Pseudotumor Associated With Metal-on-Polyethylene Total Hip Arthroplasty

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abstract

Full article available online at Healio.com/Orthopedics. Search: 20130426-33

This case report details the presentation, imaging results, and operative findings of a pseudotumor associated with a press-fit metal-on-polyethylene total hip arthroplasty (THA). An 80-year-old man presented approximately 7 years after undergoing THA with worsening right groin and lateral hip pain with an associated proximal thigh mass. Physical examination demonstrated a tender, large anterolateral thigh mass that was also evident on metal artifact reduction sequence magnetic resonance imaging.

An exploratory operative procedure revealed extensive tissue necrosis involving nearly the entire hip capsule, short external rotators, and tendinous portion of the gluteus medius muscle. In addition, marked surface corrosion was discovered about the taper at the head-neck junction of the prosthetic femoral component and the trunnion within the femoral head. The press-fit THA components were solidly fixed. The metallic head was replaced with a ceramic component, and the polyethylene liner was exchanged. The patient had complete resolution of his preoperative symptoms but had persistent problems with dislocations.

Although reports of pseudotumor and local soft tissue reactions associated with metal-on-metal THAs have become increasingly ubiquitous in the literature, similar reports involving metal-on-polyethylene THA implants are less common.

Figure: Preoperative anteroposterior radiograph depicting the original metal-on-polyethylene total hip implant (A). Preoperative T1-weighted coronal magnetic resonance image with metal artifact reduction sequence formatting depicting a large, complex, thick-walled fluid collection partially surrounding the inferior aspect of the hip joint and adjacent to the proximal femoral stem (circled in red). The mass and fluid collection is isointense to muscle on T1-weighted images but markedly hypointense on T2-weighted images (B).
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ver the past several years, reports of pseudotumors and local soft tissue reactions associated with metal-on-metal total hip arthroplasties (THAs) have become more common. Increasing interest and research on this subject has led to an improved understanding of the mechanisms responsible for this spectrum of pathologic conditions associated with metal-on-metal THAs. Similar reports involving metal-on-polyethylene THA components are less common, and understanding of this potentially unique subset of THA failures is consequentially poor. This case report describes a pseudo-tumor associated with a metal-on-polyethylene THA implant and reviews the current literature on this evolving topic.

**CASE REPORT**

An 80-year-old man underwent total hip arthroplasty (THA) of the right hip via a standard posterior approach for degenerative hip osteoarthritis by the senior author (S.M.T.) in November 2005. The components used were a #6 uncemented titanium-tapered stem (TMZF Femoral Hip Stem; Stryker, Mahwah, New Jersey) with a cobalt-chromium articulating +4 head measuring 32 mm in diameter, a titanium 56-mm acetabular shell, and a +10 highly cross-linked polyethylene liner (Trident; Stryker).

The initial postoperative course was uneventful, and the patient subjectively improved and was pleased with his outcome for 5 years. However, he returned to the clinic in January 2012 reporting a 2-year history of slow, progressive hip pain that had worsened to the point that he had difficulty ambulating and bearing weight on his right lower extremity. He also noted the gradual development of a soft tissue prominence about the lateral proximal thigh in the greater trochanter region. He reported no history of fever, chills, malaise, weight loss, or other changes in his overall health. His medical history included coronary artery disease, severe global xeroderma (which had worsened significantly over the preceding 2 decades and required prescription skin moisturizer) and exposure to Agent Orange and nuclear testing during military service. He had no known allergies or metal sensitivities or history of diabetes mellitus or autoimmune disorders.

On physical examination, a mildly tender fluctuant soft tissue mass measuring approximately 15 cm long and 10 cm wide was noted just proximal and anterior to the greater trochanter, with significant edema of the great trochanter, with significant edema of the hip region or in the area of swelling. He had full range of motion in the hip joint and adjacent to the proximal femoral stem (circled in red). The mass and fluid collection is isointense to muscle on T1-weighted images but markedly hypointense on T2-weighted images (B).

In addition, marked surface corrosion at the junction of the prosthetic femoral component and the trunion within the femoral head (Figure 2B), but no significant wear was noted about the polyethylene liner or the exterior of the metallic head, and no evidence of impingement was noted on dynamic range of motion examination under direct visualization. On further inspection, the femoral and acetabular components were found to be well fixed.
Consequently, a thorough debridement of the necrotic soft tissue and bone was performed, followed by an exchange of the femoral head to a 36-mm Delta ceramic head (CeramTec AG, Plochingen, Germany) and placement of a new +10 highly cross-linked 36-mm polyethylene liner. Minimal repair of the capsule and short external rotators was performed due to the damage found to these structures.

Intraoperative cultures were negative for bacteria, fungi, and acid-fast bacilli. Microscopic pathology evaluation of soft tissue samples demonstrated acellular necrotic fibroconnective tissue with rare polarizable foreign material, consistent with a foreign body giant cell reaction and pigment deposition. Specific testing to analyze and quantify the presence and amount of polyethylene or metallic debris was not performed on either the tissue samples or explanted implants.

The patient did well until approximately 4 weeks postoperatively, when he dislocated the THA after hyperflexing his hip while squatting. He was treated by closed reduction and short-term bracing for 2 weeks. He sustained a second dislocation approximately 6 weeks later, and a future revision to a constrained liner is planned. However, since the initial revision, his pain has subjectively improved from his preoperative state, and he has not had a recurrence of the soft tissue mass or swelling.

**DISCUSSION**

An increasing number of reports have been published regarding the spectrum of adverse local soft tissue and bony reactions detected around THAs and resurfacing implants. Various terms have been used to describe these conditions, but as Langton et al noted, the boundaries have not been clearly established to define with specificity metallosis, aseptic lymphocyte-dominated vasculitis-associated lesions, and pseudotumors.1 Broader phrasing, such as adverse reactions to metal debris1 and adverse local tissue reaction,2 have more recently been used to describe these pathologic findings around THAs that are often associated with pain, a large sterile effusion, macroscopic soft tissue or bone necrosis, and implant problems, such as loosening and dislocation.

The term pseudotumor has been used to describe a granulomatous or destructive cystic or solid lesion, which resembles a true tumor but is neither infectious nor neoplastic in nature and develops adjacent to THA implants.3 Although the term was initially used to describe granulomatous soft tissue masses thought to be related to prosthetic wear debris in a series of metal-on-polyethylene THA implants,4 it has since become more commonly used in reference to masses seen around metal-on-metal implants.3

Several reports have linked the deposition of microscopic metallic wear debris associated with metal-on-metal hip resurfacing and arthroplasty implants to the development of pseudotumors.3,5-10 Concern within the orthopedic community and general public over metal-on-metal hip implants has reached a degree that the American Academy of Orthopedic Surgeons Board of Directors recently commissioned a special technology overview on the topic.2 In addition, the US Food and Drug Administration is conducting a further review of metal-on-metal implants.11

Largely excluded from this recent interest and concern has been the distinct topic of pseudotumor or adverse local tissue reaction related to metal-on-polyethylene implants. More than 20 years ago, Tallroth et al12 reported an incidence rate of 4.6% for pseudotumors associated with failed metal-on-polyethylene THAs based on radiographic evidence. However, with increased understanding of cell-mediated osteolysis and implant loosening associated with polyethylene wear, the term pseudotumor as it is now understood was likely used in this early report and others from the same time period to describe a different process. The true incidence of a destructive granulomatous cystic/necrotic soft tissue mass associated with a metal-on-polyethylene implant is likely much smaller.

A PubMed search revealed several case reports describing granulomatous cystic soft tissue masses associated with failed metal-on-polyethylene THAs.13-22 The earlier reports, dating from 1988 to 2008, described large intrapelvic cystic masses often associated with gross implant loosening and marked polyethylene wear. The majority of the cases involved earlier generation implants, including poorer quality polyethylene liners, and gross osteolysis was detected in many of the cases.13-19 In addition, polyethylene debris was often found within the pseudotumors, prompting the authors of these reports to conclude that these masses represented a foreign-body reaction to the polyethylene debris.
Three more recent reports more closely resemble the findings in the current case report and potentially represent a distinct process.\textsuperscript{20-22} All 4 cases, including the current report, involve modern metal-on-polyethylene implants that remain in regular distribution at this time, and 3 involve the same manufacturer and implant.\textsuperscript{20-22} Although the case report by Meftah et al\textsuperscript{20} did not have a frank soft tissue mass, the report notes finding a large turbid fluid collection about the hip implants, and the periprosthetic tissue sampled demonstrated an aseptic, lymphocyte-dominated, vasculitis-associated lesion process, as was seen in the other 3 cases. In all 4 cases, the implants were found to be well fixed with minimal polyethylene wear. In addition, in 3 of the 4 cases, significant corrosion was noted about the head-neck junction, which was easily removed.\textsuperscript{20-22} In all cases, the preexisting stem and acetabular cup were retained and a ceramic head was placed with either a new ceramic or polyethylene liner, which effectively resolved the patient’s subjective symptoms and soft tissue mass on short-term follow-up.\textsuperscript{20-22}

The development of pseudotumors and the associated tissue necrosis is theorized to be a type IV delayed hypersensitivity reaction to wear debris.\textsuperscript{3,5} Keegan et al\textsuperscript{23} reported that wear debris is generated not only by mechanical wear, as is seen with polyethylene breakdown and fretting, but also by surface corrosion, which can generate both particulate and soluble wear debris.

Increasing interest has developed concerning fretting and corrosion at the modular femoral neck and head-taper junction and the association of this wear with aseptic lymphocyte-dominated vasculitis-associated lesions and pseudotumor in metal-on-metal implants.\textsuperscript{24-26} Corrosion is a process resulting in deterioration and gradual destruction of a material when it interacts with the surrounding environment, whereas fretting is a form of surface mechanical degradation by low-amplitude oscillatory sliding between surfaces in contact. Factors such as the repetitive stress and motion at the taper junction, the crevice geometry of the taper, and the differing metal interfaces in modular implants have all been theorized to cause corrosion and fretting at this location.\textsuperscript{24-29}

Goldberg et al\textsuperscript{24} developed a grading system to describe the severity of corrosion evident on retrieved metal-on-metal implants, and others have since expanded on it.\textsuperscript{30} Multiple unpublished reports presented at the Orthopedic Research Society 2012 meeting suggest that larger heads in metal-on-metal implants are associated with increased taper corrosion and wear.\textsuperscript{27-29} However, additional factors appear to play a role; Fricka et al\textsuperscript{26} compared retrieved 36-mm metal-on-metal implants with 36-mm metal-on-polyethylene implants and found a statistically significant increase in corrosive wear in the metal-on-metal implants.

In 3 of the 4 recent case reports discussed previously,\textsuperscript{20-22} including the current report, significant surface corrosion was noted about the head-neck junction, much like that described in the metal-on-metal literature. Based on these observations, it seems plausible that wear from the cobalt-chromium head on the titanium taper neck led to the pseudotumor formation and concomitant problems in these cases. However, much remains to be explored regarding this process. Although this wear development in association with pseudotumors has been well described and increasingly reported in metal-on-metal implants, it has only been described in these few recent individual case reports\textsuperscript{20-22} in association with pseudotumor formation in metal-on-polyethylene hips.

In addition, the presence and amount of polyethylene and metallic debris has not been analyzed and quantified consistently in these cases, making it more difficult to draw definitive conclusions. It also remains unknown whether patient factors, such as diabetes mellitus and inflammatory conditions, contribute to the corrosion process through local environmental changes created by hyperglycemia and pH alterations, as demonstrated with dental implants.\textsuperscript{30} Fujishiro et al\textsuperscript{31} found that microscopic perivascular and diffuse lymphocytic inflammation is commonly found in the local soft tissues around failed metal-on-polyethylene THA implants, suggesting that other patient or implant positional factors may contribute to pseudotumor formation. Although uncommon, this problem needs to be recognized as a potentially significant emerging concern associated with metal-on-polyethylene THA. The issue may become increasingly important as the current trend away from metal-on-metal bearings continues.

**REFERENCES**


