Proceedings International
Platinum Open Access Journal (ISSN 2668-6384)

Proceedings, Abstract
Volume 4, Issue 1, 2022, 62
https://doi.org/10.33263/Proceedings41.062

Bioengineering of Implantable 3D Vascular Bioconstructs Using Rapid Prototyping Techniques †

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† Presented at 1st OncoHub Conference – Connecting Scientists for Next Generation Cancer Management (13-15 October 2021, virtual)

Received: 25.10.2021; Accepted: 5.02.2022; Published: 14.02.2022

Abstract: 3D bioprinting is currently used for developing oncological research models such as organ-on-chip or organoid printing, involving the manufacturing of cellular and extracellular components of a tissue or organ. Ensuring adequate vascular supply for large organoids remains a challenge due to the need for dedicated vascular supply. In this study, vascular bioconstructs of 3-4 mm diameter were fabricated following bioink pre-cellularization and incubation. A 3 mm diameter vessel was modeled via CAD/CAM using data obtained from rat femoral arteries via microCT scans and photoacoustic ultrasound imagining (Vevo-LAZR X, Fujifilm, Visualsonics). Human mesenchymal stem cells(hMSC) were cultured, expanded, and suspended following Good Laboratory Practice standard operating procedures. Gelatin methacrylate-based hydrogel and alginate-hydrated cellulose nanofibrils hydrogel that presents a similar structure as collagen was used to provide a scaffold for the cell suspension. Uniform cell distribution in the printing bioink was assured via the rapid blending of the cell suspension and hydrogels. A BioX 3D bioprinter (BioX, CELLINK, Sweden) was used to print the mixture using 22G needles. Printed constructs were incubated for two weeks, followed by histological analysis via 4,6'-diamidino-2-phenylindole staining. We established and refined a 3D printing protocol that generated 66 vessel constructs, with an inner diameter of 3.12 ± 0.28 mm. After incubation, histological analysis demonstrated both cell viability and deposition of tissue-specific extracellular matrix. Biofabricated small-caliber vessels were successfully 3D-printed and cultured using this refined protocol, allowing further studies regarding the biocompatibility of the printed vessels.

Keywords: bioprinting; 3D bioprinting; vessel printing; nano-cellulose; biofabrication.

Funding

This research received no external funding.

Acknowledgments

This research has no acknowledgment.

Conflicts of Interest

The authors declare no conflict of interest.