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Soft Robotic System for Mechanical Stimulation of Scaffolds During Dynamic Cell Culture

Authors : Johanna Perdomo, Riki Lamont, Edmund Pickering, Naomi C. Paxton, Maria A. Woodruff

Abstract : Background: Tissue Engineering (TE) has combined advanced materials, such as biomaterials, to create affordable scaffolds and dynamic systems to generate stimulation of seeded cells on these scaffolds, improving and maintaining the cellular growth process in a cell culture. However, Few TE skin products have been clinically translated, and more research is required to produce highly biomimetic skin substitutes that mimic the native elasticity of skin in a controlled manner. Therefore, this work will be focused on the fabrication of a novel mechanical system to enhance the TE treatment approaches for the reparation of damaged tissue skin. Aims: To archive this, a soft robotic device will be created to emulate different deformation of skin stress. The design of this soft robot will allow the attachment of scaffolds, which will then be mechanically actuated. This will provide a novel and highly adaptable platform for dynamic cell culture. Methods: Novel, low-cost soft robot is fabricated via 3D printed moulds and silicone. A low cost, electro-mechanical device was constructed to actuate the soft robot through the controlled combination of positive and negative air pressure to control the different state of movements. Mechanical tests were conducted to assess the performance and calibration of each electronic component. Similarly, pressure-displacement test was performed on scaffolds, which were attached to the soft robot, applying various mechanical loading regimes. Lastly, digital image correlation test was performed to obtain strain distributions over the soft robot's surface. Results: The control system can control and stabilise positive pressure changes for long hours. Similarly, pressure-displacement test demonstrated that scaffolds with 5µm of diameter and wavy geometry can displace at 100%, applying a maximum pressure of 1.5 PSI. Lastly, during the inflation state, the displacement of silicone was measured using DIC method, and this showed a parameter of 4.78 mm and strain of 0.0652. Discussion And Conclusion: The developed soft robot system provides a novel and low-cost platform for the dynamic actuation of tissue scaffolds with a target towards dynamic cell culture.

Keywords : soft robot, tissue engineering, mechanical stimulation, dynamic cell culture, bioreactor
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