

Cobalt Chromium Alloy

Pat Campbell, Ph.D.*

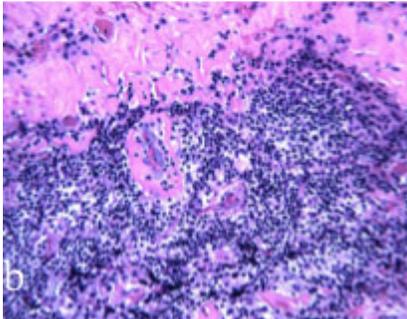
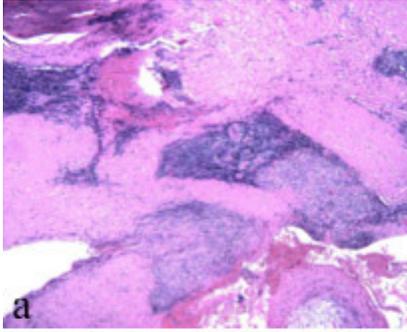
Introduction

Prosthetic bearing surfaces for joint replacement operations are currently manufactured from high carbon (0.20%-0.25%) cobalt, chromium, and molybdenum alloy (CoCr). Cobalt chromium alloy bearings for hip replacement can articulate against ultra high molecular weight polyethylene, ceramic or they can be used together in a hard-on-hard bearing. Such metal-on-metal articulations produce small but measurable quantities of mostly nanometer to submicron metal particles that can migrate systemically. The high number of these very small particles presents a large cumulative surface area for corrosion. Additional metal debris can be produced by component malposition, impingement, third-body wear or component loosening. The presence of corrosion products can be verified by elevated levels of cobalt and chromium ions in the blood or urine.

Histopathology

The migration of particulate metal and corrosion products to distant end-organs has been reported hip and knee replacements retrieved at autopsy (1) and these can induce pathological changes such as histiocytosis, fibrosis or necrosis(2). The size of disseminated particles ranges from 0.1 up to 8 microns but most particles measure less than 0.1 micron. The larger particles are phagocytosed by macrophages which form focal aggregates in the organs without apparent toxicity. The possibility of long-term consequences of chronic particulate metal release, including carcinogenicity or other metabolic disorders is often noted as a concern and chromosomal abnormalities have been reported after exposure to CoCr.(3) However similar changes occur with other biomaterials and meta-analysis showed no increased risk of cancer to patients with metal-on-metal conventional total hip replacement implants(4).

Osteolysis (progressive peri-implant bone loss causing implant loosening) as a result of metal allergy rather than excessive wear debris as the underlying cause has been reported in association with metal-on-metal hip replacements in a small number of cases(5). The periprosthetic tissues of patients who have had a revision surgery for suspected metal sensitivity are typically characterized by the extensive perivascular infiltrates of both B and T lymphocytes, often mixed with plasma cells (Fig 1). This may occur in conjunction with large areas of necrosis but typically without notable wear debris (6). To distinguish these lesions from T-cell dominated delayed type hypersensitivity, the term ALVAL (aseptic lymphocytic vasculitis associated lesions) was introduced to describe these histological features (5). If left untreated, soft tissue involvement from wear or sensitivity reactions can lead to the expansion of soft tissue bursas, with subsequent vascular occlusion and necrosis of the muscle and bone. Because the enlarged bursae radiologically and clinically resemble tumors, the term "pseudotumor" is now appearing in the Orthopaedic literature as a new complication to metal-on-metal total hip replacement.



1a. Low power light micrograph of capsule tissue from patient who had a metal-on-metal hip revised for suspected metal sensitivity. The tissues contain unusually high numbers of lymphocytes. 40X Hematoxylin & eosin

1b. Higher magnification (400X) shows that the dense lymphocyte infiltrate also contains plasma cells which is additional evidence for an immune response.

References

1. **Urban RM, Jacobs JJ, Gilbert JL, Galante JO.** Migration of corrosion products from modular hip prostheses. Particle microanalysis and histopathological findings. *J Bone and Joint Surg* 1994; 76A:1345-59.
2. **Case CP, Langkamer VG, James C, et al.** Widespread dissemination of metal debris from implants. *J Bone and Joint Surg* 1994; 76B:701-12.
3. **Ladon D, Doherty A, Newson R, et al.** Changes in metal levels and chromosome aberrations in the peripheral blood of patients after metal-on-metal hip arthroplasty. *J Arthroplasty* 2004; 19:78-83.
4. **Tharani R, Dorey FJ, Schmalzried TP.** The risk of cancer following total hip or knee arthroplasty. *J Bone and Joint Surg* 2001; 83A:774-80.
5. **Willert H-G, Buchhorn GH, Dippel-Ing, et al.** Metal-on-metal bearings and hypersensitivity in patients with artificial hip joints. A clinical and histomorphological study. *J Bone and Joint Surg* 2005; 87A:28-36.
6. **Campbell P, Shimmin A, Walter L, Solomon M.** Metal Sensitivity as a Cause of Groin Pain in Metal-on-Metal Hip Resurfacing. *J Arthroplasty* 2008; in press:

* David Geffen School of Medicine, UCLA, Dept. Orthopaedic Surgery. J. Vernon Luck Sr M.D. Orthopaedic Research Center, Orthopaedic Hospital of Los Angeles

This month's biomaterial was provided by the Implant Pathology SIG.