SIMULATION OF 3D TISSUE ENGINEERING SCAFFOLDS UNDER PRIMARY COMPRESSION

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ABSTRACT

Tissue engineering scaffold for bone is emerging as one of the viable substitutes for bone regeneration as it is cost-efficient, time-saving and environmentally friendly to fabricate, not to mention most of the bone scaffolds are made from recycled materials. However, a bone scaffold needs to have excellent porous and mechanical characteristics to be able to promote tissue regeneration and at the same time withstand the compressive stress of the recuperating bone. Therefore, this project focuses on analysing and evaluating the influence the different design parameters has in controlling the porosity and mechanical properties of a bone scaffold. 3 design parameters (filament gap, filament diameter and lay-down angle) are separately manipulated on a number of mono design 3D bone scaffolds to compare and analyse the results. Mathematical modelling is developed to obtain the porosity, while the structural analysis is simulated with an average world body weight of 62kg (608.22N) load to obtain the mechanical properties of the bone scaffold. Based on the findings, the porous and mechanical characteristics of the bone scaffolds are directly affected by the design parameters. The porosity increases with the increase of filament gap and lay-down angle, while it decreases with the increase of filament diameter; whereas the mechanical strength increases with when the filament diameter is increased, and decreases when the filament gap is increased. The mechanical strength is also assumed to increase with the decrease of lay-down angle if the design and contact positioning of filament layers is optimized. It is deduced that scaffolds with higher porosity to improve tissue regeneration and nutrient transportation will have lower mechanical strength.

Keywords: Bone scaffold, mathematical modelling, porous and mechanical characteristics, structural simulation, tissue engineering.