Fabrication of a Bioprinted Scaffold Cuff: Implications for Tissue Engineering of an Implantable Organ

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Tissue engineering can address significant need through proliferation of stem cells to grow organs sufficient for clinical transplantation. By combining 3D-printing, with growth of layered stem cells, a microenvironment is created allowing cell differentiation into specialized lineages. Traditionally, a scaffold cuff was used for angiogenesis in tissue engineering. The future application of this scaffold would be as a foundation for stem cell maturation, promoting desirable cellular interactions and supplying nutrients for maximal growth. First, an engineering design was constructed meeting the following criteria: a foundation to layer stem cells, maximizes surface area for cell proliferation, biocompatibility, multiple intrusion points, and cuff and temporary support construct within body for biodegradability. Second, the optimal bioink(s) were analyzed according to capabilities of long-term storage while maximizing stem cell growth. Bioinks analyzed were Silicone Rubber, Cellink-A, Laminink+, Pluronic F-127, Cellink Start, GelXA, and Cellink A-RGD. Ultimate Conclusions include successful scaffold cuff design of 7-layer, hexagonal outline, hollow core, diagonal channel, and horizontal extrusion path. Second, optimal scaffold bioink composition was Cellink A-RGD-Pluronic F-127 blend, cross-linked with CaCl2 solution, stored in PBS, based on its consistent extrusion range (5-15 kPa), maintenance of structural integrity for longest time, leading storage capacity (retained 80% structure for 7+ weeks) and closest Gel Fraction% (20%) to water composition in muscles and kidneys as an indicator of microenvironment similarity. 58 prints initially conducted with 100+ documented prints total. Done in coordination with the Wertheim laboratory at the University of Arizona.

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