



## Pseudotumor After Ceramic-on-Ceramic Total Hip Arthroplasty: A Case Report

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**ABSTRACT** Pseudotumors, typically associated with metal-on-metal (MoM) bearings in total hip arthroplasty (THA), have rarely been reported in ceramic-on-ceramic (CoC) THA. This case details the development of a pseudotumor in a 70-year-old female six years after an uneventful CoC THA for osteoarthritis. The patient presented with groin pain and swelling, and imaging revealed a fluid-filled mass at the hip. Aspiration provided temporary relief, but the cyst recurred. Surgical intervention showed no macroscopic wear on the bearing surfaces, but 40cc of fluid was evacuated from the acetabulum after cup removal, confirming an articular origin. Pathology revealed a macrophage-driven pseudotumor without foreign material, suggesting an inflammatory or hypersensitivity response to the ceramic materials. This case underscores the rare but significant occurrence of pseudotumors in CoC THA, emphasizing the need for thorough clinical evaluation, early detection, and intervention, as well as further research to understand the underlying mechanisms.

**Keywords:** Total hip arthroplasty, osteoarthritis, ceramic-on-ceramic, case report, pseudotumor.

### INTRODUCTION

Total hip arthroplasty (THA) is widely regarded as one of the most successful procedures in modern orthopaedic surgery, providing significant pain relief and functional improvement for patients with degenerative hip disease<sup>1</sup>. Since its introduction, continuous innovation in bearing materials has aimed to optimize implant longevity and reduce wear-related complications.

Pseudotumors are non-neoplastic, non-infectious soft-tissue masses that were first described in association with metal-on-metal (MoM) bearings, where the release of metal wear particles and ions can provoke an adverse local tissue reaction (ALTR)<sup>2-4</sup>. In some cases, this response exhibits a characteristic histopathological pattern with a dense perivascular lymphocytic infiltrate, known as an aseptic lymphocyte-dominated vasculitis-associated lesion (ALVAL)<sup>3,5,6</sup>. Subsequent reports have demonstrated that similar ALTRs and pseudotumor formation may also occur—although less frequently—in metal-on-polyethylene (MoP) bearings, often related to corrosion at the taper junction or backside wear<sup>7,8</sup>. Ceramic-on-ceramic (CoC) bearings were developed to

minimize such complications because of their excellent wear resistance, low particle generation and favorable biocompatibility<sup>9,10</sup>. Modern CoC bearings have shown extremely low linear and volumetric wear rates in both experimental and clinical studies<sup>9-11</sup>. Nevertheless, pseudotumor formation has now been reported in association with CoC articulations as well, indicating that ceramic debris and/or patient-specific biological responses may still trigger adverse soft-tissue reactions in rare case<sup>6,12-18</sup>.

To date, only a small number of case reports worldwide have documented pseudotumors or adverse local tissue reactions arising after ceramic-on-ceramic total hip arthroplasty, highlighting the rarity of this phenomenon<sup>12-18</sup>. The present case illustrates the development of a pseudotumor following CoC THA and explores potential etiological mechanisms as well as considerations for clinical management.

### PATIENT INFORMATION

In 2018, a 64-year-old female with a history of osteoarthritis presented to our clinic for elective total hip arthroplasty (THA) due to severe pain and dysfunction

in her left hip. A ceramic-on-ceramic total hip arthroplasty (THA) was selected, taking into account the patient's age and activity level. The procedure was performed via a posterior approach using a cementless titanium alloy stem (Avenir, Zimmer Biomet, Warsaw, IN, USA) combined with a ceramic femoral head (BIOLOX Option, 40 mm, -3 mm, CeramTec, Plochingen, Germany) mounted on a titanium alloy sleeve. The acetabular component consisted of a monobloc titanium shell with an integrated ceramic liner (Maxera, 52 mm, Zimmer Biomet, Warsaw, IN, USA) (Figure 1).

The operation was uneventful, and the patient had an uncomplicated recovery. She was discharged on postoperative day 7 and followed up regularly at 6 weeks, 3 months, and 1 year. During these visits, the patient reported satisfaction with the surgery, and there were no signs of complications.

### CLINICAL PRESENTATION AND DIAGNOSTIC WORKUP

At 6 years postoperatively, the patient returned to the clinic with complaints of persistent groin pain upon walking. She also reported a warm swelling at the groin region. On physical examination, a non-tender mass was noted in the anterior hip region, and the patient exhibited mild discomfort with palpation. CT scan and MRI revealed a large (74 x 43 x 49 mm) fluid-filled mass at the anteromedial aspect of the hip,

suspected to be an iliopsoas bursitis by the radiologist, with compression of the femoral vein (Figure 2). Both components were positioned within acceptable limits, with a CT-measured cup inclination of 40° and anteversion of 35° with adequate anterior coverage of the cup (Figure 3).

Inflammatory laboratory markers, including C-reactive protein (CRP), total white blood cell count, and neutrophil percentage, were within reference ranges. In light of these findings, the decision was made to proceed with aspiration of the cyst.

Under fluoroscopic guidance, 40cc of brownish, viscous fluid was aspirated, which provided immediate relief of her symptoms. Cultures grew *Staphylococcus hominis*, a skin commensal, making the clinical relevance of this finding uncertain. Due to the extreme viscosity of the sample, no quantitative red or white blood cell count could be performed. A differential analysis, however, showed that the white blood cells consisted of 39% neutrophils, 1% lymphocytes, and 60% macrophages/monocytes. The macrophages were notably laden with dark-brown granular material, suggestive of intracellular pigment such as hemosiderin. The pathology report described "bloody fluid with chronic active inflammation and no foreign birefringent material." Despite the initial relief, the patient returned 3 weeks later with swelling of the entire leg, due to compression of the femoral vein by the recurrent cyst. A decision was made to proceed with surgical intervention.



Fig. 1 — Post-operative x-ray of the THA.

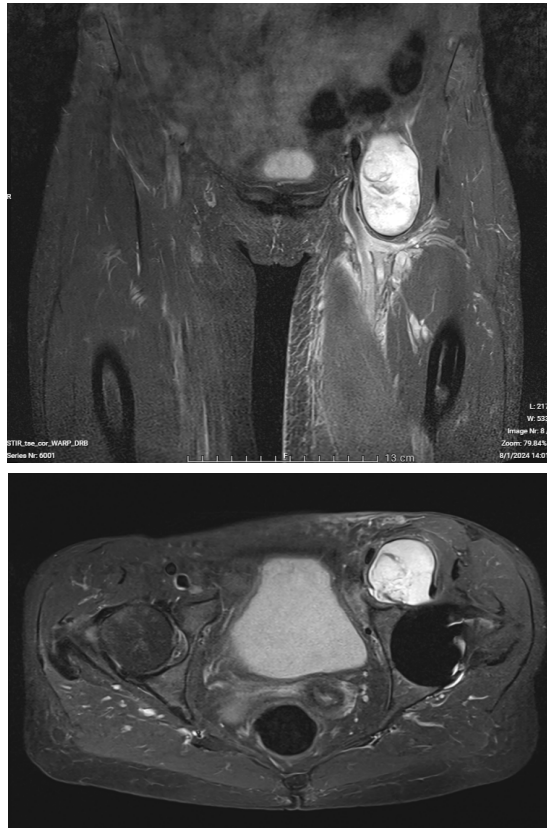


Fig. 2 — Coronal (a) and axial (b) MRI images of the fluid-filled mass, compressing the femoral artery and vein.

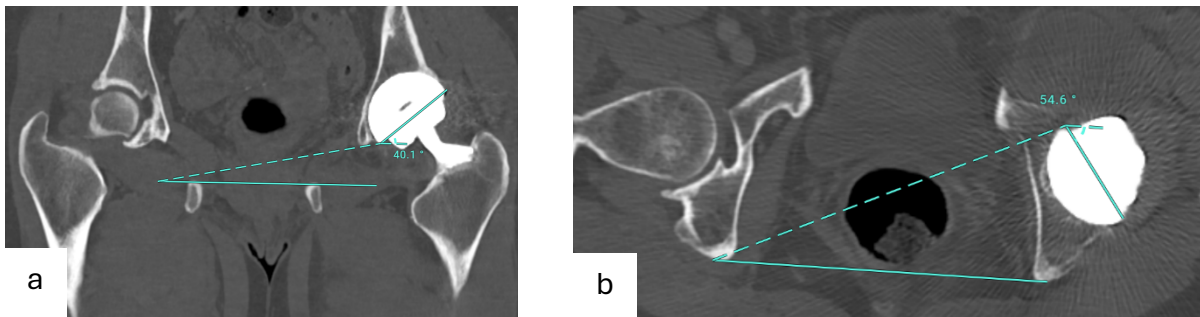


Fig. 3 — Coronal (a) and axial (b) CT images of the respectively the cup inclination of  $40^\circ$  and anteversion of  $35^\circ$  ( $90^\circ - 54.6^\circ = 35.4^\circ$ ). Adequate anterior bony coverage of the cup is noted on the axial image (b).

### SURGICAL INTERVENTION AND OUTCOME

The patient was taken to the operating room for cyst resection with cup and bearing revision. The same posterior approach used for the primary surgery was employed.

During the procedure, minimal intra-articular fluid was found, and the THA was dislocated for inspection. No signs of infection were noted. The bearing surfaces were found to be free of any macroscopic wear, and the ceramic femoral head was removed (showing

typical pencil marks due to contact with the metal cup after removal) (Figure 4). Neither the titanium sleeve of the biolox option head, nor the trunnion of the stem showed any signs of trunnionosis. The acetabular cup was easily removed without bone loss, and spontaneous evacuation of 40cc of dark-reddish viscous fluid into the acetabulum confirmed that the cyst had an intra-articular origin, arising just anterior to the anterior acetabular wall. The cyst wall was carefully mobilized and resected, and the femoral artery was well-palpated during this dissection.



*Fig. 4 — Cup and head after removal, showing no macroscopic signs of wear.*

A 52mm cementless press fit acetabular cup (Allofit, Zimmer Biomet, Warsaw, IN, USA) with a 36mm cross-linked polyethylene liner was inserted after progressive reaming. A new ceramic head (BIOLOX Option, 36 mm, +0 mm, CeramTec, Plochingen, Germany) was placed on the femoral component after stability testing. Both the cyst wall and the intra-articular fluid were submitted for microbiological and histopathological evaluation. Based on the culture result obtained after aspiration, the patient was started on a 5-day course of intravenous Vancomycin pending final culture results. After the cultures came back negative, she was discharged to a rehabilitation clinic on postoperative day 7. The patient's rehabilitation course was unremarkable, and at a 2-year follow-up, she reported complete resolution of her symptoms.

### **PATHOLOGY FINDINGS**

The pathology specimens, including the cyst wall and aspirated fluid, demonstrated findings consistent with “a macrophage-driven pseudotumor, with excessive fibroblastic proliferation and no foreign birefringent material (no ceramic nor metal particles)”; consistent with the absence of wear debris from the ceramic bearings and trunnion.

### **DISCUSSION**

Ceramic-on-ceramic (CoC) bearings are generally considered biologically inert and are associated with low wear rates and fewer adverse reactions<sup>9-11</sup>. Nevertheless, the development of pseudotumors in

CoC THA, as demonstrated in this case, represents a rare but clinically relevant complication that is increasingly recognized in the literature<sup>6,12-18</sup>.

No obvious trunnion wear was identified, and the ceramic bearing surfaces also showed no macroscopic signs of damage or abrasion. The absence of clear wear-related debris raises the question of the underlying mechanism responsible for the formation of the pseudotumor. Tribological studies have shown, however, that ceramic and metallic bearings can generate ultrasmall particles—even under apparently optimal conditions—and that such submicron debris may not be readily detectable on standard histopathological examination<sup>5,10,19</sup>. Thus, an entirely wear-independent mechanism cannot be assumed, even in the absence of visible damage.

Several hypotheses have been proposed to explain pseudotumor formation in CoC THA. One possibility is that the inflammatory response to ceramic particulate debris, although much less frequent than with metal debris, may still be sufficient to trigger pseudotumor development<sup>6,14-18</sup>. Another proposed mechanism is a hypersensitivity or inflammatory reaction to ceramic materials, which —while uncommon— has been described in association with other biomaterial-based implants<sup>8,11,14,20</sup>.

Across previously published ceramic-on-ceramic pseudotumor cases, the histological pattern is consistently characterized by a chronic macrophage-rich inflammatory reaction within a fibrous or cystic wall, often with hemorrhagic components—features that closely resemble the findings in our patient. Several reports (including those by Valcarenghi<sup>13</sup>,

Ciatti<sup>16</sup> and Piper<sup>17</sup>) have identified visible ceramic or mixed particulate debris, whereas others, such as Campbell et al.<sup>12</sup>, described macrophage-dominated pseudotumors without identifiable particles. Our case fits within this spectrum: the lesion showed a fibro-inflammatory, macrophage-driven reaction similar to that seen in other CoC cases, but—like some of the reported examples—no birefringent ceramic or metallic particles were detected, suggesting either submicron debris below histological detection or a non-particle-specific inflammatory response as the likely driver<sup>15,16</sup>.

The exact pathophysiological mechanisms remain poorly understood, and further research is needed to clarify whether these complications arise from material properties, patient-specific factors, or surgical technique.

The use of a larger (40mm) femoral head in this THA could have contributed to increased wear, as larger heads may generate higher friction and stress on the bearing surfaces, potentially leading to greater particulate release<sup>11,22</sup>.

The management of pseudotumors typically involves surgical excision of the mass and revision of the bearing surfaces<sup>3,6,7</sup>. In this case, despite the lack of macroscopic wear, the acetabular component was revised to a polyethylene liner because of cyst recurrence and persistent symptoms. The patient experienced a favorable outcome following this intervention, highlighting the value of thorough evaluation and appropriately case-specific surgical management when pseudotumor-related symptoms arise—even in well-functioning CoC bearings<sup>3,6,7,12-18</sup>.

## CONCLUSION

This case highlights the rare but possible occurrence of pseudotumors following ceramic-on-ceramic total hip arthroplasty, a complication predominantly associated with metal-on-metal bearings. The exact pathophysiology remains unclear, and further studies are needed to understand the underlying mechanisms.

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