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Metallosis and Pseudotumor around Ceramic-On-Polyethylene Total Hip Arthroplasty; Case Report and Literature Review

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ABSTRACT

Polyethylene failure is a rare complication of ceramic-on-polyethylene total hip arthroplasty due to characteristics of ceramic. Complications associated with ceramic-on-polyethylene articulations have been studied extensively, however, only few reports have described its catastrophic wear and concurrent pseudotumor formation. The etiology of this biological reaction and concurrency of pseudotumor formation with metallosis remain unclear. We report two cases of wear of the acetabular liner in a ceramic-on-polyethylene prosthesis due to total hip arthroplasty (THA) long time ago. They came back to the clinic with the history of worsening hip pain and abnormal radiological and clinical findings. Then they underwent surgery and metallosis and pseudotumors were detected and revisions were performed for them. It is necessary to evaluate patients underwent THA complaining of hip pain for component wear and be checked the cup appear well fixing and fairly oriented on follow-up radiographies. Close follow ups can prevent accelerated polyethylene wear in ceramic-on-polyethylene coupling THA.

Keywords: Polyethylene wear, ceramic-on-polyethylene system, metallosis, Total hip arthroplasty, pseudotumor

INTRODUCTION

Today, a lot of THAs are performed in worldwide every year [1], and this is likely to rise by an estimated 170% by 2030 [2]. These trends are driven by an ageing population wishing to remain active and an increasing number of obese individuals [3]. A THA procedure replaces diseased hip articular surfaces with synthetic materials [4,5]. Evidence shows THA surgery has excellent long-term survivorship in both younger and older patients. Despite the excellent outcomes of THA, there are some current areas of concern with regard to THA surgery [1]. Adverse reaction to metal debris, herein termed metallosis, usually is defined as aseptic fibrosis, local necrosis, or loosening of the prosthesis secondary to metallic corrosion and release of wear debris [6-8]. It is also associated with gray discoloration of the tissues of the joint, pain, an effusion, and elevated serum metal levels. Metallosis has been found with stainless steel, titanium, and cobalt chromium alloy femoral prostheses articulating either with a similar metal or rarely with a polymer acetabular component [9]. A pseudotumor is a granulomatous mass or a destructive cystic lesion which is neither infective nor neoplastic, when developing in relation to an arthroplasty device can potentially cause extensive collateral damage [10]. The exact cause of pseudotumors is unclear; however, the common factor in patients with history of THA has been increased wear [11]. Periarticular mass was first described by Evans et al. in one case undertaking the first generation metal-on-metal (MOM) hip replacement. Since that time, it has long been

recognized as a new type of complication occurring around the hip prosthesis [12]. Recently, pseudotumors associated with osteolysis or metallosis and periprosthetic bone loss are now being increasingly reported in patients with polyethylene-on-metal hip replacement [13-16]. In order to reduce polyethylene wear, the use of bearings has become an option in total hip arthroplasty. Ceramic's higher resistance to scratching compared to chromium cobalt (CoCr), and inert qualities in an aqueous environment contribute to the lower linear and volumetric polyethylene wear rates seen in ceramic on polyethylene bearings compared to CoCr on polyethylene bearings [17]. Reports in the literature of catastrophic wear of the ceramic-polyethylene articulation are rare and in those that reported they have implicated acetabular inclination >45°, use of gamma sterilized polyethylene, increased activity level, age <50, and backside wear as causes of failure [18, 19]. However, pseudotumor and metallosis due to ceramic-on-polyethylene has not reported yet as an adverse reaction after THA. We reported two cases of ceramic-on-polyethylene failure with metallosis and pseudotumor making in long-term follow up.

Case 1

A 44-year-old man underwent total hip arthroplasty (THA) of the right hip via a standard direct lateral approach for avascular necrosis of head of femur (AVN) by the senior author in December 2006. The components used were uncemented Ceramic on polyethylene (PE) bearing system. The initial postoperative course was uneventful, and the patient subjectively improved and was pleased with his outcome for during 5 years, thereafter. However, he returned to the clinic in November 2011 reporting a 6-month history of progressive severe hip pain that had worsened with ambulating and bearing weight on his right lower extremity. His pain was progressed in rest during these 6 months. He reported no history of fever and chills, weight loss, infection symptoms or other changes in his overall health. His past medical history was not considered any diseases. He had no known allergies or metal sensitivities or history of diabetes mellitus or autoimmune disorders. He was smoker and was not addict.

A tender soft tissue mass was noted just proximal and anterior to the great trochanter, with significant edema of the proximal thigh, on physical examination. Limitation in range of motion of right hip was detected with discomfort at the extremes of motion. No increased warmth or skin changes were observed in the hip region or in the area of swelling. Plain radiographs of the hip showed stable positioning of the THA components; but eccentric sitting of head in cup that means frank wearing with some density change of supra-acetabular bone (Figure 1).



Figure1. Plain Radiography of hip; left is case 1 and right is case 2

White blood cell count, erythrocyte sedimentation rate, and C - reactive protein values and other laboratory values were all within normal limits.

Patient was candidate for revision due to PE wearing and very severe non-tolerable pain. Operation did by extended trochanteric osteotomy. An incision was made through the scar from the previous THA. After incising through the iliotibial band, pseudo tumor, necrotic tissue and severe reaction of soft tissue into metal compounds were encountered. Severe corrosion of wear of ceramic head with PE-metal back was found. Necrotic tissue was encompassed almost the entire hip capsule, short external rotator muscles, and tendinous portion of the gluteus medius, disrupting the abductor insertion point on the greater trochanter (Figure 2). Necrotic bone lesions were discovered about the acetabulum and greater trochanter. The main corrosion was due to penetration of ceramic head PE and after complete perforation of PE, corrosion of metal back by ceramic head. On further inspection, the

femoral and acetabular components were found to be loosed (Figure 3). Thereafter a thorough debridement of the necrotic soft tissue and bone and also removal of pseudo tumor tissue was performed. Following that, exchange of the acetabulum and reconstruction with TM-Augment and continuum cup (Zimmer, Warsaw, IN, USA) with allograft were performed because of severe lesions in acetabulum. ZMR hip stem (Zimmer, Warsaw, IN, USA) was used. Also minimal repair of the capsule and short external rotators was performed due to the damage found to these structures (Figure 4). Intraoperative cultures results were negative. Intra-operative frozen-section sample showed only 2-3 PMN/hpf.



Figure 2. Pseudotumor and necrotic tissue due to metal reaction during the exploration; *upper pictures are related to case 1 and lower pictures are related to case 2*



Figure 3. Corrosion in prosthetic femoral component, the polyethylene liner and the exterior of the metallic head; *lower pictures are related to case 2 and upper case 1*

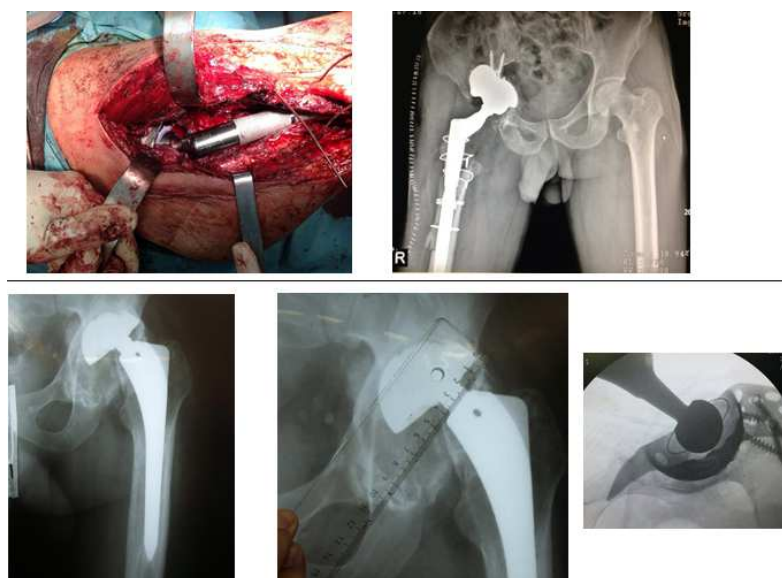


Figure 4. Revision surgery and postoperative plain radiography of hip; upper pictures are related to case 1 and lower pictures are related to case 2

The patient did well until approximately 4 weeks postoperatively. Then he had no problem in walking and flexion of hip in examination and self-reporting status. We evaluated patient for three years. He had no complicated outcomes.

Case 2

Total hip arthroplasty of the right hip in a 43-year-old man performed via a standard direct lateral approach due to avascular necrosis of head of femur (AVN) by the senior author in August 2002. The components used were uncemented Ceramic on polyethylene (PE) bearing system. His postoperative follow ups were uneventful, and the patient subjectively improved and had no problem during 10 years. He returned to the clinic in February 2012 reporting a 3-month history of severe hip pain that had worsened with ambulating and bearing weight on his right lower extremity and it was progressed in rest during this period. He reported no history of fever, weight loss, infection symptoms or other systemic changes in his overall health. His past medical history was negative. He had no known allergies or metal sensitivities or history of diabetes mellitus or autoimmune disorders. He was past smoker and was not addict. He had mentioned no history of drug usage.

A soft tissue mass was seen just proximal to the great trochanter, with marked edema of the proximal thigh, on physical examination. It was tender and he had limitation in range of motion of right hip in flexion and discomfort. Warmth or skin changes were not observed in the hip region and in the area of swelling. Plain radiographs of the hip showed stable positioning of the THA components; but eccentric sitting of head in cup that means frank wearing with some density change of supra-acetabular bone (Figure 1).

White blood cell count, erythrocyte sedimentation rate, and C - reactive protein values and other laboratory values were all within normal limits. Only eosinophil was high in his differentiation of WBC.

Patient was candidate for revision due to PE wearing and very severe non-tolerable pain. Operation did by extended trochanteric osteotomy. An incision was made through the scar from the previous THA. After incising through the iliotibial band, pseudo tumor, necrotic tissue and severe reaction of soft tissue into metal compounds were encountered in acetabulum and proximal of femur. Severe corrosion of wear of ceramic head with PE-metal back was found. Necrotic tissue was encompassed almost the entire hip capsule, short external rotator muscles, and tendinous portion of the gluteus medius, disrupting the abductor insertion point on the greater trochanter (Figure 2). The main corrosion was due to penetration of ceramic head PE and after complete perforation of PE, corrosion of metal back by ceramic head. On further inspection, the femoral and acetabular components were found to be loose (Figure 3). Thereafter a thorough debridement of the necrotic soft tissue and bone and also removal of pseudo tumor tissue was performed. Following that, exchange of the acetabulum and reconstruction with Burch-Schneider cage

(Zimmer, Warsaw, IN, USA) with allograft and Wagner SL® Revision stem (Zimmer, Warsaw, IN, USA) were performed because of severe lesions in acetabulum. Also minimal repair of the capsule and short external rotators was performed due to the damage found to these structures. Intraoperative cultures results were negative. Intraoperative frozen-section sample showed only 2-3 PMN/hpf.

The patient did well until approximately 5 weeks postoperatively. Then walked normally and flexion of hip was normal in examination. We evaluated patient for two years with uneventful outcomes.

DISCUSSION

Inflammatory responses to polyethylene wear debris and following osteolysis and loosening and making pseudotumors is the first presentation failure limiting the patients underwent THA long ago. In order to diminish polyethylene wear debris improvements was made to creating new articulating surfaces and head bearing surfaces such as ceramic-on-polyethylene. This type of bearing has better characteristics than previous one, including less polyethylene wear, osteolysis and loosening, more rounded surface with fewer sharp edges and chemically inert. Although it had better features, but a single scratch can make its failure. To our knowledge there were no similar reports and this study described concurrent inflammatory pseudotumor and metallosis after THR long-term follow up.

Catastrophic polyethylene failure is along with femoral head completely penetrated the PE liner resulting in articulation of the head with the metal acetabular cup which can cause metallosis, osteolysis and tissue damage in the periarticular area. This occurs rarely after THA and is reported rates of 0.2% to 10.9% [20]. Survival of primary ceramic-on-PE arthroplasty is up to 10 years with survival rates of 95% to 98.1%. Long term survival rates of it in 10 to 20 years had been reported ranging from 70% to 89% [19]. Our patient's failure of the ceramic-on-PE arthroplasty, attributed to patient and implant factors. Since pseudotumor is commonly reported and so well known, one joint surgeon may ignore the differential diagnosis which may lead to the development of periprosthetic soft tissue mass [21]. Such pathologic changes could be induced by a number of other factors like metabolic disease, infection, and even neoplasia. Recently, however, the potential relationship between periprosthetic mass and musculoskeletal neoplasms has been reported. Considering the serious consequences, differential diagnosis of tumors should be kept in mind despite the relative lower incidence. Once misdiagnosed, one patient will miss the optimal treatment options and suffer an irreparable disaster [22]. Therefore, the presence of a tumor needs to be included in the differential diagnosis, and more attention should be paid considering that THR is widely used in both young and elder patients. It was difficult to distinguish pseudotumors from a necrotic tumor based on the imageological or pathological examination along [22]. So, it should be considered the clinical manifestations and para-clinic such as MRI, histological examinations and so on to distinguish it from other causes. So in our study of two cases, their clinical presentations are not contributed to tumors.

Several authors have suggested that pseudotumors are a reaction to high wear [13-15] while other studies provided evidence showing that pseudotumor formation depends more on metal hypersensitivity [23, 24]. The conception at this time is that pseudotumors are an adverse reaction which consists of a spectrum of inflammatory responses to metal debris. Whether this is immunologically mediated or a unique response to particles, or both, and which factor plays the dominant role are still unclear. In addition, the causes for immune induction and subsequent immune effect remain controversial [25].

In our cases we presented concurrent pseudotumor and metallosis due to ceramic-on-PE arthroplasty which is rare. Manzano et al reported one case with a history of bilateral total hip arthroplasty presented severe osteolysis, heterotopic ossification, and complete wear of the acetabular liner, bony impingement of the femoral greater trochanter on the acetabular rim and superior migration of the femoral head. They finally reported failure of the ceramic-on-polyethylene liner in their patient due to the use of a non-cross linked polyethylene liner, a highly active lifestyle, and poor follow up [20]. Needham et al presented a case with the first reported complete wear-through of the acetabular portion of a ceramic-polyethylene arthroplasty presenting as a dislocation. Their patient's alumina ceramic femoral head penetrated the polyethylene liner and titanium shell and presented as a dislocated THA. They contributed such factors for this catastrophic failure include young patient age, high activity level, thin polyethylene liner, backside wear, component positioning, polyethylene sterilization with γ irradiation in air, and lack of appropriate follow-up [19]. Mariconda et al presented the patient with worsening pain in her left hip and an acute incapacity to bear weight on her left lower limb which twelve and eleven years earlier she had undergone bilateral

ceramic-on-polyethylene THA with acetabular expansion components of identical size on both sides. They detected dislocation and severe polyethylene wear, one large osteolytic lesion in the roof of the acetabulum and diffuse periarticular metallosis [18]. Fu et al showed two cases of pseudotumor who have accepted THR for ankylosing spondylitis (AS) and later required revision surgery and hindquarter amputation [22]. As it is seen in the literature cases which presenting both pseudotumors and metallosis due to ceramic-on-PE are rare. Our evaluation showed that the causes of these reactions are related to young age, component positioning and high activity level.

CONCLUSION

Ceramic-on-polyethylene prosthetic wear is a rare complication with severe consequences such as metallosis, osteolysis, and local tissue damage and pseudotumors due to immune system response. Shortening periods of clinical and radiological follow ups can prevent accelerated polyethylene wear in ceramic-on-polyethylene coupling THA. It is necessary to evaluate patients complaining of hip pain for component wear and be checked the cup appear well fixing and fairly oriented on follow-up radiographies. This can permit a revision of only the femoral head and acetabular liner.

Consent

Written informed consent was obtained from the patients for publication of this case report and any accompanying images.

Competing interests

The authors declare any competing interests.

Authors' contributions

Dr. Afshin Taheriazam participated in the design of the study and performed the surgeries. Dr. Amin Saeidinia conceived the study, participated in its design and helped to draft the manuscript. All authors read and approved the final manuscript.

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