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PHYSIOLOGICALLY RELEVANT ASSESSMENT OF BIOMATERIALS IN BIOMIMETIC BIOREACTORS AIMED FOR REGENERATION OF SKELETAL TISSUES

Bojana Obradovic_p[1], Jasmina Stojkovska[1], Jovana Zvicer[1], Ivana Banicevic[1], Ana Medic[23], Sasa Novak[23], Djordje Veljovic[1], Vesna Miskovic Stankovic[1]

[1] *Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia*

[2] *Department for Nanostructured Materials, Jozef Stefan Institute, Ljubljana, Slovenia*

[3] *Jozef Stefan International Postgraduate School, Ljubljana, Slovenia*

Corresponding author's e-mail: bojana@tmf.bg.ac.rs

Development of biomaterials aimed for biomedical utilization requires extensive physico-chemical characterization followed by in vitro and in vivo functional evaluation. This process is long and expensive imposing the need for methods for quick and reliable selection of the most promising candidates. Biomimetic bioreactors are recognized as valuable tools that can provide evaluation of biomaterial functionality under physiologically relevant conditions, biomechanical properties, and cell–biomaterial interactions. In the present study, we address all of these three aspects by utilizing two bioreactor types: perfusion and a bioreactor with dynamic compression. Specifically, we evaluated bioactivity of porous composite scaffolds based on hydrogels (gellan gum and alginate) and hydroxyapatite (HAp) precursor particles (bioactive glass and beta-tricalcium phosphate) aimed for bone tissue regeneration. Perfusion of simulated body fluid at superficial velocities in the range 100-500 μm/s relevant for osteogenesis was shown to significantly enhance HAp deposition revealing mass transfer limitations in traditional static tests. The bioreactor with dynamic compression applied in the regime relevant for articular cartilage (5 % deformation, 0.68 Hz frequency, 337.5 μm/s loading rate) was utilized to monitor biomechanical properties of scaffolds over time revealing slight composite weakening at lower mineral contents while an increase in dynamic compression modulus at pronounced HAp deposition. Finally, the same bioreactors were utilized for cytotoxicity evaluation of nanocomposite Ag/alginate hydrogels as potential antimicrobial cartilage implants as well as cultivation of osteosarcoma cell line in a bioactive osteogenic environment. These studies confirmed advantages of biomimetic bioreactors in providing consistent results corresponding to those found in vivo.