Corrosion of the Modular Junctions of Rejuvenate Stems

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Introduction: When fitting a patient with a THA, surgeons sometimes turn to femoral stems with modular necks in order to achieve optimal biomechanics. In June 2012, the Rejuvenate modular stem (Stryker, Mahwah NJ) was voluntarily recalled by its manufacturer over concerns that fretting and corrosion occurring at the junction of the stem and modular neck could lead to adverse local tissue reactions (ALTRs) and other symptoms. This device design is notable because, while other major orthopaedic manufacturers offer femoral stems with modular necks, the Rejuvenate has a mixed metal junction at the junction of stem (titanium) and modular neck (cobalt-chrome). This study aims to examine the corrosion found on retrieved Rejuvenate stems at both the junction of the head and modular neck, and the junction of the modular neck and stem.

Methods: 21 Rejuvenate stems from an IRB-approved retrieval center were examined for corrosion at the bore of the femoral stem, the stem taper of the modular neck, and the head taper of the modular neck. Stems were categorized as to whether they were paired with a cobalt-chrome head (10 devices), a titanium-sleeved ceramic femoral head (4 devices), or an unsleeved ceramic head (4 devices). Head type was unknown for three devices, and head taper scores for these devices were excluded from further analysis. If available, the bore of the femoral head was also examined for corrosion. All corrosion was graded on a visual scale of 0 - 3 using a modified Hood system.[1] Mean corrosion ratings were then compared using independent-samples t-tests, and were correlated with duration using linear regressions.

Results: Figure 1 shows the corrosion ratings by location. 79% of femoral head bores show corrosion (range 0 - 3, mean 1.4); 65% of head tapers of modular necks (range 0 - 3, mean 1.1); 100% of stem tapers of modular necks (range 2 - 3, mean 2.55); and 100% of femoral stem bores (range 2 - 3, mean 2.8). Corrosion was not significantly different between the two sides of the junction between femoral head and modular neck (p = 0.549, F = 0.003). Corrosion was not significantly different between the two sides of the junction between the modular neck and femoral stem (p = 0.080, F = 12.390), although this suggests a trend of higher corrosion on the bore of the femoral stem than on the taper of the modular neck. As shown by Figure 2, corrosion was significantly lower at the junction of the femoral head and modular neck than at the junction of modular neck and femoral stem (head taper of modular neck vs. stem taper of modular neck: p < 0.001, F = 6.780; bore of femoral head vs. bore of modular stem: p < 0.001, F = 15.113). There was no significant correlation of duration to corrosion for any of the four locations (bore of femoral head: p = 0.237, R² = 0.057 ; head taper of modular neck: p = 0.182, R² = 0.098; stem taper of modular neck: p = 0.301, R² = 0.011 ; bore of femoral stem: p = 0.458, R² = -0.035). There was also no significant difference in corrosion between modular stems and necks mated with cobalt-chrome heads and those mated with titanium-sleeved ceramic heads (bore of the femoral head: p = 0.384, F = 1.929; head taper of the modular neck: p = 0.670, F = 10.347; stem taper of the modular neck: p = 0.417, F = 1.354; bore of the femoral stem: p = 0.474, F = 2.308).

Discussion: The junction between the modular neck and femoral stem demonstrated significantly more corrosion than the junction between the femoral head and the modular neck, independent of head material. The bending loads at the junction between the modular neck and femoral stem are greater than those at the junction between the femoral head and modular neck, which could lead to micro-motion and fretting, which may accelerate corrosion. Differences in neck stiffness, taper geometry, femoral head size, intraoperative assembly techniques, etc. may also contribute to differences in corrosion between the two Rejuvenate junctions. The bores of the femoral head and femoral stem showed higher mean corrosion ratings than did the tapers of the modular neck, although this was not statistically significant in either case. The frequency of corrosion at the mixed-metal junction between the modular neck and femoral stem was much higher than the historical frequency of corrosion at mixed-metal junctions between femoral heads and monoblock femoral stems (56%).[2] The frequency of corrosion at the non-mixed-metal junction between the femoral head and modular neck was also much higher however, suggesting that although the mixed-metal nature of the junction between the modular neck and femoral stem certainly does not minimize corrosion, it also may not be the entire explanation for the high corrosion frequency and rating values at this junction. As more Rejuvenate stems are retrieved, this can be examined further.

Significance: Although femoral stems with modular necks can give surgeons better ability to achieve correct biomechanics for the patient, the additional junction is an additional site for possible corrosion, which may lead to negative outcomes for the patient. Mixed-metal junctions have higher corrosion ratings, and therefore have disadvantages in this application.

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References:
Figure 1. Corrosion ratings at the bore of the femoral head (1), head taper of the modular neck (2), stem taper of the modular neck (3), and bore of the femoral stem (4).
Figure 2. Corrosion scores (pooled) from the bore of the femoral head and head taper of the modular neck (1), and from the stem taper of the modular