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Optimizing Mechanical Behavior of Middle Ear Prosthesis Using Finite Element Method with Material Degradation Functionally Graded Materials in Three Functions

Authors : Khatir Omar, Fekih Sidi Mohamed, Sahli Abderahmene, Benkhettou Abdelkader, Boudjemaa Ismail

Abstract : Advancements in technology have revolutionized healthcare, with notable impacts on auditory health. This study introduces an approach aimed at optimizing materials for middle ear prostheses to enhance auditory performance. We have developed a finite element (FE) model of the ear incorporating a pure titanium TORP prosthesis, validated against experimental data. Subsequently, we applied the Functionally Graded Materials (FGM) methodology, utilizing linear, exponential, and logarithmic degradation functions to modify prosthesis materials. Biocompatible materials suitable for auditory prostheses, including Stainless Steel, titanium, and Hydroxyapatite, were investigated. The findings indicate that combinations such as Stainless Steel with titanium and Hydroxyapatite offer improved outcomes compared to pure titanium and Hydroxyapatite ceramic in terms of both displacement and stress. Additionally, personalized prostheses tailored to individual patient needs are feasible, underscoring the potential for further advancements in auditory healthcare.

Keywords : middle ear, prosthesis, ossicles, FGM, vibration analysis, finite-element method
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