Chondrocyte incorporation onto electrospun scaffolds for cartilage tissue engineering

Ângela Semitela, Gonçalo Ramalho, Paula A.A.P. Marques and António Completo
TEMA, Department of Mechanical Engineering, University of Aveiro, Portugal.

Cátia Sousa and Alexandrina Mendes
CNC, Centre for Neuroscience and Cell Biology, University of Coimbra, Portugal

***Abstract*— Cell incorporation onto three-dimensional (3D) biocompatible scaffolds is a crucial step to obtain functional tissue-engineered cartilage. The efficacy of the use of scaffolds depends on their ability to interact with cells, which begins with the incorporation process [1]. Several seeding techniques have been successfully on uniformly incorporating cells through the scaffolds [2], however those cannot be applied for electrospun scaffolds. The characteristic small pore size of these structures prevents cell infiltration, relegating tissue formation to the surface. Several methodologies have been reported to increase pore size of the electrospun scaffolds using sacrificial materials, but these manipulations generally led to degradation of the scaffold final mechanical properties [3]. Cellular integration during the scaffolds construction by electrospinning can be a suitable approach to develop functional tissue constructs, using electrospraying technology. Cell electrospraying, a concept first introduced in 2005 by Jayasinghe, enables the deposition of living cells onto specific targets by exposing the cell suspension to an external high intensity electric field [4,5]. Several cell types have been electrosprayed and survived with no significant influence on a genetic, genomic and physiological level [6]. Here, the preliminary combination of polymer electrospinning with cell electrospraying was performed, in an attempt to overcome the challenges of cell infiltration into electrospun scaffolds for cartilage tissue engineering. First, several chondrocyte electrospraying experiments were performed to access the optimal electrospraying conditions. Then, using the selected parameters, the preliminary association of chondrocyte electrospraying with polymer electrospinning was performed alternating the two technologies. The polymer selected here was the polycaprolactone (PCL) and gelatin, already reported as beneficial for cartilage repair purposes [7,8]. The prepared scaffolds were then cultured for 7 days and the respective cell viability assessed. The percentage of viability was calculated as a ratio of the metabolic activity of the electrosprayed chondrocytes and the metabolic activity of chondrocytes that did not underwent any process. The chondrocyte distribution was also evaluated. Post-electrosprayed chondrocytes viabilities were considerably high (> 80%), particularly at low needle to collector distances, confirming that the electrospraying process did not significantly influenced chondrocyte function. At higher working distances, cell loss may occur within the electrospraying chamber, resulting in decreased cell viability. The combination of both technologies was accomplished, by alternating between PCL and gelatin electrospinning and chondrocyte electrospraying. It was possible to incorporate the chondrocytes within the electrospun PCL and gelatin layers, with an apparently uniform cell distribution through the scaffolds. The presence of gelatin on the scaffolds allowed for a rapid cell attachment, due to the presence of cell recognition domains (RGD) [7]. A partial dissolution of gelatin might also have occurred, resulting in an enhanced pore size for cell migration [8]. The successful cellular integration onto the electrospun scaffolds confirmed that this technique can a promising alternative for cell incorporation into the 3D scaffolds during its electrospinning.**

Keywords – Cartilage tissue enginnering; Electrospun scaffolds; Biopolymeric biomaterials

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TOPIC

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