

AGGRESSIVE GRANULOMATOSIS AFTER CEMENTLESS TOTAL HIP ARTHROPLASTY AS A RESULT OF INFLAMMATORY REACTION TO METAL DEBRIS: CASE REPORT

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SUMMARY – Massive osteolysis and granulomatous pseudotumor tissue reactions are long-term complications of total hip replacement. It is a condition of localized bone resorption in contact with prosthetic material. It is speculated to be a consequence of metal hypersensitivity or inflammatory reaction to excessive wear. Ten years after total cementless hip replacement (metal on polyethylene surface), a 70-year-old patient presented with hip pain and pseudotumor with massive osteolysis of proximal femur on x-ray. Intraoperatively, extensive metallosis with significantly worn metal head (316L stainless steel) and only slightly worn polyethylene insert was found. Upon extraction, parts of the affected tissue and bone that were in direct contact with the prosthesis were sent for histopathologic analysis. Microscopic examination showed necrotic soft and bone tissue, mainly bone marrow with numerous histiocytes and multinucleated giant cells containing lots of pigmented particles (presumed to be metal particles as a result of implant surface wear). In this case, the primary cause of osteolysis and granulomatosis was inflammatory reaction to metal debris. Aggressive granulomatosis has been first described in cemented prostheses and afterwards also in cementless ones. Conditions such as primary or metastatic neoplastic processes and infection should be excluded. The presence of foreign molecular particles due to wear of the prosthesis by different mediators has been presumed to cause an inflammatory reaction that leads to bone resorption and loosening of the prosthesis.

Key words: *Hip prosthesis; Prosthesis failure; Osteolysis; Granuloma, plasma cell; Case report*

Introduction

Massive osteolysis and granulomatous pseudotumor tissue reactions are long-term complications of total joint replacement and can present as joint pain or implant instability as a consequence of aseptic prosthesis loosening¹. It is a condition of localized bone resorption in contact with prosthetic material that can be seen on radiographs. For diagnosis, infection and

malignancies should previously be excluded. Metal hypersensitivity or inflammatory reaction to excessive wear have been speculated as the underlying cause of foreign body reaction in histopathologic specimens, also depending on the prosthetic material, but the basic pathophysiological mechanism still remains unclear. We present a case of a 70-year-old patient that presented with hip pain 10 years after total hip arthroplasty due to this condition.

Case Report

A 70-year-old patient presented with pain in his left hip in the past year. Ten years before, at the

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Fig. 1. Pseudotumour with massive osteolysis of proximal femur.

age of 60, he had undergone cementless total hip arthroplasty (metal on polyethylene surface) for osteoarthritis. He was pain free for the next 9 years. Radiologic follow up showed pseudotumors with massive osteolysis of proximal femur due to massive



Fig. 2. Extensive metallosis of the surrounding soft tissue.

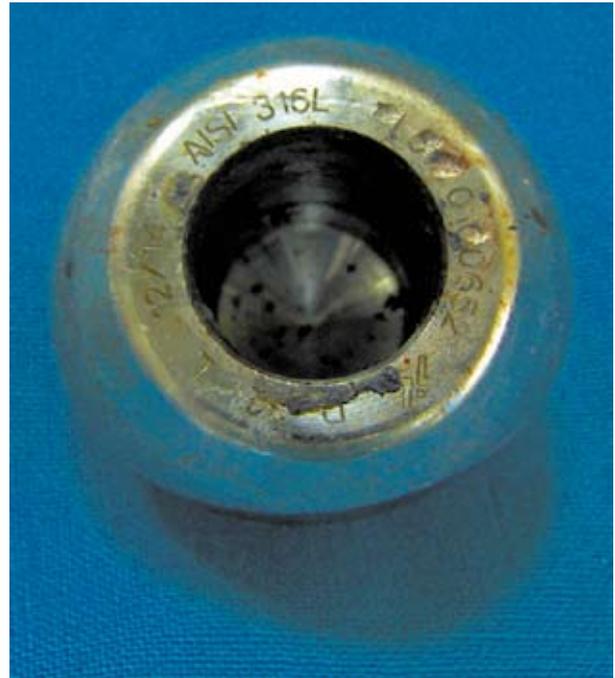


Fig. 3. Worn metal head type AISI 316L.



Fig. 4. Elliptic head as a result of wear.



Fig. 5. Worn polyethylene insert with metal debris.

granulomatosis with stable distal part of the femoral stem (Fig. 1). Intraoperatively, extensive metallosis (Fig. 2) with significantly worn metal head was found (Figs. 3 and 4). Only a small portion of the polyethylene insert was worn (Fig. 5). Acetabular and femoral parts of the prosthesis were stable. After removal of the altered tissue, bone defect at the edge of the acetabulum and at the proximal part of the femur were filled with autologous and allogeneic cancellous bone. At the end of the procedure, the polyethylene insert and femoral head were replaced with new ones. Postoperatively, the patient was normotensive². Upon extraction, parts of the affected tissue and bone that were in direct contact with the prosthesis were sent for histopathologic analysis. Microscopic examination showed necrotic soft and bone tissue, mainly bone marrow with numerous histiocytes and multinucleated giant cells containing lots of pigmented particles (presumed to be metal particles as a result of wear of the femoral head surface). Polarized light microscopy demonstrated the presence of free foreign material in the specimen, as well as incorporated in some histiocytes that were speculated to be conglomerates of metal worn from the implant surface. The analysis also concluded that it was aggressive granulomatous reaction to wear debris, mainly of the femoral head, as a consequence of inflammation.

Discussion

Aggressive granulomatosis as a result of reaction to the prosthetic material in the body is a described cause of pain or joint instability in patients with joint implants. Harris *et al.* were the first to describe this condition in a cemented hip arthroplasty. Later cases reported the same condition associated with cementless prosthesis³. Differential diagnosis in patients presenting with osteolysis and tumor-like masses surrounding the prosthesis on radiographs after total hip arthroplasties includes primary or metastatic neoplastic processes and infection⁴. These conditions should be excluded first. Definitive diagnosis is established after histopathologic examination of the affected tissue. Pathophysiologically, it can be explained as a foreign body reaction. The presence of foreign material (metal, in our case from cobalt/chromium prosthesis) in the joint and its wear debris cause an inflammatory reaction through bone resorption mediators such as prostaglandin E₂, collagenase and interleukin-1 and 6, and induce monocyte-macrophage response. Wear of different molecular particles can lead to this condition, from ultra-high molecular weight polyethylene, polymethyl methacrylate, hydroxyapatite degradation products to metal or particles of cement. It is presumed that they cause the same reaction through different mediators, or are directly toxic to phagocytic cells (as seen in cases of metal hypersensitivity). The ultimate result of these processes is proliferation of mature macrophages and multinuclear foreign body type giant cells that lead to weakening of the periprosthetic tissue. Proliferation of fibroblasts leads to their ingrowth between the bone and the prosthesis. This also contributes to periprosthetic loosening⁵. Replacement of the femoral head material in a metal-on-polyethylene bearing from metal to alumina resulted in a reduction of polyethylene wear. However, osteolysis caused by polyethylene debris generated by alumina-on-polyethylene prostheses is still not prevented. The fact that most of osteolysis and granulomatosis occur around proximal and not distal part of the implant can suggest that the primary cause is wear of polyethylene (originating from the acetabular socket) and not metal debris^{6,7}. Several studies report causal relationship of metal hypersensitivity and foreign body reaction due to wear particles. Wirganowicz and Thomas found elevated concentrations of aluminum

(0.4%), cobalt (0.05%) and chromium (0.03%) in synovial tissue (normal concentrations are 0.0000115%, 0.0000049% and 0.0000146%, respectively), suggesting that alumina on ceramic bearings are not as inert as previously thought⁸. In opposite to these suggestions, as well as the findings in our case, where in the histopathologic specimen particles of worn metal but also polyethylene were found, Moholkar and Tamblyn found metal wear particles with no evidence of any polyethylene debris¹. Wear test suggests wear rate in metal on polyethylene, alumina on polyethylene and metal on metal to be 0.22, 0.05, 0.0018 mm *per* year, respectively. Although the intention in biomechanics is to decrease the wear rate and the intention with the introduction of metal-on-metal implants was that metal particles in opposite to polyethylene are too small (6-744 and 50-5000 nm, respectively) to initiate osteolytic reaction, there still are such reports and problems of osteolysis, periprosthetic loosening and granulomatosis reaction around the implant have not yet been solved.

In this case, a significant wear of the prosthesis head was found (surgical stainless steel, AISI 316L with 16-18% Cr, 10-14% Ni and extra-low carbon, which have high resistance to corrosion but low wear resistance). Due to the low wear resistance of 316L stainless steel head, abrasion and extensive metallosis occurred. It is presumed that the presence of foreign molecular particles (mainly metal) cause an inflammatory reaction. This inflammatory reaction was responsible for massive bone resorption and pseudotumor on radiographs.

Conclusion

Osteolysis and granulomatous pseudotumors can occur after total hip arthroplasty as a result of inflammatory reaction to wear debris of different materials

(metal, polyethylene) used in hip implants. The fact that most of osteolysis and granulomatosis in this case occurred around the proximal part of the femoral stem (Fig. 1) and extreme wear of the femoral head (Figs. 3 and 4), as well as histopathologic findings suggest that the primary cause was inflammatory reaction to metal debris.

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Sažetak

AGRESIVNA GRANULOMATOZA NAKON UGRADNJE BECEMENTNE TOTALNE ENDOPROTEZE KUKA KAO REZULTAT UPALNE REAKCIJE NA ČESTICE METALA: PRIKAZ SLUČAJA

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Masivna osteoliza i pseudotumorska granulomatozna reakcija su dugoročne komplikacije totalne artroplastike kuka. Radi se o stanju lokalizirane koštane resorpcije na mjestu kontakta s protetskim materijalom. Pretpostavlja se da je to posljedica preosjetljivosti na metal ili upalne reakcije na prekomjerno trošenje materijala. Deset godina nakon totalne artroplastike kuka (metalna glava, polietilenski acetabularni umetak) 70-godišnji bolesnik dolazi s bolovima u kuku te masivnom osteolizom proksimalnog femura na radiogramu. Intraoperacijski je nađena opsežna metaloza sa značajno istrošenom metalnom glavom (316L nehrđajući čelik) i samo manjim dijelom istrošenim polietilenskim umetkom. Dijelovi zahvaćenog tkiva i kosti koji su bili u izravnom dodiru s protezom su poslani na patohistološku analizu. Mikroskopski pregled je pokazao nekrotično meko i koštano tkivo, koštanu srž s brojnim histiocitima i multinuklearnim gigantskim stanicama koje sadrže puno pigmentnih čestica (pretpostavlja se da su to čestice metala kao rezultat trošenja površine implantata). Uzrok osteolize s granulomatozom u ovom slučaju je bila upalna reakcija na čestice metala nastale trošenjem glave proteze. Agresivna granulomatoza je prvi puta opisana u cementnim protezama, a potom i kod bescementnih proteza. Primarni ili metastatski neoplastični procesi i infekcije prvotno moraju biti isključeni kao uzrok. Pretpostavlja se da prisutnost molekularnih čestica kao posljedica trošenja endoproteze preko različitih posrednika uzrokuju upalnu reakciju koja dovodi do resorpcije kosti i nestabilnosti proteze.

Ključne riječi: *Kuk, proteza; Proteza, zatajivanje; Osteoliza; Granulom, plazminih stanica; Prikaz slučaja*