Cyprus University of Technology
Faculty of Engineering and Technology

Master's Thesis

In vitro and *in vivo* characterization of poly(glycerol sebacate urethane) scaffolds for tendon tissue engineering

Zacharoula Xenou

Limassol, January 2023

CYPRUS UNIVERSITY OF TECHNOLOGY

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING AND MATERIAL SCIENCE AND ENGINEERING & ELECTRICAL ENGINEERING, COMPUTER ENGINEERING AND INFORMATICS

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Approval Form

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ABSTRACT

One of the promising fields in Biomedical Engineering today is tissue engineering. This is specifically important in the application of tendon regeneration. Tendons are characterized by a slow and painful, recovery and usually partial and ineffective healing. More specifically, tendon engineering is a promising field that aims to enhance tendon healing or regeneration. Tendon tissue engineering is an interdisciplinary field that combines biology, chemistry, and engineering to support tendon development. The common general strategy used to achieve this goal is the creation of a scaffold in combination with biological factors and the appropriate structure for tendon regeneration. Thus, the aim of this study was to fabricate a synthetic scaffold from poly(glycerol sebacate urethane) that mimics the structure and properties of the tendon to be replaced.

In the present study, poly(glycerol sebacate urethane glycerol) scaffolds with anisotropic porous microstructure were fabricated using the freeze-drying method. Scaffolds with different amounts of reactants were synthesized and tested for their suitability for tendon tissue engineering. More specifically, the microstructure of the scaffolds was studied in terms of pores and their anisotropy. In addition, an optimal strategy of cell implantation was investigated along with the *in vitro* biocompatibility of the scaffolds. Subsequently, the scaffolds were implanted subcutaneously in mice to examine their *in vivo* biocompatibility, their biodegradation rate and tissue growth through the scaffold. Finally, since the aim was to apply it to tendon tissue engineering, the most suitable scaffold was implanted *in situ* in mouse tendon-model to study and investigate the distribution of the tissue created and its similarity with the native tendon tissue.

By the end of this study anisotropic porous PGSU scaffolds were fabricated which were found to be biocompatible *in vitro* and *in vivo*. The implantation of the scaffold fabricated in the flexor tendon in mouse model showed to enhance tissue ingrowth and the tissue regenerated was anisotropically structured mimicking the microstructure of the tendon.

Key words: tendon tissue engineering, porous anisotropic scaffolds, *in vitro* biocompatibility, *in vivo* biocompatibility, biodegradation rate, *in vivo* tissue ingrowth