3D Bioprinting Of Complex Blood Vessel Structures

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Abstract

In recent years, bio-inks mostly consist of natural polymers due to their advantages like being similar to human ECM [1]. Bio-inks need to support the cell binding, proliferation and function. Hydrogel based bio-inks that provide the required oxygen and nutrition transportation in a 3D biomimetic micro-environment are more suitable for recapitulation of in vivo cellular activities [2]. However, preservation of the target geometry in a cell-laden hydrogel is difficult to achieve. Quite a lot hydrogel optimization is required to obtain the ideal concentration that allows high cell viability in the desired shape. Therefore, some applications like targeted UV curing, chemical crosslinking, direct bioprinting in another supportive biodegradable hydrogel, bioprinting using cell-laden hydrogel with another more viscous sacrificial hydrogel or hybrid bioprinting of biodegradable synthetic polymer shell with cell-laden hydrogel bio-inks are used to preserve the desired geometry [3]. Sacrificial bio-inks are widely used to preserve the target geometry and provide integrity to the bioprinted tissue by means of supporting cell-laden hydrogel during and after the bioprinting process [4]. The aim of this study is to develop tubular and complex blood vessel structures (Y-Shaped 3D in-vitro vessel model) with GelMA and polysaccharide-based components by means of a universal sacrificial bio-ink that helps to preserve the ideal shape. Path planning is generated according to the system used (a custom built bioprinter: BioLogic). As a consequence of our approach, high cell viability (more than 95%) and proliferation in the desired geometry are obtained.

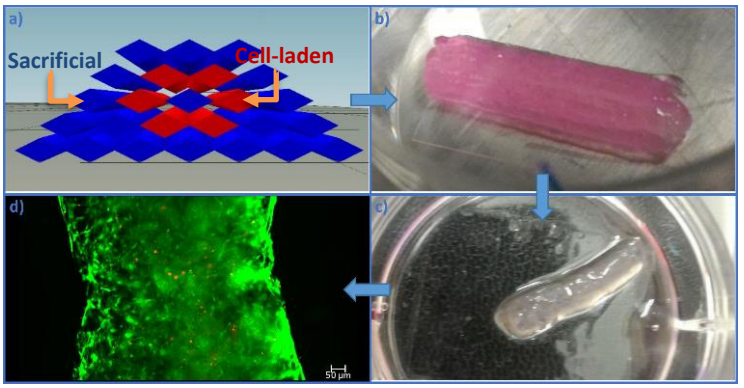


Figure 1. Sequential steps followed in the bioprinting of cell-laden hydrogel to obtain a vessel model. a) Path planning of the blood vessel model, b) 3D bioprinting of SMC-laden main hydrogel surrounded by the universal sacrificial bio-ink, c) The 3D bioprinted vessel (after 48h culture) and d) Live/Dead Assay of bioprinted vessel (green: alive, red: dead cells)

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Recent publications

1. Aydin, L. & Kucuk, S. (2018). A method for more accurate FEA results on a medical device developed by 3D technologies. Polymers for Advanced Technologies.
2. Aydin, L., Kucuk, S., Kenar, H. (2016). Design and Construction of a Novel Micro-Extrusion System for Bio-printing Applications. International Journal of Applied Mathematics, Electronics and Computers, 4 (Special Issue-1), 52-56. DOI: 10.18100/ijamec.264681.

Biography



Levent Aydin is an inventor who has an exceptional vision based on his multidisciplinary background including medical prototype design and construction, biomaterial research, medical device validation, CAE, biomedical engineering and tissue engineering. His creative nature has no limits and makes almost everything possible without getting tired. He expertise in the fields of robotics, medical 3d printer design/construction, biomedical device manufacturing, thermoplastic polymers, and CAV during his master. He starts to study bioprinting and biotechnology in his Ph.D. He builds a various type of machines including a bioprinter and develops target specific natural polymer-based bio-inks to print tissue substitutes. He loves high-tech, science-fiction and computers.

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Notes/Comments: