Optimisation of Electrospinning Parameters for Fibre Formation and Vascular Graft Scaffold Development

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ABSTRACT

Electrospinning is a highly used technique in the tissue engineering field, particularly for the development of cardiovascular scaffolds [1,2]. Currently there is research in improving the surgical methods for coronary artery bypass graft surgery, and the tissue engineering route provides highly beneficial alternatives for the existing surgical methods. This paper is focused on the electrospinning process and its ideal conditions for producing cardiovascular scaffolds. With use of a series of biocompatible polymers and solvents, solutions were tested in various electrospinning settings in order to produce microscale fibres. The production of these fibres is directly related to the electrospinning parameters in use, hence the importance of optimising this process. Upon simple fibre optimisation, the electrospinning setup was progressed to include rotational collection for scaffold development. A series of scaffold samples were built from various solutions in different parameter conditions. The scaffolds were analysed with scanning electron microscope images for fibre diameter measurement. Furthermore, dynamic loading, creep and stress relaxation tests were conducted in order to interpret the material properties of each sample. Of these samples, those with least permanent deformation after loading were recreated for cell seeding attempts, which is the current state of our project.

Within this paper, an expert system for electrospinning will be is made based on the preformed experiments. Input to the system are material properties of the tested solutions, needle electrode dimensions, the flow rate of the solution, the distance between electrodes and the applied voltage. Expert system will include machine learning algorithms to enable adequate output - fiber characteristics that would be obtained on the collector: diameter of the fiber, their homogeneity and mechanical properties. Such system, could be further adapted to be more user friendly in the form of a phone or tablet application and could be used in combination with larger input database in order to reduce number of experiments performed, thus also reducing solution material consumption, equipment maintenance costs etc.

ACKNOWLEDGEMENTS

1) III41007 Ministry of Education, Science and Technological Development of Republic of Serbia;

2) This project has received funding from the European Union's PanBioRA – Horizon 2020 research and innovation programme under grant agreement No. 760921

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