

WEAR OF A TITANIUM-ALLOY SHOULDER PROSTHETIC HEAD

J. P. SIMON, L. DE SMET, G. FABRY

We present a case report of extensive wear that occurred on the surface of the titanium-alloy head of a shoulder prosthesis after only 2 years' service. Such wear warrants discontinuing the use of titanium-alloy articulating surfaces even in nonweight-bearing joints.

Keywords : shoulder ; prosthesis ; titanium.

Mots-clés : épaule ; prothèse ; titane.

INTRODUCTION

Wear of titanium articulating surfaces has been repeatedly reported in total hip arthroplasty (1, 2, 4). Titanium debris from the stem and/or the femoral head generated by micro-movements or macromovements may contribute to osteolysis and aseptic loosening of total hip components. Titanium particles may additionally increase polyethylene wear by the mechanisms of third-body wear and adhesive wear.

The present report documents extensive wear that occurred over a brief period in the nonweight-bearing head of a shoulder prosthesis.

CASE REPORT

A 47-year-old woman with multiple epiphyseal dysplasia had a shoulder hemiarthroplasty for degenerative changes in that joint in September, 1992. Previously she already had an osteotomy of the left hip, an osteotomy of both knees and a total hip arthroplasty of the right hip. A hemiprosthesis with a modular nitride-coated titanium head (3M™) fixed on a Morse taper was used to replace the humeral head. The postoperative period was uneventful. She however experienced progressive pain during the fourth month following surgery, while the mobility of the shoulder remained restricted. Infection was unlikely, as the

ESR and CRP were both normal and cultures from aspirated joint fluid remained sterile. Mobilization under general anesthesia was performed in March, 1994.

Nevertheless the pain increased and cranial displacement of the humeral component was noted on radiographs. A revision was done in September, 1994, two years after the first operation. The stem was well fixed. The antero-inferior glenoid rim was clearly eroded. The synovium and the glenoid fossa were stained dark owing to accumulation of titanium debris. The cartilage of the glenoid fossa had been completely eroded. After the titanium-alloy prosthetic head (fig. 1) was removed, a polyethylene glenoid component was implanted and a chromium-alloy humeral head was used to replace the titanium component.

The patient made an uneventful recovery. Two years following the revision the patient was still completely pain free. She had an active elevation of 100° and an active abduction of 110°.

DISCUSSION

Implants manufactured of titanium-alloy have excellent biocompatibility. Nonetheless the known drawbacks of titanium alloys include poor resistance to frictional wear, notch sensitivity, and potential toxicity of aluminum and vanadium. A high loosening rate and extensive osteolysis have been reported for components made of titanium alloy in weight-bearing joints (2). Extensive burnishing of titanium-alloy (Ti-6Al-4V) femoral heads has been observed to occur *in vivo* (1). A 10-fold increase in wear rate of titanium femoral

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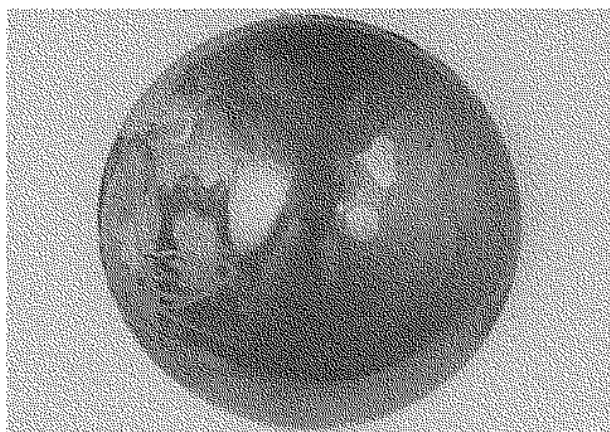


Fig. 1. — Excessive and extensive wear is apparent on the nitride-coated titanium-alloy prosthetic head. Scratches are artefacts caused during revision surgery.

heads has been noted *in vitro* when titanium femoral heads were compared to cobalt-chromium-alloy femoral heads articulating against polyethylene (3).

Nitrogen-ion implantation has been used in order to improve the wear resistance of titanium-alloy articulating surfaces both for femoral heads in total hip replacement and for femoral components in total knee replacement. This process, not to be confused with nitride coating as applied to the humeral component discussed in this paper (fig. 1), hardens the prosthetic surface. Ion implantation within the surface occurs merely at a depth of 0.02 to 0.2 micrometer, while metal is gradually removed with time. Therefore this technique provides only temporary increased resistance to metal wear and a transient assurance against surface roughening (3). Additionally wear of the articulating metal surface contributes to polyethylene wear. Metal particles accelerate polyethylene wear through the processes of third-body wear and adhesive wear. The relationship between polyethylene wear and the roughness of the metal articulating surface was experimentally determined by Dowson *et al.* (4). As the roughness of the metal surface increases, the polyethylene wear may be enhanced by 50% to 300% owing to increasing friction.

Avoiding the use of nonhardened titanium-alloy has been strongly recommended for weight-bearing joints (1). The present report however documents

that rapid and extensive wear of a titanium-alloy surface may occur as well in a nonweight-bearing joint over a brief period.

Such wear warrants discontinuing the use of titanium-alloy articulating surfaces even in nonweight-bearing joints. Even surface hardening through nitrogen-ion implantation does not make titanium alloy a suitable material as part of a wear couple in a weight-bearing or a nonweight-bearing joint.

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SAMENVATTING

J. P. SIMON, L. DE SMET, G. FABRY. Slijtage van het titanium oppervlak van een schouderprothese.

Een uitgebreide en snel progressieve slijtage van het titanium oppervlak van een schouderprothese werd vastgesteld slechts twee jaar na implantatie. Het gebruik van titanium articulerende oppervlakken dient te worden vermeden, zelfs in niet gewichtdragende gewrichten.

RÉSUMÉ

J. P. SIMON, L. DE SMET, G. FABRY. Usure d'une prothèse céphalique d'épaule en alliage de titane.

Une usure étendue et rapide de la surface en titane d'une prothèse d'épaule a été notée deux ans déjà après l'implantation. L'utilisation de surfaces articulaires en titane doit être évitée même sur les articulations non portantes.