Investigating the Effect of Stiffness in Hemiarthroplasty Implants

Background: Hemiarthroplasty is an attractive alternative to total arthroplasty because it conserves tissue, allows for quicker recovery, and has a lower cost. However, likely due to the high stiffness of the implant, hemiarthroplasties often lead to accelerated wear of the opposing native cartilage.

Hypothesis and Methods: The purpose of this study was to investigate the maximum contact stress on the capitellum for different currently available biomaterials in radial head hemiarthroplasty and compare them to the native radial head. A finite element model was developed in ABAQUS (Dassault Systèmes Simulia Corp., RI, USA). An axial load of 100N was applied to the implant through the center of rotation. The implant materials investigated were CoCr, PEEK, HDPE, UHMWPE, Bionate 75D, Bionate 55D, and Bionate 80A.

Results: The CoCr implant had a maximum contact stress over 114% higher than the native radial head. By changing the material to lower the stiffness of the implant, the maximum contact stress was 24%, 70%, 105%, 111%, 113%, and 113% higher than the native radial head for Bionate 80A, Bionate 55D, Bionate 75D, UHMWPE, HDPE, and PEEK respectively.

Discussion: This work shows that lowering implant stiffness can reduce the contact stress on cartilage in hemiarthroplasty implants. By changing the material below a Young's modulus of ~100MPa elevated stresses on the capitellum can be markedly reduced and hence potentially reduce or prevent degenerative changes of the native cartilage. Further work is required to assess the efficacy of these materials for articular bearing applications.