Finite Element Analysis Of Porous Medical Grade Cobalt Chromium Alloy Structures Produced By Selective Laser Melting

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ABSTRACT

The recent introduction of selective laser melting (SLM) for the processing of medical grade cobalt chromium (CoCr) alloy has led to a complex shape fabrication of porous custom CoCr alloy implants with controlled porosity to meet the requirements of the anatomy and functions at the region of implantation. This paper discusses finite element (FE) analysis and mechanical characterization of porous medical grade CoCr alloy in cubical structures with volume based porosity ranging between 60% and 80% produced using SLM rapid manufacturing process. Analysis by FE is considered beneficial to predict the effective mechanical properties of the porous structures manufactured by SLM due to minimization of the need for expensive and time consuming physical testing. Cellular structures modelling for fabrication with Direct Metal Laser Sintering machine were designed to vary between 60% and 80% to study the effect of structural variation on mechanical properties of the cellular porous structure. ANSYS 14.0 FE modelling software was used to predict the effective elastic modulus of the samples and comparisons were made with the experimental data. FE results show that with the material properties in the functions of porosities, minimum mesh size of 0.2 mm for triangular shape mesh and boundary as well as load conditions as applied in this study, agreement in equivalent stress, strain and deformation with the experimental results can be achieved to some extent. The technique for FE in this study can be used to investigate stress distribution in three dimensional model of real bone.

KEYWORDS: Cellular structure, FEA, Mechanical characteristics, Elastic modulus, Biomechanics