-4

4 Philippot R, Boyer B, Farizon F. Intraprosthetic dislocation: a specific complication of the dual-mobility system. Clin Orthop Relat Res 2013;471:965-970. https://doi.org/10.1007/S11999-012-2639-2

5 Noyer D, Groupe Gilles. La troisième articulation des prothèses de hanche à double mobilité. Maîtrise Orthopédique 2003;121:20-22.

6 Neri T, Boyer B, Geringer J, et al. Intraprosthetic dislocation of dual mobility total hip arthroplasty: still occurring? Int Orthop 2019;43:1097-1105. https://doi.org/10.1007/S00264-018-4054-0

7 Charnley J, Halley DK. Rate of wear in total hip replacement. Clin Orthop Relat Res 1975;112:170-179. https://doi.org/10.1097/00003086-197510000-00021

8 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:737-755. https://doi.org/10.2106/00004623-196951040-00012

9 Woo R, Morrey B. Dislocations after total hip arthroplasty. J Bone Jt Surg Am 1982;64:1295-306.

10 DeLee J, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res 1976;121:20-32.

11 Hodgkinson J, Shelley P, Wroblewski B. The correlation between the roentgenographic appearance and operative findings at the bone-cement junction of the socket in Charnley low friction arthroplasties. Clin Orthop Relat Res 1988;228:105-109.

12 Moore MS, McAuley JP, Young AM, et al. Radiographic signs of osseointegration in porous-coated acetabular components. Clin

Orthop Relat Res 2006;444:176-183. https://doi.org/10.1097/01.BLO.0000201149.14078.50

13 Miller AN, Su EP, Bostrom MPG, et al. Incidence of ceramic liner malseating in Trident acetabular shell. Clin Orthop Relat Res 2009;467:1552-1556. https://doi.org/10.1007/S11999-009-0770-5

14 Chalmers BP, Dubin J, Westrich GH. Modular dual-mobility liner malseating: a radiographic analysis. Arthroplast Today 2020;6:699-703. https://doi.org/10.1016/J.ARTD.2020.07.034

15 Romero J, Wach A, Silberberg S, et al. 2020 Otto Aufranc Award: malseating of modular dual mobility liners. Bone Joint J 2020;102-B:20-26. https://doi.org/10.1302/0301-620X.102B7.BJJ-2019-1633.R1

16 Guntin J, Plummer D, Della Valle C, et al. Malseating of modular dual mobility liners. Bone Jt Open 2021;2:858-864. https://doi.org/10.1302/2633-1462.210.BJO-2021-0124.R1

17 Tarity TD, Koch CN, Burket JC, et al. Fretting and corrosion at the backside of modular cobalt chromium acetabular inserts: a retrieval analysis. J Arthroplasty 2017;32:1033-1039. https://doi.org/10.1016/J.ARTH.2016.09.038

18 Lombardo DJ, Siljander MP, Gehrke CK, et al. Fretting and corrosion damage of retrieved dual-mobility total hip arthroplasty systems. J Arthroplasty 2019;34:1273-1278. https://doi.org/10.1016/J.ARTH.2019.02.008

19 Nam D, Salih R, Nahhas CR, et al. Is a modular dual mobility acetabulum a viable option for the young, active total hip arthroplasty patient? Bone Joint J 2019;101-B:365-371. https://doi.org/10.1302/0301-620X.101B4.BJJ-2018-0834.R1

20 Chalmers BP, Mangold DG, Hanssen AD, et al. Uniformly low serum cobalt levels after modular dual-mobility total hip arthroplasties with ceramic heads: a prospective study in high-risk patients. Bone Joint J 2019;101-B:57-61. https://doi.org/10.1302/0301-620X.101B6.BJJ-2018-1403.R1

21 Markel D, Bou-Akl T, Rossi M, et al. Response profiles of circulating leukocytes and metal ions in patients with a modular dual-mobility hip implant. Hip Int 2019;July 21. https://doi.org/10.1177/1120700019865530 [Epub Ahead of Print]

22 Markel D, Day J, Siskey R, et al. Deformation of metal-backed acetabular components and the impact of liner thickness in a cadaveric model. Int Orthop 2011;35:1131-1137. https://doi.org/10.1007/S00264-010-1077-6