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The Design of Bone Scaffolds for Implantation into Femoral Defects for a Male Adolescent

Tissue engineering is a growing application in the medical field, in which human tissue can be regrown instead of implanted. Bone tissue scaffolds simply are formed by seeding Mesenchymal Stem Cells (MSCs) on a three-dimensional template, and be able to function normally in the implanted body. These features need to be tested in-silico.

The objective of this research was to design a feasible scaffold that could be implanted into human femoral defects through the process of modeling and in silico testing. The scaffold cross-sections were designed using Draftsight, a 2D CAD software and FlexPDE, a finite element analysis system. For each design, a load was set as xstress and placed in the u (vertical) direction. These scaffolds were placed, through software, at the base of the femur. The femoral dimensions and properties tested were those of an adolescent male.

Two designs were made, one similar to that in literature, and another original scaffold, placed on the dorsal end of a full femur bone. Poly L Lactic acid was the material used for the scaffold in testing, and both the Young's Modulus and Poisson's Ratio were found for it. The first design was a rectangular cross-section and proved energy consuming when placed in the FlexPDE. The second cross-section and bone were ultimately drifted slightly, displacing the entire system. The main reasons for such drifting were due to issues with boundary conditions to eliminate drift. The loading that was placed on the edges of the cross-section along with adjustment of some of the boundaries of bone created newer problems.

Through this experiment, the various loads and stresses a human bone can withstand were understood. This information will be helpful in future designs in understanding what locations and environments can affect scaffold integrity. Future steps would be to create a consistent scaffold that can be successfully implanted in real human femoral defects.