A BIOMECHANICAL ANALYSIS OF THE RADIOCARPAL ARTHROPLASTY UNDER A PHYSIOLOGICAL LOAD CONDICTION

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Introduction

Diseased wrist joints, in such cases as rheumatoid arthritis, are often required to be replaced by prosthesis to relieve pain and to recover the wrist's function. Nowadays, total wrist arthroplasty still fails due to serious problems that occur, like imbalance, loosening, instability or infection [Adams, 2004]. However, the major reason why artificial joints eventually fail can be associated with the risk of aseptic loosening, according to reports published [Krukhaug, 2011]. Loosening can be associated with the presence of abnormally high levels of tension in the bone around the prosthesis.

The main goal of this work was to study and compare the biomechanical behavior of the radius in its native and arthroplastic state, with the Maestro prosthesis, in a physiological loading condition. Thus, numerical models were developed and used to determine the biomechanical behavior of the cancellous bone attached to the component.

Methods

For this study a native and arthroplastic finite element (FE) models of the radius were considered. According to this, the radius structure were modelled, as well as the radius component of the Maestro prosthesis. The models considered were constrained on the diaphysis of the radius and all the interfaces between the components were fastened. The physiological loading condition used was representative of a grasp function generating 10N [Schuind, 1995]. The load-case applied was used to access the principal strains at the cancellous bone of the radius, before and after arthroplasty, in the frontal aspect.

Results

The patterns of the maximal principal strains at the cancellous bone of radius can be seen in Figure 1.

Comparing the principal strains of the arthroplastic model, near the radius component, with the native model, it can be observed that the introduction of the Maestro prosthesis leads to an increase of the bone strains along the implant length, in the metaphyseal region, with peak strains observed at the implant tip. In fact, the increase of maximal principal strains, for the arthroplastic case, was 8times higher (49 to 440 μstrain) than for the native case. For the minimal principal strains the arthroplastic case presented an increase of 2,5times (-270 to -940 μstrain) when compared with the native case.

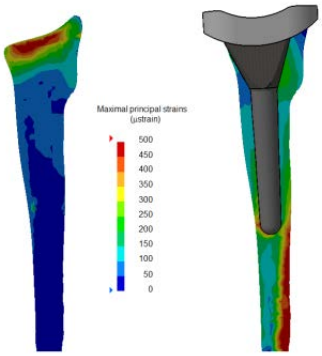

Figure 1: Maximal principal strains in cancelous bone of native (left) and arthroplastic (right) cases.

Discussion

The numerical results showed that the introduction of the component in the radius caused an increase in mechanical stress, thus enhancing its fatigue failure.

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References

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