A NEW STRONTIUM AND ZINC DOPED BIOGLASSES FOR TISSUE ENGINEERING

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Introduction

Bioglasses are materials known for the ability to create a strong bond with tissues, especially bone tissue. Numerous studies revealed beneficial effects of strontium on bone tissue such as increasing osteoblasts proliferation or stimulating bone remodeling [1], whereas zinc is reported to have antibacterial performance [2]. The aim of the study was to describe influence of the glass modifiers (strontium and zinc) on the glass structure and *in vitro* bioactivity. What is more, their influence on the growth and differentiation of bone and cartilage tissue cells have been investigated.

Materials and Methods

Glasses from the SiO_2-CaO-P_2O_5-SrO and the SiO_2-CaO-P_2O_5-ZnO systems have been obtained by the sol-gel route. They were differing in CaO/SiO_2 ratios and the concentration of modifier oxides (SrO and ZnO), varying between 0-5 % molar percents. Materials were subjected to the structural analyses (XRD diffraction, FTIR spectroscopy, NMR spectroscopy). Moreover, *in vitro* bioactivity tests in simulated body fluid solution were performed. For the biological test purposes glass powders were incorporated into PCL polymer matrix with the 50% glass particles weight fraction The series of *in vitro* biological tests was made in order to evaluate the influence of the additives type and concentration on the bone (NHOst Lonza) and cartilage (NHAC, Lonza) tissue cells phenotype and the behavior. Osteoblasts culture was analyzed for cytotoxicity, level of ALP, and extracellular matrix mineralization level. Moreover, cells morphologies were evaluated by acridine orange fluorescent staining. Chondrocytes were analyzed for collagen type II level and aggrecan expression.

Results and Discussion

Structural analyses of obtained glasses changes occurring in the materials structure along with the introducing of SrO or ZnO in place of CaO. Sr incorporation effected in the increase in the amount of the non-bridging Si-O- bonds, what was probably an effect of the differences in size between Ca^{2+} and Sr^{2+} cations. Our study has shown that the effect of strontium oxide on the structure and properties of gel-derived biomaterials largely depended not only on SrO concentration but also on the chemical composition of starting materials.

Bioactivity *in vitro* tests indicated that all of obtained materials were bioactive, but the dynamics of the process and bioactive layer morphology depended on the bioglass composition.

Biological tests indicated that incorporation of Sr and Zn to glasses significantly affects cell behavior and phenotype. Strontium containing glasses favored osteoblast cells differentiation and increased ALP activity, whereas both Zn or Sr-containing glasses. Results of the mineralization assay *in vitro* performed on the osteoblast cells after 21 days of culture indicated that the highest level of ECM mineralization exhibited cells cultured in the material with Sr-containing glass particles. Moreover, modifying bioglass with strontium has significantly improved ECM mineralization in comparison with other materials, especially with TCPS and bare PCL film. Studies of the collagen type II level produced by the chondrocytes cultured on the model bioglass/PCL composite films indicated that after 7 day of culture the total collagen production was similar for all tested materials. After 14 days the level of produced collagen type II in A2/PCL and PCL materials was lower than for the TCPS, whereas the highest level of production was detected for the material containing glass doped with 5% mol of zinc what indicated that Zn-doped bioglasses stimulated chondrocytes to collagen type II production better than other tested materials.

Conclusions

Our study has confirmed that addition of strontium and zinc to glasses can improve their biological response in vitro in contact with various cell lines.

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References

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