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Mid-Term Results of the Metal-on-Metal Total Hip Arthroplasty

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ABSTRACT

When it came into use, meta-metal surfaces, which received immense attention due to their varied advantages, were successfully applied for a while. However, over time, their use decreased because they were associated with some complications that developed due to metal wear. This study aimed to analyze the findings on metal-on-metal surfaces. Metal-on-metal total hip replacement prosthesis applied in our clinic between 2004 and 2008 was retrospectively screened. A total of 90 hips of 77 patients included in the study were evaluated. The average Haris hip score in the mid-term controls was 89.8 (±10.9). A revision was performed in six hips for different reasons (6.6%), and the total prosthesis survival rate was 93.3%. Symptomatically, only 2 (2.2) patients had pseudotumor and 28 patients (31.1%) developed stress shielding due to prosthetic design. Similar success was achieved with other surface alternatives in terms of functional results and prosthetic survival in metal-on-metal surfaces in the medium term.

Key words: Metal on metal, pseudotumor, total hip replacement

INTRODUCTION

Previously, total hip replacement (THR) was preferred only in elderly patients due to its short life. However, in recent years, it has been successfully applied to younger patients due to reasons such as advances in prosthesis design, increasing experience of surgeons, rapidly increasing biomechanical studies, changing people's living standards, increasing prosthesis lifespan, and decreasing complications. This has led to the development of many new prostheses. After the 1960s, the use of metal-on-metal (MOM) implants in total hip arthroplasty has gradually increased due to reasons such as theoretically better functional results, especially in young and active patients (1,2). Especially the thinner metal liner allowed the use of a larger head, and thus increased stability was an important advantage. Besides, 10–100 times less debris was formed on MOM surfaces compared with conventional polyethylene surfaces, and the debris formed was much smaller than polyethylene debris (3,4). Due to such advantages, its use gradually increased in the early 2000s and its early results were encouraging (5-7).

Later, the identification of significant problems with the use of MOM surfaces began to change the approach to this surface alternative. Immunological reactions to metal debris in bone and soft tissues, metal hypersensitivity, and concerns about the possible carcinogenic potential of increased metal ion levels in the circulation have reduced its use and even led to the withdrawal of some products from use (8-10).

Despite all these new negative results regarding the use of MOM, good results have been reported regarding the survival of surfaces, and new and different results are published every day about MOM (11,12). Due to these different results and approaches in the literature, the present study aimed to determine the functional and clinical results, complications, and prosthetic survival rates of MOM THR cases in this study.

MATERIAL AND METHODS

After obtaining the necessary ethics committee approval (No: 99950669/233) and permission, MOM

hip arthroplasty records collected prospectively in the clinic were evaluated retrospectively. All MOM THA cases between January 2004 and December 2008 for different etiological reasons were determined by examining the files and hospital records of 358 patients. Patients who were missing in their files and data, refused to participate in the study, did not attend regular controls, and were operated based on pathological fractures (malignancy) were excluded. Primary coxarthrosis, coxarthrosis due to rheumatological diseases, developmental hip dysplasia, traumatic coxarthrosis, and MOM THA were accepted as the inclusion criteria. Further, 90 hips of 77 patients who met the inclusion criteria were evaluated. Informed consent was obtained from patients who participated in this study.

Surgical technique

All patients were operated on under general, epidural, or spinal anesthesia using a posterolateral (modified Gibson) incision (13). They were operated on by two senior surgeons. In all cases, cementless prostheses were placed as press-fit. Cormet cup was used as the acetabular component, Corinium stem 12/14 extended bi-coat as the femoral stem, and Optimom head (Corin, Cirencester, Gloucestershire, UK) as the head.

First-generation cephalosporin (cefazolin) was given to all patients half an hour before surgery. Later, the dosage was 3 × 1 g/day 1 day postoperatively and intravenously. For deep vein thrombosis prophylaxis, 0.4 mL of low–molecular weight heparin (S.C) was started 12 h ago in the patients; lower–molecular weight heparin was given for 28 days postoperatively. Subsequently, low–molecular weight heparin was discontinued, and 100 mg acetylsalicylic acid was given to the risky patient group as an antiaggregant.

The patients were mobilized on the first postoperative day. They were evaluated clinically and radiologically in 2, 4, 8, 12, and 24 weeks postoperatively. Routine anteroposterior (AP) and lateral hip radiographs were taken. Patients who were allowed to give partial weight for the first 3 weeks were mobilized with full weight after the third week.

Clinical and radiological evaluation

The functional results of the patients were evaluated using the Harris hip score (14). The Trendelenburg sign was used in the clinical evaluation for preoperative and postoperative leg length and muscle strength measurement. In radiological evaluation, AP and lateral hip radiographs and orthoroentiogram were taken routinely. In the radiographic analysis of the prosthesis, the radiolucent areas between the acetabular component and the bone tissue were evaluated according to the three regions defined by DeLee and Charnley (15). Femoral component loosening was evaluated according to the Gruen regions (16). The prosthesis length used in the patients was determined and recorded. Acetabular cup inclination angles were calculated on pelvis AP radiographs.

Statistical evaluation

SPSS 18.0 version (SPSS, Inc., IL, USA) program was used for the statistical analysis of the data. The conformity of the data to normal distribution was evaluated by visual (histogram and probability graphs) and analytical methods (Kolmogorov–Smirnov/Shapiro–Wilk test).

RESULTS

Bilateral THR was applied in 13 (16.8%) of the patients. The mean age of the patients was 58.3 (± 11.8) (range 31–78) years; 51 (66.2%) were female, and 26 (33.8%) were male. The average follow-up duration was 85 (66–112) months. The demographic data of the patients are given in Table 1.

The mean score at the last control was 89.8 (± 10.9). When the patients with low scores and in the poor group were evaluated separately, it was observed that these patients had advanced cardiological problems and were of advanced age. The acetabular

Table 1 Demographic information of the patients

Variables	Numbers/Ratio
Number of patients/Hips	77/90
Average age (year)	58, 32
Male:female	26–51
Primary idiopathic coxartrosis	53 (58.8%)
Developmental hip dysplasia	26 (28.8%)
Avascular necrosis	3 (3.3%)
Femoral neck fracture	3 (3.3%)
Ankylosing spondylitis	1 (1.1%)
Rheumatoid arthritis	4 (4.4%)

cap inclination degree was calculated as 46.8 (±7.5) degrees on average. In five patients, the inclination degree was above 55 and the maximum value was 70 degrees. However, the lowest value was below 35 degrees in at least two patients; it was calculated as 31 degrees. The acetabular revision was performed in one of the patients (1.1%) due to the hip dislocation three times, and the acetabular inclination angle was found to be very high in this case. In two (2.2%) patients, periprosthetic fracture developed due to falling and was treated, and in two (2.2%) patients, an early infection developed. The prosthesis was removed due to the failure of recovery despite washing, debridement, and antibiotic therapy, and two-stage revision surgery was performed. However, Girldstone was applied in both patients due to the failure of the treatments and re-infection (Table 2).

Table 2 Functional and clinical results of the patients

Variables	Number of patients	%
Harris Hip score		
Excellent	52	67.86
Good	12	14.9
Mild	10	13.5
Bad	3	4.1
Dislocation	1	1.1
Early infection	2	2.2
Acetabular loosening and revision	3	3.3
Stress shielding	28	31.1
Heterotopic ossification	12	13.3
Deep vein thrombosis	2	2.2
Prosthetic survival	84 (hips)	93.3

In the radiological evaluation of the patients, the radiographs taken in the previous controls and the radiographs in the controls were compared. The acetabular cup was found to be loosened in three (3.3%) cases (a radiolucent area larger than 2 mm between the acetabular cup and the bone). These patients were re-evaluated to support their clinical findings. Since the femoral component did not loosen in all three patients, the femoral head was revised with only the acetabular component and polyethylene insert. A cystic size of 82 × 41 × 27 mm^3 in one patient and a solid pseudotumor of 50 × 25 × 15 mm^3 in the other was detected (Fig. 1) and removed (Fig. 2). Thus, revisions were performed in six (6.6%) hips during the follow-up period, and only two (2.2%) of these revisions were attributed to complications due to MOM surfaces. The total prosthesis survival rate was 93.3%.

Since the femoral stem did not loosen in any of the patients but the stem was involved distally, cortical hypertrophy in the femur was detected in 15 patients, especially in the distal one third of the stem. Various degrees of pain in the anterior thighs were also found in these patients. However, stress shielding developed in the proximal femur and trochanter major in 28 (31.1%) patients due to the femoral stem with distal involvement (Figs 3 and 4).

Heterotopic ossification was observed in 12 patients (13.3%). In two patients, a fracture was found in the trochanter major, and it was fixed intraoperatively. In one patient, a fracture occurred in the trochanter

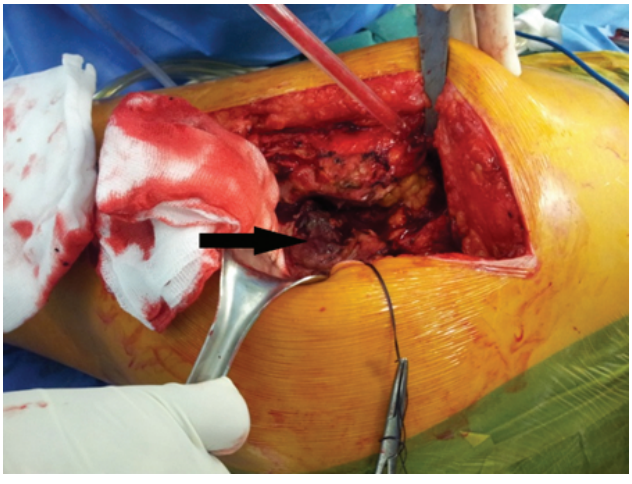


Figure 1 Intraoperative view of the pseudotumor (black arrow).

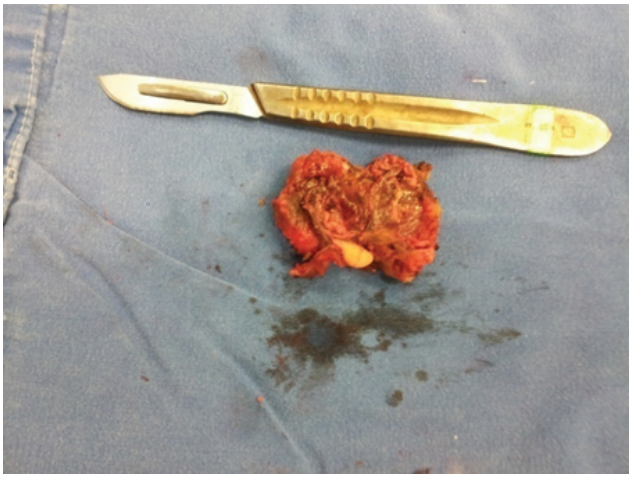
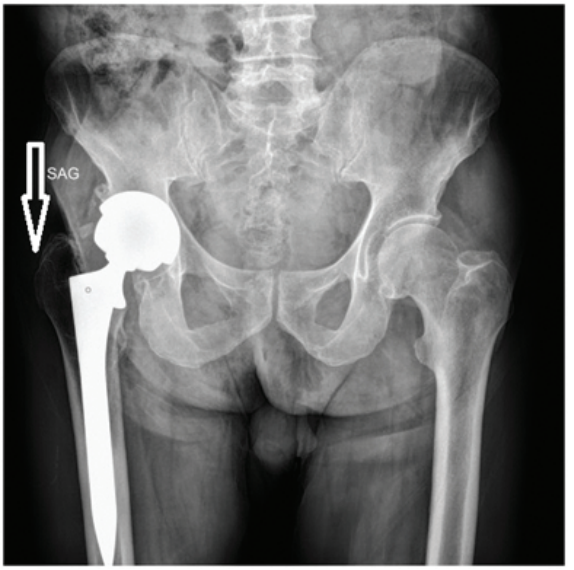


Figure 2 Macroscopic view of the pseudotumor after removal.



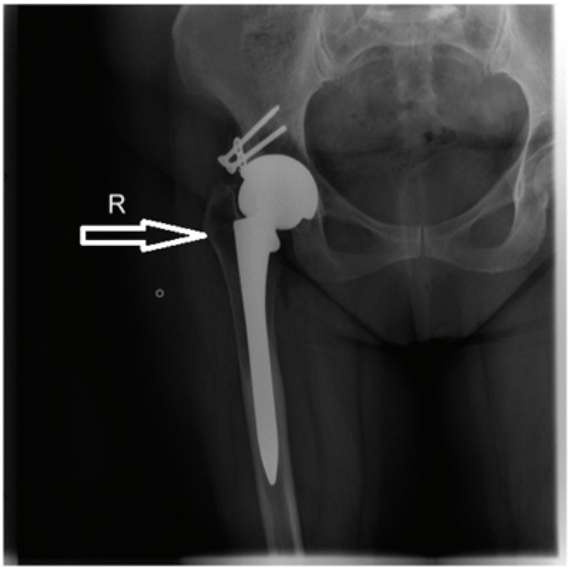


Figure 3 and 4 Stress shielding on x-ray radiographs (white arrow).

major as a result of a fall in the follow-up, but the patient was not treated because he did not accept the operation and the fracture did not union. Deep vein thrombosis was found in two (2.2%) patients in the postoperative period. None of the patients had femoral cortex perforation, late dislocation, or sciatic nerve complications.

DISCUSSION

DMOM surfaces, which are the most effective treatment method in hip osteoarthritis, were used in total hip arthroplasty very frequently especially in the early 2000s; the high satisfaction and reported excellent results in the early period in patients encouraged surgeons. In addition, these positive results significantly increased the mobility of the patients and accelerated their return to normal daily life (17). This rate was higher, especially in younger patients. However, the fact that it allowed large-scale head use significantly reduced dislocation and related revision rates (18,19). The most striking result in the present study was that stable and highly functional results were obtained in the medium term in MOM THR cases. Except for one case with technical errors, the absence of dislocation was important for hip stability and prosthesis survival. Similar to the present study, Thomas et al. (20) reported the average Harris hip score of 92.5 (10–100) in the MOM THR results during a 5- to 10-year period, and Yalçın N et al. (21) reported the average Harris score as 90.3 in their patients with MOM THA. When the results of THR using metal-on-polyethylene, which is the most commonly used method as the other surface alternative, were evaluated, Harris hip scores were 92 in the study by Kim, 93 in the study by Bojescul et al., 84 in the study by Aldinger (22-24). These findings showed that MOM THR provided stable and good functional results in the medium term.

Despite all these positive results, the use of MOM THR is controversial due to some problems detected. Immunological reactions have been detected in bone and soft tissue, especially depending on the metal debris formed (25-28). Despite different results regarding the complications related to MOM-bearing surfaces, an association with pseudotumor formation has been found. Nowadays, pseudotumor development due to MOM-bearing surfaces has been reported in an increasing number of studies. It is particularly effective in prosthesis loosening. It may lead to worse clinical results after revision compared with other MOM revisions (29). However, in many patients, pseudotumors develop asymptomatically and do not show clinical symptoms. Hart et al. (30) found the rate of pseudotumor as 57%–61% in patients with poor and good hip functions scanned by MRI, and they showed no

significant difference in the prevalence. Weegan et al. (31) found the prevalence of pseudotumor to be 27% in their asymptomatic patients. In addition, the fate of these pseudotumors is not very clear. Sulaiman et al. (32) observed that pseudotumors enlarged in 6 of 10 asymptomatic patients, shrank in 1 patient, and completely disappeared in 3 patients. Of the five patients with revision, pseudotumors completely disappeared in four patients and shrank in one patient. Mo clear data are available in favor of the complete abandonment of MOM-bearing surfaces. In the present study, pseudotumor was detected intraoperatively in two of three patients whose acetabular component was revised. In these patients, sufficient data were not available to link the cause of revision to the formation of pseudotumor; the revision rate was in line with other THR results with different bearing surfaces and compatible with the literature.

An important factor affecting the component wear and the amount of metal debris formed in patients with MOM THR is the placement of the acetabular component in the correct position. The inclination angle where the acetabular component is placed is one of the most important factors. In the biotechnical study conducted by Angadji et al. (33) MOM acetabular components placed at an inclination angle of 35, 50, and 60 degrees were more worn in the acceleration phase than in the fixed speed state, but with no significant difference between them. They found that the wear was higher compared with that in the case of the acetabular cup placed at 35 degrees and the wear volume increased as the angle increased in the constant-velocity phase. Similarly Hart et al. (34) reported that in 26 patients operated, the inclination angle greater than 50 degrees was statistically significantly higher in blood chromium and cobalt. In the present study, the mean acetabular cup angle of the patients was calculated as 46.8 (±7.5) degrees. Successful results were achieved in the range of 35–55 degrees, which is the defined safe range; the wear rate specified in the literature is low.

Since asymptomatic patients were not screened in the present study, the pseudotumor prevalence could not be calculated, but one study focused on pseudotumor and long-term survival. The important limitations of the present study were that the metal ion levels of the patients were not monitored in the preoperative and postoperative periods, and acetabular anteversion was not calculated.

In conclusion, no difference was found in mid-term clinical results and postoperative complications such as infection, loosening, and dislocation in patients with MOM THR compared with other surface alternatives. However, longer-term studies are needed to understand the complications related to symptomatic and asymptomatic metallosis that may occur in MOM THR applications in the future.

Conflicts of interest: The authors declare no conflicts of interest.

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REFERENCES

1. Kumar N, Arora GN, Datta B. Bearing surfaces in hip replacement - Evolution and likely future. Med J Armed Forces India. 2014;70(4):371-376. doi:10.1016/j.mjafi.2014.04.015
2. Ebreo D, Bell PJ, Arshad H, Donell ST, Toms A, Nolan JF. Serial magnetic resonance imaging of metal-on-metal total hip replacements. Follow-up of a cohort of 28 mm Ultima TPS THRs. Bone Joint J. 2013;95-B(8):1035-1039. doi:10.1302/0301-620X.95B8.31377
3. Wawrose RA, Urish KL. Diagnosis and Management of Adverse Reactions to Metal Debris. Oper Tech Orthop. 2019;29(3):100732. doi:10.1016/j.oto.2019.100732
4. Catelas I, Bobyn JD, Medley JB, et al. Effects of digestion protocols on the isolation and characterization of metal-metal wear particles. I. Analysis of particle size and shape. J Biomed Mater Res. 2001;55(3):320-329. doi:10.1002/1097-4636(20010605)55:3<320::aid-jbm1020>3.0.co;2-3
5. Bernasek TL, Polikandriotis JA, Levering MF, Dalury DF, Fisher DA, Adler MJ. Five- to ten-year outcomes for modular metal-on-metal total hip arthroplasty. J Arthroplasty. 2013;28(7):1231-1234. doi:10.1016/j.arth.2013.03.012
6. Cicek H, Kilicarslan K, Yalcin N, Arslan E, Dogramaci Y, Yildirim H. Primary metal-on-metal total hip arthroplasty with large-diameter femoral heads: a clinical trial of 59 hips. Acta Orthop Belg. 2010;76(6):758-765.
7. Garfinkel JH, Gladnick BP, Pachter CS, Cochrane NH, Romness DW. Perioperative factors associated with increased length of stay after revision of metal-on-metal total hip arthroplasty. J Orthop. 2019;16(2):109-112. Published 2019 Jan 17. doi:10.1016/j.jor.2019.01.003
8. Willert HG, Buchhorn GH, Fayyazi A, et al. Metal-on-metal bearings and hypersensitivity in patients with artificial hip joints. A clinical and histomorphological study. J Bone Joint Surg Am. 2005;87(1):28-36. doi:10.2106/JBJS.A.02039pp
9. Pandit H, Glyn-Jones S, McLardy-Smith P, et al. Pseudotumours associated with metal-on-metal hip resurfacings. J Bone Joint Surg Br. 2008;90(7):847-851. doi:10.1302/0301-620X.90B7.20213
10. Bergiers S, Hothi HS, Henckel J, Eskelinen A, Skinner J, Hart A. Wear performance of retrieved metal-on-metal Pinnacle hip arthroplasties implanted before and after 2007. Bone Joint Res. 2018;7(11):595-600. Published 2018 Dec 1. doi:10.1302/2046-3758.711.BJR-2018-0143.R1

11. Mikhael MM, Hanssen AD, Sierra RJ. Failure of metal-on-metal total hip arthroplasty mimicking hip infection. A report of two cases. J Bone Joint Surg Am. 2009;91(2):443-446. doi:10.2106/JBJS.H.00603
12. Trevisan C, Piscitello S, Klumpp R, Mascitti T. Long-term results of the M2A-38-mm metal-on-metal articulation. J Orthop Traumatol. 2018;19(1):21. Published 2018 Dec 7. doi:10.1186/s10195-018-0514-y
13. MacKenzie JR, Kelley SS, Johnston RC. Total hip replacement for coxarthrosis secondary to congenital dysplasia and dislocation of the hip. Long-term results. J Bone Joint Surg Am. 1996;78(1):55-61. doi:10.2106/00004623-199601000-00008
14. 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(4):737-755.
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. Amstutz HC, Le Duff MJ. The mean ten-year results of metal-on-metal hybrid hip resurfacing arthroplasty. Bone Joint J. 2018;100-B(11):1424-1433. doi:10.1302/0301-620X.100B11.BJJ-2017-1459.R2
18. Dowson D, Hardaker C, Flett M, Isaac GH. A hip joint simulator study of the performance of metal-on-metal joints: Part II: design. J Arthroplasty. 2004;19(8 Suppl 3):124-130. doi:10.1016/j.arth.2004.09.016
19. Higuchi Y, Seki T, Takegami Y, Komatsu D, Morita D, Ishiguro N. Same survival but higher rate of osteolysis for metal-on-metal Ultamet versus ceramic-on-ceramic in patients undergoing primary total hip arthroplasty after 8 years of follow-up. Orthop Traumatol Surg Res. 2018;104(8):1155-1161. doi:10.1016/j.otsr.2018.08.005
20. Bernasek TL, Polikandriotis JA, Levering MF, Dalury DF, Fisher DA, Adler MJ. Five- to ten-year outcomes for modular metal-on-metal total hip arthroplasty. J Arthroplasty. 2013;28(7):1231-1234. doi:10.1016/j.arth.2013.03.012
21. Yalcin N, Kilicarslan K, Cicek H, Kayaalp C, Yildirim H. Crowe Type I and II DDH managed by large diameter metal-on-metal total hip arthroplasty. Hip Int. 2011;21(2):168-175. doi:10.5301/HIP.2011.7418
22. Kim YH, Oh SH, Kim JS. Primary total hip arthroplasty with a second-generation cementless total hip prosthesis in patients younger than fifty years of age. J Bone Joint Surg Am. 2003;85(1):109-114. doi:10.2106/00004623-200301000-00017
23. Bojescul JA, Xenos JS, Callaghan JJ, Savory CG. Results of porous-coated anatomic total hip arthroplasty without cement at fifteen years: a concise follow-up of a previous report. J Bone Joint Surg Am. 2003;85(6):1079-1083. doi:10.2106/00004623-200306000-00015
24. Aldinger PR, Breusch SJ, Lukoschek M, Mau H, Ewerbeck V, Thomsen M. A ten- to 15-year follow-up of the cementless spotorno stem. J Bone Joint Surg Br. 2003;85(2):209-214. doi:10.1302/0301-620x.85b2.13216
25. Kindsfater KA, Sychterz Terefenko CJ, Gruen TA, Sherman CM. Minimum 5-year results of modular metal-on-metal total hip arthroplasty. J Arthroplasty. 2012;27(4):545-550. doi:10.1016/j.arth.2011.07.002
26. Hjorth MH, Søballe K, Jakobsen SS, Lorenzen ND, Mechlenburg I, Stilling M. No association between serum metal ions and implant fixation in large-head metal-on-metal total hip arthroplasty. Acta Orthop. 2014;85(4):355-362. doi:10.3109/17453674.2014.922731
27. Robinson PG, Wilkinson AJ, Meek RM. Metal ion levels and revision rates in metal-on-metal hip resurfacing arthroplasty: a comparative study. Hip Int. 2014;24(2):123-128. doi:10.5301/hipint.5000113
28. Brewster DH, Stockton DL, Reekie A, et al. Risk of cancer following primary total hip replacement or primary resurfacing arthroplasty of the hip: a retrospective cohort study in Scotland. Br J Cancer. 2013;108(9):1883-1890. doi:10.1038/bjc.2013.129
29. Ando W, Yasui H, Yamamoto K, et al. A comparison of the effect of large and small metal-on-metal bearings in total hip arthroplasty on metal ion levels and the incidence of pseudotumour: a five-year follow-up of a previous report. Bone Joint J. 2018;100-B(8):1018-1024. doi:10.1302/0301-620X.100B8.BJJ-2018-0414.R1
30. Hart AJ, Satchithananda K, Liddle AD, et al. Pseudotumors in association with well-functioning metal-on-metal hip prostheses: a case-control study using three-dimensional computed tomography and magnetic resonance imaging. J Bone Joint Surg Am. 2012;94(4):317-325. doi:10.2106/JBJS.J.01508
31. van der Weegen W, Smolders JM, Sijbesma T, Hoekstra HJ, Brakel K, van Susante JL. High incidence of pseudotumours after hip resurfacing even in low risk patients; results from an intensified MRI screening protocol. Hip Int. 2013;23(3):243-249. doi:10.5301/hipint.5000004
32. Almousa SA, Greidanus NV, Masri BA, Duncan CP, Garbuz DS. The natural history of inflammatory pseudotumors in asymptomatic patients after metal-on-metal hip arthroplasty. Clin Orthop Relat Res. 2013;471(12):3814-3821. doi:10.1007/s11999-013-2944-4
33. Angadji A, Royle M, Collins SN, Shelton JC. Influence of cup orientation on the wear performance of metal-on-metal hip replacements. Proc Inst Mech Eng H. 2009;223(4):449-457. doi:10.1243/09544119JEIM518
34. Hart AJ, Buddhdev P, Winship P, Faria N, Powell JJ, Skinner JA. Cup inclination angle of greater than 50 degrees increases whole blood concentrations of cobalt and chromium ions after metal-on-metal hip resurfacing. Hip Int. 2008;18(3):212-219. doi:10.5301/hip.2008.948