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Cystic Adverse Local Tissue Reactions in Asymptomatic Modular Metal-on-Metal Total Hips May Decrease Over Time

Jeffrey M. Goldstein, MD^a, Thomas K. Fehring, MD^{b,*}, Keith A. Fehring, MD^b^a Illinois Bone & Joint Institute—Morton Grove, Morton Grove, Illinois^b OrthoCarolina Hip & Knee Center, Charlotte, North Carolina

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ABSTRACT

Background: The presence of pain as a harbinger of bearing-related problems has recently been challenged. Adverse local tissue reactions (ALTRs) have been noted on cross-sectional imaging even in asymptomatic patients. The purpose of this study was to determine the natural history of such lesions in asymptomatic patients.

Methods: Eighty-three asymptomatic patients with modular metal-on-metal total hip arthroplasties underwent metal ion reports and metal artifact reduction sequence magnetic resonance imaging (MARS MRI). MARS MRI images were reviewed and evaluated for the presence or absence of an ALTR lesion by a musculoskeletal radiologist and the senior author. We defined an ALTR lesion as abnormal fluid collections, solid or semisolid pseudotumors, or muscle or bone damage and was classified according to the MRI Classification System of Hart et al. In addition, serum cobalt and chromium levels were measured and analyzed at the time of MRI.

Results: Twenty-six of 83 (31%) asymptomatic patients had cystic lesions identified. All patients with positive MRIs were contacted to have repeat studies a year later. Nineteen of 26 were available for follow-up. Three patients who became symptomatic were revised. Most ALTRs in asymptomatic patients with modular metal-on-metal total hip arthroplasties that underwent repeat MARS MRI decreased in size (15 of 19 [79%]); 3 lesions increased, whereas 1 remained the same. All patients in the series had Co and Cr ion levels below the threshold of 7 ppb.

Conclusion: Although most cystic lesions decreased in size, vigilance is still required as 3 patients became symptomatic requiring revision.

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Large head metal-on-metal (MoM) bearing surfaces in total hip arthroplasty (THA) gained widespread popularity among surgeons because of the purported benefits of reduced wear and improved stability [1]. Unfortunately, bearing-related complications ranging from abnormal fluid collections to solid pseudotumors have diminished enthusiasm for this bearing couple.

To avoid the negative sequela of adverse local tissue reactions (ALTRs), including irreparable muscle or bone damage, early recognition is essential to recognize patients with a failing MoM THA. Clinical information consistent with a poorly functioning

MoM bearing includes hip pain, muscle weakness, and mechanical symptoms. The presence of an implant with a poor track record or radiographic evidence of poor implant position can help identify a malfunctioning bearing. Although serum cobalt and chromium ion levels can also be helpful, a direct correlation between ion levels and soft tissue damage is lacking [2].

Cross-sectional imaging in the form of ultrasound or metal artifact reduction sequence magnetic resonance imaging (MARS MRI) has been used to evaluate the presence or absence of ALTRs [3]. However, cross-sectional imaging abnormalities have been noted in 32% of asymptomatic MoM THA patients evaluated by ultrasound and 5%, 30%, and 61% by MARS MRI in asymptomatic patients [3–6]. A recent study from our center noted MRI abnormalities in 31% of asymptomatic patients with modular MoM implants [7].

There are little published data that conclusively convey the natural history of ALTRs in these asymptomatic MoM patients. In a follow-up ultrasound study, Almousa et al [8] suggested that ALTRs frequently increase in size in asymptomatic patients with

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* Reprint requests: Thomas K. Fehring, MD, OrthoCarolina Hip & Knee Center, 2001 Vail Avenue, Suite 200A, Charlotte, NC, 28207.

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occasional remission of small masses. Conversely, Van der Weegen et al [9] reported that asymptomatic ALTRs in MoM hip resurfacings showed little variation within 1 year of repeat MARS MRI scans.

The natural history of MARS MRI abnormalities in asymptomatic patients with modular MoM hips remains undefined. Therefore, as we aim to refine an algorithmic approach to the management of patients with MoM bearings, it is important to determine the prognostic value of a variety of diagnostic tests currently in use, including MARS MRI.

Therefore, as the natural history of ALTRs in asymptomatic modular MoM patients is currently unclear, we asked (1) what happens to the size and type of such lesions on MARS MRI over time; (2) what happens to the serum ion levels in these asymptomatic patients over time; and (3) what happens clinically to asymptomatic patients with lesions detected on MARS MRI over time?

Patients and Methods

In 2012, our institution used MARS MRI as part of the standard of care diagnostic workup for MoM THAs. In our previously published study, we identified 114 patients with modular MoM THAs, 83 of whom remained asymptomatic. All of these patients underwent metal ion reports and MARS MRI [7]. These patients underwent their index THA procedure 57 months (range, 26–240 months) before their initial MRI scans.

The MARS MRI images were reviewed and evaluated for the presence or absence of ALTRs lesion by a trained musculoskeletal radiologist and the chief investigator. The same MRI machine was used for all patients at both the first and second read. The same metal suppression techniques, protocols, and sequences were used in all cases. We used the vertical high field magnet (naturally tilted 90°) and used subtraction techniques to enhance the sensitivity for fluid and mass detection around the MoM prosthesis. This is accomplished by subtracting T1 from T2 MARS images. Coronal, sagittal, and axial images were assessed. No view angle tilting was needed. We defined an ALTR lesion as abnormal fluid collections, solid or semisolid pseudotumors, or muscle or bone damage. The location of each lesion was identified and the size of each lesion was

measured and calculated in cubic centimeters. The type of lesion was classified according to the MRI Classification System of Hart et al [3]. In this system, a type 1 lesion is thin walled and cystic, a type 2 lesion is thick walled and cystic, and a type 3 lesion is solid. In addition, serum cobalt and chromium levels were measured and analyzed at the time of MRI.

As previously reported, 26 of 83 (31%) asymptomatic patients had cystic lesions identified with no examples of solid lesions in the series [7]. Seventeen of 26 patients had a type 1 lesion, whereas 9 of 26 patients had a type 2 lesion. The mean lesion size was 45.5 cm³ (range, 0.2–418). The median lesion size was 14.2 cm³. The mean abduction angle of acetabular components, measured using TraumaCad software (Voyant Health, Ltd, Petach-Tikva, Israel) was 40°, with a median of 39° (31–45°). Of the 26 asymptomatic patients with identified ALTRs, 22 of 25 (88%) had cobalt levels <7 ppb (mean 4.2), whereas 23 of 25 (92%) had chromium levels <7 ppb (mean 2.2). One patient in the series did not have initial ion levels drawn. Four of 26 asymptomatic patients had a modular stem (SROM; Depuy Orthopaedics, Inc, Warsaw, IN). All others contained a non-modular stem. Of the 26 asymptomatic patients, there were 19 with 36-mm heads, 6 with 40-mm heads, and 1 with a 44-mm head.

All 26 asymptomatic patients with positive MRIs were subsequently contacted to have repeat studies a year later. Three patients had developed pain and mechanical symptoms and were revised before repeating the MRI and obtaining ion levels. One patient moved out of state and was lost to follow-up. Three patients refused MRI because of financial concerns, although all remained asymptomatic.

The remaining 19 patients underwent repeat MARS MRI at a mean of 17 months (median 18 months, range 7–24 months) after the initial MRI study. All but one of these 19 patients had the Pinnacle metal-on-metal Hip System (Depuy Orthopaedics, Inc.) used (Table 1). The mean abduction angle was 39° (median, 39°; range, 31–45°) for the 19 patients. The MARS MRI images were again reviewed and evaluated for the presence or absence of ALTRs by a trained musculoskeletal radiologist and the chief investigator. The location of each lesion was identified, and the size of each lesion was measured and calculated in cubic centimeters. Each lesion was graded using the MRI Classification System of Hart [3].

Table 1
Data Set of Asymptomatic Modular MoM Patients With MRI Abnormalities.

Patient	Implant	Volume 1	Volume 2	Lesion Type 1	Lesion Type 2	Co 1	Co 2	Cr 1	Cr 2	Status at the Time of Publication
1	Depuy Pinnacle	48	61.2	2	2	14	2.9	2.3	1.3	Asymptomatic
2	Depuy Pinnacle	79.2	45.1	1	1	0	0	0	0	Asymptomatic
3	Depuy Pinnacle	19.8	4.8	2	2	1.1	0	1.5	1.1	Asymptomatic
4	Depuy Pinnacle	30	2.5	1	1	1.8	2.3	1.6	1.4	Asymptomatic
5	Depuy Pinnacle	12.6	0.6	1	1	0	1.2	1.2	1	Asymptomatic
6	Depuy Pinnacle	15.8	7.2	1	1	1.5	1.1	2	1.7	Asymptomatic
7	Depuy Pinnacle	12	32	1	1	0	0	0	1.2	Asymptomatic
8	Depuy Pinnacle	18.5	17.1	1	1	1	1.4	1.4	1.2	Asymptomatic
9	Depuy Pinnacle	4.5	0	1	0	1.9	5.1	0	1.8	Asymptomatic
10	Depuy Pinnacle	12.3	5.5	2	1	5.2	2.7	3	1.9	Asymptomatic
11	Depuy Pinnacle	5.7	0.1	1	1	5.6	1.1	1.3	1	Asymptomatic
12	Depuy Pinnacle	6.5	33.5	1	1	6.7	6.2	3.8	2.9	Asymptomatic
13	Depuy Pinnacle	34.5	0.8	1	1	0.8	1.3	2	0	Asymptomatic
14	Depuy Pinnacle	8	6	1	1	5.2	2.7	3	1.9	Asymptomatic
15	Depuy Pinnacle	160.1	0	2	0	2.6	2.3	0	1.2	Asymptomatic
16	Depuy Pinnacle	254.7	163.4	2	2	4.9	4	2.7	1.7	Asymptomatic
17	Depuy Pinnacle	32.3	19.6	1	1	0	1.5	0	1.2	Asymptomatic
18	Depuy Pinnacle	3.7	4.4	2	1	2.7	3.9	2.2	2.5	Asymptomatic
19	S&N R3	0.2	0.1	1	1		1.7		1.6	Asymptomatic
20	Depuy Pinnacle	23.3	—	1	—	1.2	0	1.3	0	Asymptomatic, refused MRI
21	Depuy Pinnacle	55.9	—	1	—	3.9	—	2.3	—	Asymptomatic, refused MRI
22	Depuy Pinnacle	0.5	—	1	—	2.4	0	2	1.6	Asymptomatic, refused MRI
23	Depuy Pinnacle	1.7	—	2	—	2.5	—	0	—	Lost to follow-up
24	Depuy Pinnacle	0.6	—	2	—	16	—	10	—	Revised
25	Depuy Pinnacle	2.1	—	2	—	16	—	10	—	Revised
26	Depuy Pinnacle	418	—	1	—	9.7	—	4.1	—	Revised

MoM, metal on metal; MRI, magnetic resonance imaging.

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