Massive Pseudotumor in a 28mm Ceramic-Polyethylene Revision THA: A Case Report

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Abstract

This report reviews the findings of a massive pseudotumor detected pre-operatively in a 13-year-old revision total hip arthroplasty. The case is unique in that the bearing involved was a 28mm zirconia ceramic head on a polyethylene liner. We propose that the pseudotumor arose from ultrafine titanium particles liberated from the proximal porous coating of the femoral stem. We suspect that the osteolysis produced from polyethylene wear exposed the proximal porous coating and, via a process of mechanical abrasion with the surrounding soft tissues, liberated ultrafine titanium particles. We believe the pseudotumor formed because the patient was pre-sensitized to metal debris based upon a pre-operative lymphocyte T-cell proliferation test (LTT). Based upon this unique case, we feel that pseudotumors more likely form when there is a high rate of ultrafine metal particles generated in a pre-sensitized patient. Finally, we introduce what we believe are the main biologic wear responses in THA. Further research is needed to validate this proposed model.

Keywords: pseudotumor, ceramic, polyethylene, osteolysis, THA, bearing wear response, titanium debris

Level of Evidence: AAOS Therapeutic Study Level IV

Introduction

Over the last decade, pseudotumor has become a rising complication of total hip arthroplasty (THA). It was first described by Griffiths in 1987 in a series of 15 patients with metal-on-polyethylene THA. [8] The presentation of pseudotumor varies, ranging from asymptomatic cases accidentally observed during routine follow-up, to a patient with well-fixed implants having pain, to severe osteolysis with implant failure requiring complex revision arthroplasty. Although the pseudotumor response was first described in metal-polyethylene implants, the more recent literature of the last 10 years impugns metal debris as the pro-inflammatory nidus for pseudotumor formation. [1,5,6,7]

We report a case of a massive pseudotumor that arose in a revision THA with a ceramic-polyethylene bearing. Based on intra-operative observation and review of histologic tissue, we propose a mechanism of pseudotumor formation in this case.

Case Review

HISTORY

This case involves a 59-year-old female suffering from avascular necrosis of the hips. She has idiopathic thrombocytopenia and has no other risk factors for avascular necrosis. She had a splenectomy at age 27. For the right hip, she had a core decompression at age 30. Her right hip condition still remains stable with only mild intermittent pain.

The left hip was treated with primary THA at age 30 (May 1984). Her reconstruction provided a good functional lifestyle, allowing her to enjoy life as a mother. At 15 years post-op she began having pain and a limp. She
underwent revision THA in June 2000 (16 years post-op) for osteolysis and mechanical loosening of her implants. On the acetabular side, the patient was revised with a porous plasma spray modular titanium cup (Vision™, Biomet, Warsaw, IN) with 3 screws. The acetabular liner was a compression-molded polyethylene cup (Himont 1900 UHMWPE) with a 10 degree posterior hole placed inferi-orly and posteriorly. Her stem was revised with a titanium alloy modular revision stem (Modular Reach™, Biomet, Warsaw, IN). The head was a 28mm zirconia ceramic bearing (CeramTec, Plochingen, Germany). Post-operatively, she recovered with no problems and again enjoyed an active lifestyle as a mother of 3 children.

She suffered one late dislocation in 2007 which was treated with a closed reduction in the emergency room. She had no subsequent dislocations.

At 9 years post-op from her revision THA, the patient noted no pain or problems with her hip on annual review. The patient was then seen at 10.5 years post-op. She reported suffering from mechanical low back pain and mild left hip pain. At the time she started a weight loss program with daily exercise and had lost 30 pounds. Eccentric polyethylene wear was noted radiographically. Her hip exam showed no hip irritability. She was started on a lumbar trunk stabilization program and her hip was observed. The patient returned at 12 years post-op and was symptomatic in her left hip. She reported hip clicking with flexion and had activity-related pain and mild hip “fullness.” Her hip range testing was comfortable with passive range, but her mid-thigh circumference at that time was 2cm greater on the left. Radiographs showed increased eccentric polyethylene wear. At that time a modular bearing exchange and debridement surgery of the hip was recommended. No other radiographic studies were ordered. The patient declined surgery to finish her teaching duties at an elementary school for the upcoming year.

At 13 years post-op the patient returned with increased pain and swelling (Figures 1a-1b). She had developed numbness and tingling in her left leg. An MRI of the lumbosacral and upper pelvis was performed to evaluate for sciatica. Two tumors were seen on this study which prompted further studies by her local physician. These included MRI’s of the pelvis and thigh and a CT scan of the pelvis and chest. Loculated masses were identified within the pelvis, hip, and thigh; all appeared to emanate from the hip region (Figures 2a-2c). In addition, one mass was seen extending to the anterolateral distal thigh. Her hip exam revealed only mild irritability. Her mid-thigh circumference was now 6cm greater on the left.

A hip aspiration was performed, drawing off 175cc of thick, dark fluid with a dark brown and maroon coloring. There was a normal string sign. All cultures were negative. These included aerobic, anaerobic, fungal, and mycobacterium cultures. Fluid analysis showed a red cell count of 840,000 and a white cell count of 1,000 with 58% neutrophils, 32% lymphocytes, and 10% monocytes. Serum C-reactive protein was mildly elevated at 1.6mg/dL (normal <0.3) and erythrocyte sedimentation rate was 32mm/hr (normal 0-15). Her CBC was normal. Serum blood was drawn for a metal lymphocyte T-cell proliferation test (LTT) which was sent to Orthopaedic Analysis. [10,11,19,39] Results showed moderate sensitivity to nickel metal particles (Figure 3).
Intra-operative examination showed a large multiloculated mass that was extending in multiple directions surrounding the hip region. A large 8x14cm mass was lateral to the greater trochanter and extended superiorly within the gluteus maximus. Upon entering the mass, the fluid exited under considerable pressure, shooting out approximately 20cm in distance. The fluid was bloody with a coloration of dark brown and maroon (Figure 4).

The hip showed implants that were well affixed to bone with porous coating (Figure 5). Severe osteolytic bone loss was noted in the proximal femur down to the metadiaphyseal region. The cup showed several osteolytic holes.

Five major pseudotumor masses were seen. One pseudotumor mass extended along the iliopsoas into the pelvis for a distance of 12cm (Figures 6a-6b). Another mass extended along the femur and under the vastus lateralis to the distal one-third of the thigh. The third mass extended in between the lateral ilium and gluteus medius up to the iliac crest. The lateral peritrochanteric mass extended posteriorly over the gluteus maximus. Finally, the fifth large mass extended down the medial adductor for a distance of 7cm.

The pseudotumors were excised and a modular bearing was inserted.
ing exchange was performed (Figure 7). The femoral taper showed no corrosion or adverse wear (Figure 8). A highly cross-linked, vitamin E infused polyethylene cup (Biomet, Inc., Warsaw, IN) was used. The head was changed over to a 36mm Delta ceramic head with an internal titanium sleeve (CeramTec, Plochingen, Germany). At 1 year post-op the patient still has a mild gluteus medius lurch, but remains pain free.

**HISTOLOGY**

The histologic examination of the pseudotumor was obtained near the base of the intragluteal pseudotumor, just superior to the acetabulum. It was a representative sample of all five pseudotumor masses resected. The histologic images are presented in figures 9a-9b. Within the cyst there contained old, decaying red blood cells and fibrin clots. The wall of the pseudotumor was thin, measuring 1.5 to

**Figures 9a-9b.** Photomicrographs of histologic specimens of pseudotumor. Specimens were preserved in formalin and processed with Hematoxylin and Eosin (H&E).

![Figure 9a](image-url) 4x magnification of pseudotumor showing that the wall itself measures 1.5 to 3mm. Within the cyst there is decaying RBC’s along with fibrin clots (left side). One can see the collagen matrix and fibroblasts that form the pseudotumor sac. The inner lining consists predominantly of monocytic histiocytes. There is no lymphocytic response seen within the pseudotumor or in the perivascular regions.

![Figure 9b](image-url) 40x magnification of pseudotumor wall near its inner surface. Notice specifically the ultrafine light grey/bluish colored particles within the histiocytes. The particles do not refract, indicating that the particles are not polyethylene debris. Instead, these ultrafine particles are likely a titanium alloy particulate shed from the proximal porous coating of the femur.
3mm, and consisted primarily of collagen fibers aligned
haphazardly and interspersed with fibroblasts. The inner
lining of the pseudotumor predominantly contained mono-
cytic histiocytes. There was a paucity of giant cells. Fur-
thermore, there was no lymphocytic response within the
pseudotumor wall or perivascular vessels. [3,9,10,37] The
histiocytes contained ultrafine titanium metal particles
(there was no other metal alloy in the hip construct). [29]
Some histiocytes contained hemosiderin pigments likely
acquired from the decaying RBC’s within the cyst. No par-
ticles were seen freely interspersed within the collagen ma-
trix. Vascularity to the pseudotumor wall came from local
connections from the outer wall to the surrounding muscle.
[32,33]

Discussion

This case of pseudotumor formation is unique. The se-
nior author (ejm) has an extensive history of treating met-
al-metal bearing associated pseudotumors and this case
was by far the most extensive pseudotumor he has treat-
ed. In all, five large pseudotumor masses were excised in
a 5-hour long operation. The bearing in this case was a
small-diameter head (28mm) made of zirconia ceramic.
The eccentric wear was visually evident, but could not be
described as excessive. In addition, we carefully examined
the head-taper junction and did not visually observe any
taper corrosion reaction nor adverse metal wear. [13] We
feel in this case that the osteolysis produced from polyeth-
ylene wear exposed the proximal porous coating and, via a
process of mechanical abrasion with the surrounding soft
tissues, liberated ultrafine titanium particles. Histological-
ly, the histiocytes in the pseudotumor contained ultrafine
metal particles. Since no other metal was used in the case,
we must conclude that the metal debris derived from the ti-
tanium implants.

Most surgeons currently believe the metal debris caus-
ning pseudotumors derives from cobalt-chrome alloy bear-
ings. [14,15,16,18,19] This is based upon the wear debris
phenomenon seen with metal-metal bearings over the last
decade. [20,22,24,27,28] The toxic reactive synovitis seen
with this bearing can cause effusion, pain, and, in some
cases, pseudotumor formation when the bearing couple is
improperly designed or mated.

A pseudotumor reaction consists of an expanding ex-
tra-capsular inflammatory process consisting of collagen,
fibroblasts, and, in this case, histiocytes. Anecdotal evi-
dence provided by older arthroplasty surgeons described
this phenomenon, verbally, as far back as 27 years ago
and was associated with metal-polyethylene hip bearings.
[8,35] Since polyethylene induced osteolysis is well de-
scribed and consistent in presentation, the early and later
descriptions suggest metal debris as the initiator of pseu-
dotumor formation. The pseudotumor reaction, therefore,
may reflect the interaction of an overactive immune system
in combination with metallic particulate debris. [10,39]

In this case we call into question the effect of porous
coating as a contributor to the particulate metallic load
within the effective joint space. Many porous coatings
on titanium alloy stems are known to shed debris. [20,38]
Furthermore, exposed porous coated surfaces resulting
from classic PE-induced osteolysis can release increasing
amounts of metal as the area of exposed porous coating in-
creases. In this case the sequence of pseudotumor forma-
tion followed an escalating course of periprosthetic oste-
ylosis. We propose that the sequence of events forming the
pseudotumor syndrome is the following: (1)PE-induced
boney osteolysis eroded the proximal femoral metadiaph-
tysis [4,17,23,25]; (2)the exposed prosthetic porous coated
surface mechanically abraded with the soft tissues intro-
ducing ultrafine particulate debris into the effective joint
space [21,26,30,36]; (3)the patient’s pre-sensitization to
metal (positive LTT results) triggered inflammatory cyto-
kines to form the pseudotumor capsule. [19,28,31,34]

This case illustrates the point that a pseudotumor can
form in the absence of cobalt-chrome implants. A major-
ity of reports in the last decade have impugned cobalt and
chrome metal particles of eliciting an immune response
unique to that metallic alloy. [10] Based upon this case, we
reject that concept outright. We believe that the biological
response to particulate hip debris can be categorized into
due to metal-polyethylene hip bearings. [3,9,10,11,20]
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Bearing Wear Responses THA

<table>
<thead>
<tr>
<th>Primarily PE Particles – In local excess</th>
<th>Primarily Metallic Debris – Not in local excess</th>
<th>Primarily Metallic Debris – In local excess</th>
<th>Primarily Ultrafine Metallic Debris – In local excess</th>
<th>Primarily Metallic Debris – In local excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteolysis Syndrome</td>
<td>Allergic Hip Syndrome</td>
<td>Metal Synovitis Syndrome</td>
<td>Pseudotumor Syndrome</td>
<td>Dead Hip Syndrome</td>
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<tr>
<td>Sensitivity to Metals (Ni or others)</td>
<td>No sensitivity to Metals (Ni or others)</td>
<td>Sensitivity to Metals (Ni or others)</td>
<td>Toxic local levels of Cobalt and/or Chrome</td>
<td>No Hypersensitivity</td>
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<tr>
<td>Macrophage reaction</td>
<td>Intra-articular synovitis</td>
<td>Intra-articular synovitis</td>
<td>Extra-articular spread of inflammatory cystic mass along musculoskeletal planes</td>
<td>Intra-articular tissue necrosis</td>
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<tr>
<td>Intra-articular synovitis</td>
<td>Generally aching pain 24/7</td>
<td>Intra-articular synovitis</td>
<td>Periarticular osteolysis</td>
<td>Periarticular osteolysis</td>
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<tr>
<td>Periarticular effusion</td>
<td>Minimal osteolysis</td>
<td>Intra-articular metallosis</td>
<td>Periarticular bone necrosis</td>
<td>Periarticular bone necrosis</td>
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<td>Onset of symptoms occurs 8-12 years after prosthetic implantation</td>
<td>Onset of symptoms occurs shortly after prosthetic implantation (within 6 months)</td>
<td>Onset of symptoms occurs 1-5 years after prosthetic implantation</td>
<td>Onset of symptoms occurs 3-10 years after prosthetic implantation</td>
<td>Onset of symptoms occurs 5-8 years after prosthetic implantation</td>
</tr>
</tbody>
</table>

Figure 10. Diagram describing the proposed five major biologic wear responses in THA.

References


