Exploring the osteoconductive effect of silanol groups by using human adipose stem cells

Ana I. Rodrigues[1,2], Manuela E. Gomes[1,2], Isabel B. Leonor[1,2], Rui L. Reis[1,2]

1- 3B's Research Group - Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, AvePark, 4806-909 Taipas, Guimarães, Portugal
2- ICVS/3B's - PT Government Associate Laboratory, Braga/Guimarães, Portugal

Current methods for bone tissue engineering are concentrated in the *in vitro* expansion and osteogenic differentiation of stem cells since they are a key element to achieve tissue regeneration. One critical strategy for bone tissue engineering is to provide the cues necessary for guiding cell recruitment and driving tissue regeneration by mimicking the bone microenvironment. Silicon is known to have an influence on calcium phosphate deposition and on the differentiation of bone precursor cells [1, 2]. In previous work [3] we demonstrated that a blend of corn-starch with polycaprolactone (30/70 wt.%, SPCL) with silanol (Si-OH) groups sustained human adipose stem cells (hASC) proliferation and differentiation when cultured under dynamic conditions. The present study attempts to analyze in more detail the role of Si-OH groups on the osteogenic gene expression of hASC. Thus the in vitro evaluation of SPCL with and without Si-OH groups, using hASC, was done in either α-MEM or osteogenic medium up to 21 days. Results showed that hASC readily proliferated and migrated into the interior of the wet-spun fibre mesh scaffolds, and calcium and phosphate on the cell surfaces were detected, within only 14 days of culture. Moreover, the studies *in vitro* indicated a synergistic enhancement of osteogenic gene expression of hASC when cultured in the presence of Si-OH groups vs. SPCL without those groups. The present work evidenced that the combination of wet-spinning technology with a calcium silicate solution as a non-solvent allowed scaffolds to be designed and produced with key cues to render an osteoconductive behavior as the classic ceramic materials for regenerating bone tissue. Additionally, these results suggests that silicon and calcium either individually or in combination may relevantly contribute to properly drive hASC towards the osteoblastic phenotype and highlight the potential of those ions in the control of cellular response such as cell differentiation, cell migration and cell adhesion, and protein adsorption, among others.

[1] Hoppe A, Guldal NS, Boccaccini AR, A review of the biological response to ionic dissolution products from bioactive glasses and glass-ceramics. Biomaterials 32: 2757-2774, 2011.

[2] Beck Jr GR, Ha S-W, Camalier CE, Yamaguchi M, Li Y, Lee J-K, Neale Weitzman MN, Bioactive silica-based nanoparticles stimulate bone-forming osteoblasts, suppress bone-resorbing osteoclasts, and enhance bone mineral density in vivo. Nanomedicine: Nanotechnology, Biology, and Medicine, 1-11, 2011.

[3] Rodrigues AI, Gomes ME, Leonor IB, Reis RL, Bioactive starch-based scaffolds and human adipose stem cells are a good combination for bone tissue engineering. Acta Biomaterialia, 2012. (DOI: 10.1016/j.actbio.2012.05.025).