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What Is the Natural History of “Asymptomatic” Pseudotumours in Metal-on-Metal Hip Arthroplasty? Minimum 4-Year Metal Artifact Reduction Sequence Magnetic Resonance Imaging Longitudinal Study



Young-Min Kwon, MD, PhD^{*}, Ming Han Lincoln Liow, MD, Dimitris Dimitriou, MD, Tsung-Yuan Tsai, PhD, Andrew A. Freiberg, MD, Harry E. Rubash, MD

Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts

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ABSTRACT

Background: Metal Artifact Reduction Sequence Magnetic Resonance Imaging (MARS-MRI) is an important cross-sectional imaging modality in detection of metal-on-metal (MoM) hip arthroplasty (HA) pseudotumours. Potential evolution of pseudotumours detected by MARS-MRI in “asymptomatic” patients with MoMHA arthroplasty beyond 2 years remains largely unknown. The aims of this longitudinal study were to (1) determine the natural history of pseudotumours in “asymptomatic” MoMHA patients under MARS-MRI surveillance and (2) characterize MRI feature(s) associated with progressive pseudotumours.

Methods: A total of 37 MoMHA (32 patients, mean 56 years old) with pseudotumours on MARS-MRI were evaluated longitudinally using a standardized MARS-MRI protocol. Serum cobalt and chromium levels, pseudotumour size, thickness of the cyst wall, and MRI signal intensity of the abnormality were recorded and analyzed.

Results: At minimum of 4-year follow-up (range 49–54 months), 4 Type II pseudotumours (11%) demonstrated MRI evidence of progression. Five Type I pseudotumours (14%) were found to have “regressed.” No measurable MRI progression was detected in remaining patients (75%). MRI features associated with progressive pseudotumours included the presence of increased cystic wall thickness and “atypical” mixed fluid signal. MRI pseudotumour progression was not associated with metal ion levels.

Conclusion: The natural history of type I cystic pseudotumours continues to be nonprogressive in most “asymptomatic” MoMHA patients at minimum 4 years, suggesting the importance of patient symptoms and MRI characteristic features in the clinical decision-making process. Routine follow-up MARS-MRI evaluation of “asymptomatic” patients with low-grade cystic pseudotumours in the absence of interval clinical changes may not be indicated.

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Systematic treatment risk stratification based on the currently available evidence has recently been recommended to optimize evaluation and management of patients with metal-on-metal (MoM)

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^{*} Reprint requests: Young-Min Kwon, MD, PhD, Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, 55 Fruit Street, YAW 3700, Boston, MA 02114.

hip arthroplasty (HA), as early recognition and diagnosis will facilitate the initiation of appropriate treatment before significant adverse local tissue reactions (pseudotumours) [1,2]. These treatment algorithms focus on the importance of a thorough clinical evaluation and radiographic and laboratory tests to delineate potential intrinsic and extrinsic cause(s) of pain in MoM patients. Pseudotumours are often seen in association with failed MoMHAs. As plain radiograph appearances are normal in most cases of pseudotumours, an integral component of these systematic treatment algorithms recommends the use of cross-sectional imaging such as magnetic resonance imaging (MRI) to detect the presence of pseudotumours.

Metal artifact reduction sequence MRI (MARS MRI) is an important cross-sectional imaging modality in detection of pseudotumours as it has the capacity to produce high-resolution images of the periprosthetic tissues in patients with MoMHAs [3]. Its use in

surveillance of MoM arthroplasty patients has been recommended to include even those MoM patients with low metal ion levels [4]. Although utilization of established MARS MRI classifications would allow standardized reporting of pseudotumour prevalence and differentiate between benign fluid collections and “real” pseudotumours [5–7], it has been suggested that current systems may overestimate the incidence of clinically relevant pseudotumours [8]. In our study, we have used an established MARS MRI classification system [9] which has been validated for the identification of MoMHA-associated pseudotumours [10].

With increasing utilization of MARS MRI, high prevalence (ranging from 31% to 61%) of the so-called cystic pseudotumours in patients with well-functioning hip prostheses has been reported [5,11]. Interestingly, the prevalence of the so-called cystic pseudotumours was similar in patients with a well-functioning hip prosthesis (61%) and patients with a poorly functioning hip (57%) [5]. A similarly high prevalence of adverse reaction to metal debris detected on MARS MRI has been reported in a study of 209 consecutive patients with MoMHAs [4]. Although several recent studies have reported on the longitudinal MRI of pseudotumours with short-term follow-up of up to 2 years [12–15], potential evolution of pseudotumours detected by MARS MRI in “asymptomatic” patients beyond 2 year remains largely unknown. This information would be of importance in providing evidence-based clinical recommendations in evaluation and treatment of “asymptomatic” patients with MoMHAs. The aims of this longitudinal study were to (1) determine the natural history of “asymptomatic” pseudotumours detected by MARS MRI in “asymptomatic” MoMHA patients being managed with surveillance and (2) characterize MRI feature(s) associated with progressive pseudotumours.

Patients and Methods

Patients

A total of 37 implanted MoM hips (14 hip resurfacing and 23 total HAs) in 32 patients (24 male, 8 female) with a mean age of 56 years (range 40–71 years) were identified from the database to meet the selection criteria and were evaluated longitudinally. All index procedures were performed through a posterolateral approach. The clinical data on the patient cohort are summarized in Table 1. These patients were referred for further evaluation based on various

Table 1
Summary of the Clinical Data on the Study Patient Cohort.

Parameter	Values
Males	24
Females	8
Mean age (range)	56 y (40–71 y)
Time since index surgery (range)	51 mo (49–54 mo)
Metal-on-metal (MoM) implants (number)	Birmingham Hip Resurfacing (6) Cormet Hip Resurfacing (6) Conserve Plus Hip Resurfacing (2) Magnum M2a MoM THA (5) Durom MoM THA (4) Articular surface replacement MoM THA (3) Pinnacle MoM THA (11)
Median femoral head diameter (range)	MoM Hip Resurfacing femoral component size: 48 mm (44–54 mm) MoM THA femoral head size: 36 mm (32–44 mm)
Mean acetabular inclination (range)	46° (42°–54°)
Mean acetabular anteversion (range)	27° (–5° to 47°)
Median serum cobalt (µg/L; range)	4.1 (0.9–6.1)
Median serum chromium (µg/L; range)	4.5 (0.5–5.1)

THA, total hip arthroplasty.

reasons including concerns over “recalled” implants, “abnormal” metal ion levels, and seeking reassurance. In all cases, the clinical reasons for electing nonoperative treatment with surveillance were “asymptomatic” patients (defined as those patients with no complaints of pain related to the hip arthroplasty, no pain with clinical examination, and satisfied with the outcome of the index procedure).

All study patients were identified from the database of a multidisciplinary tertiary referral MOM center at the authors' institution specializing in evaluation and treatment of patients with MoMHAs. Institutional review board approval was obtained for this study. The study needed to include patient cohort with representative standardized MARS MRI scans performed over a period of time. Thus, to ensure a valid comparison of the serial MRI findings could be evaluated longitudinally, the study patients were selected using the following selection criteria:

Inclusion Criteria

- Patients who had MARS MRI performed during a 6-month period from March 2011 to August 2011. The reason for selecting this time period was due to the fact that the MARS MRI protocol currently in use was used from March 2011. This would ensure that the repeat follow-up MRI scans would be performed using the identical protocol.
- “Asymptomatic” patients with pseudotumours on MARS MRI (reported by musculoskeletal radiologists), who have elected to be treated nonoperatively with close surveillance.

Exclusion Criteria

Patients were excluded if they had the initial or the follow-up MRI at an outside institution. This was imposed to ensure that a valid comparison of the serial MRI findings could be assessed.

Data Collection

All study patients were prospectively followed up longitudinally and imaged using a 1.5-T magnet MRI (Siemens AG, NY). The MARS protocol utilized has been previously published [9]. The MRI imaging protocol involves using T1-weighted spin-echo and short tau inversion recovery coronal and axial sequences. The use of a high bandwidth was used to reduce metal artifacts. An experienced specialist musculoskeletal radiologist who was blinded to the clinical details reported all MRI scans. Serum cobalt and chromium levels were analyzed in a blinded fashion using inductively coupled plasma mass spectrometer. The detection limit of cobalt and chromium in serum was 0.3 µg/L. Standardized anteroposterior pelvis and shoot-through lateral radiographs were taken to assess for abnormalities, particularly osteolysis or loosening. Acetabular component abduction angle relative to the pelvic horizontal and anteversion angle was measured.

MRI Classification of Pseudotumours

For all MARS MRI in the study patients, the following features of the pseudotumours were recorded: the size, the thickness of the cyst wall, the proportion of the cystic and solid components, the position, bone and muscle involvement, and the MRI signal intensity of the abnormality. In accordance with the published classification system for adverse periprosthetic soft tissue reactions, a pseudotumour was defined as any mass, solid or cystic, with the definite presence of a cyst wall, in continuity with the hip joint [9]. Isolated distension or thickening of a noncommunicating trochanteric bursa was excluded. All abnormalities detected on MARS MRI were classified into types I, II, and III [9]. This

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