

Is Corrosion at the Modular Junction of Revision Total Knee Arthroplasty Clinically Significant?

E Bailey Terhune, John Wong, Deborah J Hall, Jennifer L Wright, Julia P Hochstatter¹, Amy Miller, Brett Russell Levine, Robin Pourzal

¹Department of Orthopedics

INTRODUCTION:

Fretting corrosion at modular junctions in revision total knee arthroplasty (TKA) is recognized but poorly understood in relation to implant failure. These processes produce metal debris, potentially causing osteolysis or adverse local tissue reactions (ALTR). Most designs couple CoCrMo femoral condyle with a Ti6Al4V stem, and a less concerning Ti6Al4V/Ti6Al4V couple at the tibia. The purpose of this study was to evaluate the junctions of modular revision TKA components for corrosion and assess the correlation with clinical failure.

METHODS:

We assessed 82 revision TKA femoral condyle/stem couples from 12 manufacturers: tapered (n=57) and threaded (n=25). Median time in situ was 24.7 months (range 2-184.1) for tapered and 14.8 months (range 1.9-158.3) for threaded junctions (p=0.21). Mean age at explant was comparable between groups (67.7±10.6 vs. 67.8±12.0 years). The cohort included 43 males and 39 females. Periprosthetic infection was the leading revision indication (n=41), followed by aseptic loosening (n=28). Corrosion was scored on femoral and tibial junctions using a modified Goldberg scale (1–4). Scanning electron microscopy (SEM) with energy-dispersive spectroscopy (EDS) was used to characterize corrosion products. For femoral components with an mGS of 4, wear was quantified with an optical coordinate measuring machine (RedLux). For bore tapers, high-precision molds (Microset) were made for wear measurements. Radiographs were evaluated for changes around the modular junction indicated osteolysis. Statistical analyses included Mann-Whitney U and Spearman's correlation tests.

RESULTS: Tapered modular junctions demonstrated significantly more fretting corrosion than threaded junctions (p<0.0001). Threaded junctions showed minimal damage across all interfaces (median score=1). In contrast, median scores for tapered junctions were 4 (femoral condyle), 3 (femoral extension), and 2 (tibial tray and extension). The damage score distribution on the CoCrMo bore taper and the Ti-alloy taper was None: 9% and 9%, Mild: 16% and 22%, Moderate: 9% and 22%, and Severe: 66% and 47%, respectively. Taper damage showed typical fretting and corrosion features with dark deposits (Figure 1). SEM/EDS revealed corrosion products typical of fretting corrosion. For the majority of severely corroded CoCrMo tapers, no quantitative assessment could be made because molding was not possible, either due to design features (holes at the side of the bore) or due to severe removal damage at the taper opening. The median (min., max) material loss for the remaining eight bores was 0.54 (0.0, 27.7) mm³ (Fig. 3). The corresponding material loss from the Ti-alloy extension taper was 0.14 (0, 1.2) mm³. Corrosion severity did not correlate with reason for revision. Radiographic analysis did not yield any association between taper corrosion and localized radiolucency.

DISCUSSION AND CONCLUSION:

In modular revision TKA components, tapered junctions exhibited significantly more corrosion than threaded junctions. However, no direct association was observed between corrosion severity and radiographic findings. Corrosion products different from those typically observed in THA, indicating potentially different corrosion mechanisms. Further research is required to determine the clinical consequences of corrosion at this junction.

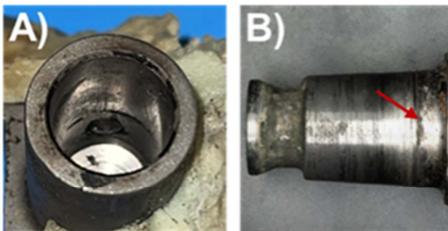


Figure 1 Example of severe taper corrosion at the A) CoCrMo bore taper, and B) the Ti-alloy stem taper. The red arrows points to CrPO₄ deposits.

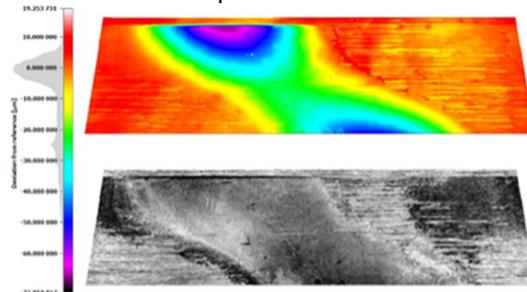


Figure 2 Example of a heat map (top) and light intensity map (bottom) of a successfully fitted bore taper with severe corrosion.