Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

Dynamic Finite Element Modelling of Bone Anchored Hearing Aids

Mostafa Mohamed, Lindsey Westover
Department of Mechanical Engineering, University of Alberta, Edmonton, Canada
*mostafa5@ualberta.ca

ABSTRACT

The Advanced System for Implant Stability assessment (ASIST) is a vibration-based system that measures the stability of bone anchored (osseointegrated) implants. It estimates the stiffness of the bone implant interface (k) through matching the dynamic response of an analytical model with clinical measurements. A previous finite element (FE) model of bone anchored hearing aids simplified the implant, abutment and locking screw as one merged part that is directly attached to the bone. The model indicated that the ASIST determines the interface condition with minimal influences from the system's geometry compared to solely relying on the natural frequencies. In this work, a more realistic FE model was developed where the three components (implant, abutment, and screw) were treated as separate parts. The objectives of this study involve: (1) comparing the response of the FE model to the in-vitro experimental results and (2) understanding the effect of the system's parameters, namely the impact stiffness (K_I) and the torsional stiffness (K_T), on the dynamic response. The Oticon Ponto implant-abutment system geometry was used. To improve the simulation time, some features (like the threads) were simplified and removed on Geomagic Design X. A dynamic explicit model of the system was created on ABAQUS and frictional contact was used to simulate the interaction between the different components. H-refinement using linear tetrahedral elements was used to check for the model's convergence. Correlations between the analytical and the FE model parameters were determined and were used to match between the experimental results and the FE simulations. Results indicate similarity between the response obtained from the FE model and the in-vitro experimental results. Moreover, the effect of changing the system's parameters in the FE model was similar to the behavior predicted by the discretized analytical model. This indicates that the developed FE model is capable of representing the physical system and that it can be used to provide insight on the effect of system's parameter's (K_I & K_T) on the dynamic response. A better understanding of those parameters can potentially be used to improve the performance of the current ASIST approach for monitoring osseointegrated implants stability. It can also extend the system's ability to measuring the screw tightness level along with the bone-implant interface condition simultaneously.

Word count: 368