15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-48

DESIGN AND FABRICATION OF BIOMIMETIC 3D ANISOTROPIC FIBROUS SCAFFOLDS FOR CARTILAGE TISSUE ENGINEERING APPLICATIONS

André F. Girão, Ângela Semitela, Gonçalo Ramalho, Paula A.A.P Marques, António Completo

University of Aveiro, Portugal
andrefgirao@ua.pt, angela.semitela@ua.pt, g.ramalho@ua.pt, paulam@ua.pt , completo@ua.pt

Keywords: cartilage tissue engineering, anisotropic scaffold, electrospinning

Summary: The major challenge and also the main opportunity of cartilage tissue engineering is to recreate in vitro the depth dependent nanostructural organization of the fibrous collagen network that comprises the native cartilaginous tissue. In fact, the fibre size and orientation rearrangement of the cartilage natural extracellular matrix progresses from perpendicular to the subchondral bone surface in the deepest zone, to random in the middle zone and to parallel in the superficial region, leading to anatomically and functionally complementary features that are responsible for the biochemical and mechanical properties of this tissue. Though the encouraging results of both fibrous and porous scaffolds during the past few years, none of the followed methodologies is currently capable of guaranteeing an optimal balance between biological features, mechanical properties and suitable topographic cues.

Thus, in this study, with the purpose of accurately recreating each cartilaginous zone, we purpose a versatile design and fabrication strategy involving the combination of different electrospinning set ups that are sequentially used to control the size and alignment of the Polycaprolactone (PCL) fibres towards a 3D structure. In this way, we were able to adapt the methodology in order to develop alternative fibrous scaffolds with distinct anisotropy properties capable of offering singular mechanical and topographic characteristics and therefore theoretically influence cell behaviour differentially. The morphology of the 3D electrospun scaffolds together with their individual fibrous zones were analysed via SEM and their mechanical properties were evaluated via static and dynamic (via a bioreactor) compressive and tensile tests.

The results confirmed that although the mechanical and swelling properties of the electrospun scaffolds are related with the specific anisotropic organization used in each design, all the scaffolds show compatible features for cartilage cell culture protocols and therefore the potential of being used as alternative enhanced cellular microenvironments capable of promoting cartilage regeneration using different pathways.

This work was supported by the funding of Program COMPETE-FEDER, Programa Operacional Competitividade e Internacionalização through the project POCI-01-0145-FEDER-016574 and by Fundação para a Ciencia e Tecologia I.P. (FCT, IP) through the project PTDC/EMS-TEC/3263/2014. The authors thank to FCT for the PhD grants SFRH/BD/130287/2017 and SFRH/BD/133129/2017.