Introduction: There is considerable interest within the orthopedic community in understanding the multifactorial process of fretting corrosion in modular components in total hip arthroplasty. The size of the tapered interlock has been identified as a possible contributor to this phenomenon [1], however, variations in the as-manufactured taper surfaces among manufacturers and device designs, may confound this analysis [2]. The purpose of this study was to identify the effect that taper type has on taper damage by analyzing retrievals of two different taper sizes, known as the C-Taper or the V-40, produced by the same manufacturer (Stryker Orthopaedics, Mahwah, NJ) with comparable taper surface finishes. The C-Taper is based on the 12/14 Eurotaper design, whereas the V40 was designed with 8% less taper length and approximately 20% lower surface area (Figure 1) but with a similar taper angle of
5° 40’. We tested the null hypothesis, that there was no difference in taper fretting and corrosion damage between the two taper designs. A secondary goal of this study was to identify which factors are associated with taper damage in these devices.

**Methods:** Two hundred fifty-two (252) cobalt chromium (CoCr) femoral heads, manufactured by Stryker Orthopaedics with either a C-Taper or a V40 taper, were identified in a collection of devices obtained in a multi-institutional retrieval program. These components comprised seventy-seven (77) C-Tapers and one hundred seventy-five (175) V40 tapers. Information on the stem material was available for 45 devices in the C-Taper cohort (CoCr n=18; Ti6Al4V n=27) and 104 devices in the V40 cohort (CoCr, n=32; Ti6Al4V n=19; TMZF, n=53). Mean patient age at implantation for these devices was 60 years (range, 13 - 80 years) and implantation time averaged 5.4 ± 6.0 years (range, 0 - 26 years). The components were revised predominantly for loosening (n=93), infection (n=47), and instability (n=29). Before analysis, these components were cleaned by two 20-minute soaks in a 1:10 disinfecting solution (DisCide®, Palmero Health Care, Stratford, CT) followed by two 30-minute sonication periods in water. The flexural rigidity for the devices was also calculated after measuring the taper diameters where the stem exits the femoral head for the available stems. The taper interfaces were then semi-quantitatively analyzed for fretting and corrosion damage using a previously described 4-point scoring method [3]. Step-forward multivariate linear modeling was used to identify the effect of taper design (i.e. C-Taper vs. V40). The variables that were included in this analysis that may influence corrosion damage were: implantation time, stem material, weight, head offset, flexural rigidity, head size, UCLA score, age, height, BMI and gender. Components were then selected to create two balanced cohorts, matched on the significant variables from the multivariate analysis. Statistical analyses were performed using commercial statistical software (JMP 11.0; Cary, NC) with α=0.05.

**Results:** From the multivariate analysis of covariance, implantation time (p<0.001), stem material (p<0.001), weight (p<0.001) and head offset (p=0.001) were significant predictors of taper fretting and corrosion damage. The ANOVA model incorporating these variables was able to explain 48% of the variation in fretting corrosion damage scores. In the multivariate model, taper design was not found to be a significant predictor of fretting and corrosion damage (p=0.91). Using the significant factors from the ANOVA model, twenty-three (23) V40 components were matched to the same number of C-Taper components to balance covariates between the two taper cohorts (n=46 total). No difference was found in the damage scores (Median Score = 2 for both cohorts; p=0.34; Figure 2) between the matched cohorts with the numbers available.

**Discussion:** These results support the hypothesis that fretting and corrosion damage is insensitive to differences between the C-Taper and V40 taper, when controlling for variables such as implantation time, taper alloy (related to stem flexural rigidity) and head offset. The multivariate model derived in this analysis explains almost half of the fretting corrosion damage we observed and is consistent with other studies identifying implantation time, material combination and head offset as contributing factors [3]. In addition to implant factors, we found patient weight to be a predictor of fretting corrosion in the retrieval series. This study is limited primarily by the semi-quantitative nature of the damage scoring technique, the relatively limited matched cohort size, and the inclusion of only 2 taper designs. Additional investigations with additional designs and retrievals may be useful to better understand the effect of taper design on fretting corrosion in total hip arthroplasty.
**Significance:** Fretting corrosion damage at tapered connections in total hip arthroplasty is a multifactorial process that needs to be understood in order to develop improved countermeasures. This study explores whether taper design may be related to fretting and corrosion damage, when considered in the context of a multivariate analysis.

Figure 1: Comparison of the C-Taper (left) and V40 (right) designs at the same magnification
Figure 2: Box plot showing the variation in femoral head damage score between the two matched cohorts (n=23 for each cohort)

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