THE ENCAPSULATION OF ANTIBACTERIAL DRUGS IN POLYMER NANOPARTICLES AND THEIR USE IN DRUG DELIVERY SYSTEMS ON ZrO_2 SCAFFOLD WITH BIOACTIVE COATING

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Introduction

Bone infections are relatively common problem, and at the same time their treatment is difficult, due to the limited ability of antibiotics to accumulate in the bone [1]. There is also an increase in infections of joints, particularly after their surgical treatment. This is due to an aging population that results in a reduced immune response, more hip fractures, and more frequent use of invasive joint surgery, with the risk of microbial infections. Bacteria can cause serious damage to bone tissue as well as spread to neighbouring tissues and organs [2,3].
The aim of this study was to: 1) bioactivate the ZrO_2 bioinert scaffolds using the biomimetic calcium phosphate (CaP) layer deposition method, 2) create polymer nanoparticles (NPs) of poly(L-lactide-co-glycolide) loaded with antibacterial drugs and 3) immobilize NPs on ceramic scaffolds, using the drop-casting method and incorporating NPs during the deposition process of the bioactive layer.

Materials and Methods

The nanoparticles were obtained using the double emulsion method with solvent evaporation. Gentamicin (gent) and bacitracin (Bct) were used as antibacterial drugs. NPs shape and size were characterized using scanning electron microscopy (SEM) and dynamic light scattering (DLS), respectively. Ceramic scaffolds were made by pressing and sintering method and then immersed in ten-time concentrated solution of simulated body fluid (10xSBF). The quality and thickness of the deposited layers were tested by means of SEM. The effectiveness of the immobilization of NPs by both methods and their adhesion to the substrate after incubation in a simulated biological environment was also checked.

Results and Discussion

The results showed that the proposed method is effective in NPs preparation. NPs are of spherical shape and their size is ca. 200 nm. The high efficiency of encapsulation and changes in surface potentials have been confirmed by the OPA and Zeta potential tests, respectively (TABLE 1). The result of NPs immobilization was confirmed by SEM (FIG. 1).

TABLE 1. NPs characterization.

	PLGA	PLGA_gent	PLGA_Bct
Average size [nm]	226,3	207,4	202,4
Zeta potential [mV]	-30,5	-23,9	-13,4
Encapsulation [%]	--	54,3	37,5

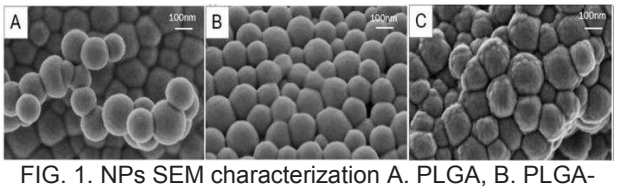

FIG. 1. NPs SEM characterization A. PLGA, B. PLGA-Gent, C. PLGA-Bct.

The microstructure of the deposited layers was examined by SEM. The bioactive layer consisted of flakes-like mineral crystals (FIG. 2).

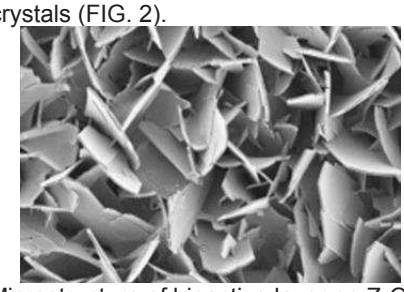

FIG. 2. Microstructure of bioactive layer on ZrO_2 scaffold.

NPs were deposited on the scaffolds by two methods: co-precipitation in SBF and by drop-casting. As SEM microphotographs show (FIG. 3) both methods seem to be suitable do deposit NPs on CaP bioactive layer.

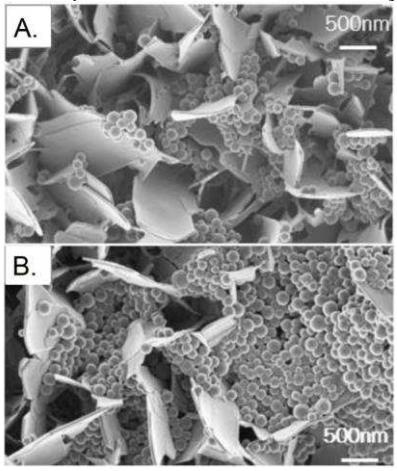

FIG. 3. SEM microphotographs of NPs deposited on ZrO_2 scaffolds during the CaP layer preparation process (A) and by drop-sitting method (B).

Conclusions

The presented processes of surface bioactivation and immobilization of NPs are effective in creating bioactive ceramic scaffolds that can be used in tissue engineering and as drug delivery systems to treat bone infections.

Acknowledgments

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