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Antibacterial silica-borate glasses for bone tissue engineering applications

JS Fernandes[1,3], M Martins[2], RA Pires[1,3] and RL Reis[1,3]
[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]*IBB-Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, Braga, Portugal;* [3]*ICVS/3B's - PT Government Associate Laboratory, Braga/Guimarães, Portugal*

One of the major problems in bone tissue engineering/reconstruction is the possibility of occurring bacterial contamination during the surgical procedure. Bacterial strains such as *Staphylococcus aureus* and *Pseudomonas aeruginosa* proved to be very difficult to eliminate from bone grafts [1]. Silica-based bioglasses, namely from the silica-borate system is gaining interest in this field [2]. Knowing in advance that boron has antibacterial properties [3]; it is relevant to evaluate the anti-bacterial properties of silica-borate glass formulations [4, 5]. In fact, bioglasses have been used in bone tissue engineering for several decades due to their capacity to improve, for example, the scaffolds mechanical performance, bioactivity or to promote osteoinduction. In this view, the substitution of the current bioglasses with one that, added to the previous listed properties, present an inherent antibacterial activity is a relevant approach in the development of bone tissue engineering strategies. In this context, we synthesized silica-borate glass compositions by melt quenching, where a suitable composition of starting chemicals (e.g. B_2O_3, $CaCO_3$, etc.) are mixed in a crucible and fired to a temperature capable of melting the whole mixture (typical temperatures between 1000 °C and 1300 °C). The synthesized glass particles were ground to produce microparticles (below 63 μm) that were tested for their cytotoxicity. Glass compositions of general formula $0.20B_2O_3$:$0.40SiO_2$:*x*MgO:*y*CaO:(0.35-*x*-y)SrO:$0.05Na_2O$ (molar ratio, where x, y = 0.35 or 0.00, and $x \neq y$) were synthesised and biologically tested. The cytotoxicity assessment was made by direct contact of each glass sample (9, 18 and 40 mg/mL) with human osteosarcoma cell line SaOs-2 at a density of $1.5E10^4$ cells/mL during 7 days of incubation (37 °C and 5% CO_2 atmosphere). For 1, 3 and 7 days of culture, the cell proliferation (DNA quantification) and metabolic activity (MTS) were monitored. The *in vitro* results (DNA and MTS) allow us to state that cells remain viable during the 7 days of culture. Preliminary agar diffusion assay tests, measuring the antimicrobial effect of the glass compositions against *S. aureus* and *P. aeruginosa* showed that the $0.20B_2O_3$:$0.40SiO_2$:0.35SrO:$0.05Na_2O$ glass inhibits bacterial growth at 9 and 18 mg/mL. Further studies are required to test different: glass compositions (with varying proportions of SrO); glass concentrations in the medium; and bacterial strains.

References:

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DOI: 10.1002/term.1822