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BIOFABRICATION FACILITY, TISSUE PRINTING ON THE INTERNATIONAL SPACE STATION

Abstract

Techshot is excited to present initial findings from the maiden flight of its BioFabrication Facility (BFF) operated aboard the ISS after its launch on the SpaceX CRS-18 mission. Purpose: Techshot believes 3D printing in microgravity provides a unique opportunity to utilize biological materials as the foundation for tissue and organ construction. Techshot began developing novel bioinks based in part on cell selection and in part on the fluid physics learned during the previously mentioned parabolic campaign with the bioprinter to print a neonatal-sized ventricle with human stem cells. The original hypothesis held that structures can be printed with low viscosity inks to allow cell motility within the structures and rapid fusion of layers. Knowing the viscosity range is only the first hurdle as the microenvironment of the cell must be able to maintain its viability until the vasculature develops. This is harder in the diffusion limited environment of microgravity. Nutrients and factors either must be both sequestered and actively transported throughout the construct. Methods: The experimental tissue are printed using the Techshot, purpose-built 3-locker sized bioprinter capable of multicomponent printing using its four-independent head design. The human extracellular matrix derived components are blended with both partially and terminally differentiated cells to form the custom bioinks. These bioinks are printed into a proprietary bioreactor, developed by Techshot that is housed within an Advanced Space Experiment Processor (ADSEP) tissue cassette. The tissue cassette will be placed directly below multiple print heads located on a gantry system with three axes (X, Y, Z) control. Once a print is complete, the tissue will be stimulated inside of the bioreactor. Fluidic controls, mechanical and electrical stimulation, within the ADSEP tissue cassette, are handled in a manner like its many past space bioreactor projects, with a series of logic-controlled valves, micro-pumps, bags and solenoids. Results: Anticipated for this first technology demonstration flight aboard the ISS, the Techshot BFF will print multiple test structures, as well as structural cardiac tissue. Detailed physical and histopathological examinations will compare space printed and ground printed samples. Conclusion: This muscularized tissue could be placed within a patient's damaged cardiac tissue and be inosculated into the coronary blood flow and regain muscular tone. These early demonstrations are the precursor for future microgravity whole organ printing investigations. This 3D bioprinting capability on the ISS will lead to significant commercial advancements in the healthcare industry, while helping mankind explore beyond low Earth orbit.