

Cobalt Chromium Debris Release in Contemporary Total Knee Replacement May Be an Under-Recognized Clinical Issue

David Langton, Rohan Mangesh Bhalekar, Stephen Robert Wells, Matthew Nargol, Sonali Natu¹, Moreica Pabbruwe², Antoni Nargol¹

¹University Hospital of North Tees, ²Royal Perth Hospital

INTRODUCTION: Several studies have reported significant cobalt (Co) and chromium (Cr) elevations in the blood of patients with total knee replacements (TKRs), and histological signs of metal sensitivity have been reported in up to 44% of patients undergoing revision of their TKRs. We carried out this investigation to determine the source and quantity of metal release in TKRs.

METHODS:

We identified all TKRs with polished CoCr trays (N=90) [Design A=29, Design B =35, and Design C=26]. These were analyzed using peer-reviewed [coordinate-measuring-machine (CMM)] methodology to measure the volumetric wear of the polyethylene (PE) bearing surfaces and trays. The trays were analyzed using 2D-profilometry (surface roughness-Ra: average surface roughness) and 4D-microscopy. Scanning electron microscopy energy-dispersive X-ray spectroscopy (SEM EDX) was performed. Histological and blood metal ion concentration analyses were performed.

RESULTS:

The median (IQR) PE wear rate was 10 (6to20) mm³/year. Microscopic analysis identified pitting on the superior surface of 51(57%) trays (Figure 1). Ra [median (IQR)] of the superior surface of pitted trays [0.076 (0.060-0.084) μ m] showed a statistically significant increase ($p < 0.001$) compared with unpitted trays [0.057(0.049-0.066) μ m]. There was polishing of the inferior surface of the tibial trays consistent with abrasive wear (Figure 2). Embedded debris was identified on the PE backside surface of Design A and SEM EDX analysis confirmed the presence of Co and Cr (Figure 3).

4D-microscopy and CMM analysis estimated wear volumes of up to 2mm³ secondary to pitting. The median (range) Co and Cr concentrations were 2.5 μ g/l (0.2–69.4) and 1.7 μ g/l (0.5-12.5) respectively in 40 patients. Of the tissue samples examined in 30 patients, 6 had at-least “mild”-ALVAL infiltrate. All corresponding “ALVAL” (Aseptic lymphocyte-dominant vasculitis-associated lesion) explants were found to be pitted and/or show evidence of loosening of the tray.

DISCUSSION AND CONCLUSION: This study provides further evidence that CoCr release in TKR appears to be an under-recognized cause of adverse clinical outcomes. Gross metal ion elevations occurred in association with micromotion/loosening

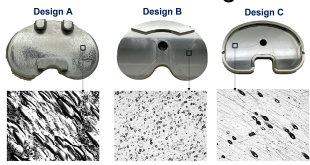


Figure 1. Light microscopy showed pitting on the superior surface of explanted CoCr tibial trays.

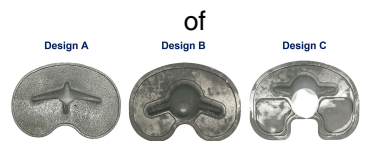


Figure 2. Visual inspection of CoCr trays showed polishing of the inferior surface, indicating micromotion at the cement-implant interface.

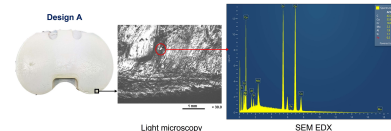


Figure 3. Light microscopic inspection of Design A PE insert backside surface showed the presence of embedded debris, indicating 3rd body wear. SEM coupled with EDX analysis on the embedded debris identified the presence of Co, Cr, and Mo elements i.e., the alloying elements of CoCr alloy tray.