3D MODELS OF TRACHEA FOR FURTHER INVESTIGATION OF EPITHELIAL IN VITRO MODELS

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ABSTRACT

3D Printing technology and advancements through the years have opened new avenues in biomedical engineering, particularly in the treatment of injuries and diseases revolving around invasive and non-invasive therapeutics related to trachea pathologies [1]. Tracheomalacia and stenosis of the human trachea are two of the main pathological conditions leading to breathing problems in humans [2]. An innovative solution to overcome these difficulties is the use of artificial substitutes to replace long-segment narrowed tracheas. The methods used so far for solving such problems involve re-anastomosis leading to complications after surgery. Through tissue engineering and 3D-printing techniques, however, it is possible to design a customized tracheal model with a morphology suitable for patient support of biological and mechanical profiles [3,4]. In this particular research effort, the design of 3D models of trachea is based on patient-specific tracheal characteristics, thereby producing a model with realistic tissue properties. The approach employs geometrical features of the patient's tracheal structural profile, thus elevating numerical and materials data on those features as priority in the design process. To that end, the initial prototype developed in our Lab was based on data from an actual patient received through Magnetic Resonance Imaging (MRI). The 3D Slicer software program was used to create 3D models in a 3D printable file. Key considerations, such as resolution, layer thickness, and printing techniques, emerge as dominant factors and were taken into consideration in the implementation of the effort, and are discussed to exemplify the accuracy and reliability of the produced tracheal constructs. Furthermore, selection and production of elastomer-like materials and/or embedded organic components was pursued in our Lab and led collectively to a well-configured structural model through 3D printing. Optimization and development of our 3D printed trachea provides a novel and useful tool in tissue engineering, meriting further entry into clinically adapted research for future use in surgical rectification of abnormalities, arisen as a result of tracheal stenotic processes.

KEYWORDS: 3D Printing, Trachea, Bioprinting, Scaffold, Biomaterials

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