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Premature fracture of a modular femoral neck after total hip arthroplasty: Comparison of two different stem-neck alloys

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Statement of the Problem: An alarmingly large number of femoral modular stems of titanium alloy neck suffer from premature fractures. The cobalt-chromium neck was introduced for its better wear and mechanical properties, although it fails even earlier. Until now there were no direct comparisons between two different femoral modular necks for the same type of stem implant. Experts from orthopaedic surgery and metallurgy have combined their research efforts to compare the femoral modular stem-necks of similar titanium and dissimilar titanium/cobalt-chromium alloy systems from the clinical and metallurgical points of view.

Orientation: Two premature fractured modular neck Hip endoprostheses of similar and dissimilar metals systems were investigated. Multivariate analyses were performed to assess the differences in the fretting, corrosion and fatigue of similar alloys and dissimilar alloys modular joints. Patient's demographic information was collected from medical records.

Findings: Similar stem-neck metals of hip endoprostheses failed due to continuous dynamic micro-motions, crevice corrosion, fretting and fatigue, as well as improper neck dimensions. The mechanism of titanium alloy modular neck fracture is shown in Figure 1. The dissimilar metals stem-neck fractured due to continuous dynamic micro-motions, selective leaching of cobalt ions from the cobalt-chromium-molybdenum alloy and formation of titan-chromium-molybdenum interfacial phase and severe crevice corrosion. The mechanism of cobalt-chromium-molybdenum alloy modular neck fracture is shown in Figure 2 The dissimilar joints suffered more corrosion than the similar joints due to additional galvanic corrosion.

Conclusions: Fretting, corrosion and fatigue occurred on both neck-stem retrievals of the similar and dissimilar metals. Both metal-alloy systems used in this application are known to be highly corrosion resistant and giving rise to the bio-tribo-corrosion processes needs to be understood and characterized so that appropriate changes in design and materials can be upgrade.