EVALUATION METHOD FOR HIGH FLEX LOOSENING OF POSTERIOR STABILIZED FEMORAL KNEE IMPLANTS UNDER DYNAMIC LOADING

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Introduction

Femoral loosening under high flexion is not covered by common biomechanical testing methods [1, 2]. Nevertheless, failures are reported and weight bearing in maximum flexion was associated with early loosening of the femoral component [3]. These failures can occur at two interfaces, bone-cement / implant or bone-cement / bone or as a mixture of these. This study focuses on the bone cement / implant interface.

Method

3 different posterior stabilized knee designs (prototypes and clinically established) were tested in a high flexion fatigue set-up with a minimum of n=3 specimens per test group. All specimens were cemented covering the anterior and distal surface using BonOs® R Genta (Osartis, Germany) on specially prepared aluminum blocks that simulated the prepared distal femur. The bone cement was prepared by vacuum mixing and used in a late stage of the application phase. The dorsal areas of the condyles were not covered to simulate osteolysis and / or insufficient cement application. Tests were conducted in 37 °C heated deionized water to respect the influence of environmental conditions regarding hydrolysis of the interface and mechanical properties of the bone-cement. A flexion angle of 160° was simulated during the test for all specimens. The load was applied with 5 Hz starting at a load level of 500 N, followed by incremental raising the load with steps of 250 N for 200 000 load cycles each until failure. Tests were evaluated regarding number of cycles, load level until failure and failure mode of the interface.

Results

Figure 1 shows the average numbers of cycles and the corresponding load level until failure for each design. Failure with remaining bone cement on both surfaces (implant and set-up) and failure without remaining bone cement on the implant were observed.

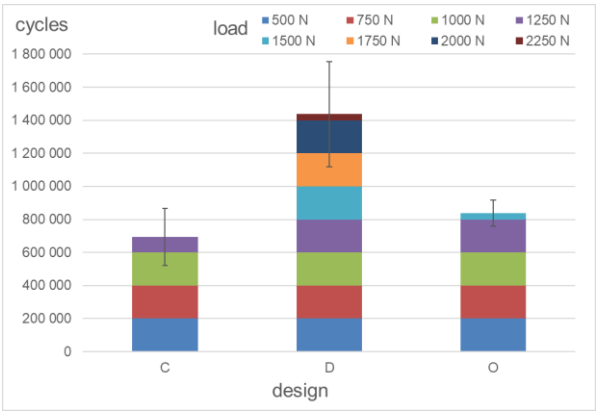

Figure 1: Number of cycles until failure (mean +/- standard deviation) and corresponding load level for each design

Discussion

This test method is appropriate to differentiate between designs of posterior stabilized femoral knee implants regarding the loosening under dynamic loading in high flexion. The number of cycles and load level at failure correspond to the failure mode respectively amount of remaining bone-cement on the implant.

References

1. C.-K. Cheng et al. / Medical Engineering and Physics 72 (2019) 49–54
2. ISO 21536
3. H. S. Han, et al. / J Bone Joint Surg [Br] 2007;89-B:1457-61.