CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
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Project Number
38476

Project Title
Optimizing Architecture of Bioprinted Cardiac Tissue

Abstract

Objectives/Goals
The goal is to design and construct a geometry of 3D printed constructs that would address the 3D bioprinting issues of contractility, feasibility and functionality of cardiac tissues to, ultimately, serve as an alternative treatment for patients with cardiovascular diseases.

Methods/Materials
In this study, I will optimize the architecture of 3D-printed constructs to ensure that the parameters are sufficient to support 3D bioprinted cardiac tissues; consequently, I want to be able to predict the survivability and function based on the geometry of the 3D-printed construct. I designed each construct with computer-aided design software (OnShape) under 3D printing constraints. I calculated permeability of each construct with different geometries by measuring time with stopwatch and pressure with gauge. I used silicone oil to perfuse through each construct, deriving permeability from viscosity of the fluid, pressure differences, flow velocity, and thickness of the porous medium (construct). Practically, the experiment with silicone oil is a method to try to measure the permeability of the 3D printed construct based on Darcy's Law, an equation that describes flow of a fluid as it passes through a porous object.

Results
The permeability of the 3D constructs with numerous holes was compared after passing through silicone oil versus after passing through a 2D construct with fewer holes. The 2D waffle construct had the lowest permeability average of 0.899 H*m^-1 while 3D cross-section construct had the highest permeability of 2.967 H*m^-1. The permeability of the 3D construct was shown to be the highest, which indicates that the 3D construct is the most effective.

Conclusions/Discussion
The performance of the 3D cross-section construct for exhibiting the highest permeability under 3D printing constraints was higher than that of the 2D construct. This means the 3D cross-section construct can be used as the primary model for a 3D bioprinted cardiac tissue. This reveals that the 3D construct had the allowed for the highest permeability because, according to Darcy's law, mechanical forces are constantly changing through a 3D matrix architecture, which allows for an extended period of flow rate.

Summary Statement
I designed and constructed the most optimal geometry for bioprinting cardiac tissues by experimentally calculating their permeability using the perfusion of silicone oil through 3D-printed plastic construct

Help Received
I designed and performed the experiments myself. I got help in understanding how to operate and convert files for the 3D printer initially.