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Simulated Mechanical Analysis on Hydroxyapatite Coated Porous Polylactic Acid Scaffold for Bone Grafting

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Abstract : Bone loss has risen due to fractures, surgeries, and traumatic injuries. Scientists and engineers have worked over the years to find solutions to heal and accelerate bone regeneration. The bone grafting technique has been utilized, which projects significant improvement in the bone regeneration area. An extensive study is essential on the relation between the mechanical properties of bone scaffolds and the pore size of the scaffolds, as well as the relation between the mechanical properties of bone scaffolds with the development of bioactive coating on the scaffolds. In reducing the cost and time, a mechanical simulation analysis is beneficial to simulate both relations. Therefore, this study highlights the simulated mechanical analyses on three-dimensional (3D) polylactic acid (PLA) scaffolds at two different pore sizes (P: 400 and 600 µm) and two different internals distances of (D: 600 and 900 µm), with and without the presence of hydroxyapatite (HA) coating. The 3D scaffold models were designed using SOLIDWORKS software. The respective material properties were assigned with the fixation of boundary conditions on the meshed 3D models. Two different loads were applied on the PLA scaffolds, including side loads of 200 N and vertical loads of 2 kN. While only vertical loads of 2 kN were applied on the HA coated PLA scaffolds. The PLA scaffold P600D900, which has the largest pore size and maximum internal distance, generated the minimum stress under the applied vertical load. However, that same scaffold became weaker under the applied side load due to the high construction gap between the pores. The development of HA coating on top of the PLA scaffolds induced greater stress generation compared to the non-coated scaffolds which is tailorable for bone implantation. This study concludes that the pore size and the construction of HA coating on bone scaffolds affect the mechanical strength of the bone scaffolds.

Keywords : hydroxyapatite coating, bone scaffold, mechanical simulation, three-dimensional (3D), polylactic acid (PLA).
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