Quantifying Femoral Head Taper Damage in a 15 Year Retrieval Database

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Introduction: The use of tapered junctions in primary hip arthroplasty has excellent long term results. Large femoral heads are being used to mitigate dislocation and optimize range of motion [1-2]. The prevalence of larger heads, coupled with recent findings regarding corrosion artifacts at tapered surfaces, has spurred growing interest. Visual and quantitative scoring methods have been used to assess the level of fretting and corrosion of tapered junctions [3-5]. The purpose of this study was to determine if correlations exist between severity of corrosion artifacts and head size, head offset, time in vivo, or head material in a 15 year retrieval database. Secondarily, the agreement of visual and quantitative scoring methods was assessed using the database.

Methods: Retrieved hip arthroplasty devices with Cobalt-Chromium-Molybdenum (CoCrMo) or Oxidized Zirconium (OxZr) femoral heads revised from 1997 to 2012 were investigated for corrosion artifacts in this study. Male and female tapered surfaces were scored independently by a panel according to the Goldberg system [3] for assessment of corrosion. A score of 1 (none), 2 (mild), 3 (moderate) and 4 (severe) was given to a taper surface depending on the level of fretting and corrosion. Exclusion criteria included less than 1 week in vivo, ceramic taper, and modular proximal stem sleeves. Evaluation was performed on only stem/head taper junctions.

Vertical straightness profile (VSP) measurements were taken on a subset of devices as an additional measure to quantify corrosion within the taper contact region by measuring depth of material loss. VSP analyses were performed using a Taylor Hobson TR290 roundness machine with a 1 mm diameter ruby tipped probe. For each measured taper, eight vertical straightness profiles were taken at 45 degree intervals around the circumference. Profile mapping at these locations was acquired. The deviation was used to represent the depth of material loss (Figure 1a).

Results: A total of 227 retrievals containing taper surfaces from 1997 until 2012 were evaluated. Of these, 200 met the inclusion criteria (CoCrMo, n = 166; OxZr, n = 24). Time in vivo ranged from 1 week to 10 years. The majority of the head tapered surfaces were 12/14 in size. There were n = 95 heads 36 mm or greater. Head size did not correlate to higher Goldberg scores (n = 183, R² = 0.23). There was a parabolic correlation between head offset (9 offset sizes evaluated) and average Goldberg score (n = 156, R² = 0.89), with the more negative offsets and the more positive offsets exhibiting higher scores. There was no correlation between time in vivo and Goldberg score (n = 104, R² = 0.11). There was a correlation between head material and Goldberg score, with OxZr having a lower score as compared to CoCrMo heads (1.9 ± 0.6 vs. 2.5 ± 0.9, p = 0.002) (Figure 1b and 1c). VSP measurements were taken on heads with a Goldberg score of 3 (CoCrMo, n = 20; OxZr, n = 3) and 4 (CoCrMo, n = 5; OxZr, n = 0). Measureable maximum material loss was found on 13 heads (CoCrMo, n = 13; OxZr, n = 0). Maximum material loss for CoCrMo heads ranged from 1.4 to 102.6 µm (Figure 1d). There was a general trend that tapers with a higher Goldberg score (GS) had a higher maximum depth of material loss on average (GS:3 = 2.2 µm, GS:4 = 29.4 µm).

Discussion: CoCrMo heads have 20+ years of clinical success, but as shown in this study are still associated with a quantifiable amount of taper corrosion. Though impaction force, taper cleanliness, patient factors and other myriad multi-factorial issues may contribute to taper corrosion, in this study no correlation was observed for head size or time in vivo and amount of corrosion. An OxZr head material exhibited decreased fretting corrosion as compared to the traditional CoCrMo head used in hip arthroplasty.

Significance: Taper corrosion in hip arthroplasty is dependent upon the femoral head material. Oxidized Zirconium femoral heads are associated with decreased corrosion susceptibility based on a 15 year retrieval database.

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associated with the contact area and surface topography. *J Orthop Res* 2013:1-

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