BONE IMPLANTS WITH POROUS SURFACE AND BIOACTIVE GLASS COATING

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Introduction

Various coatings have been used to enhance osseointegration of Ti-based implants. Among them, bioactive glass (BAG) is known by its good bioactivity and antibacterial properties achieved by incorporation of specific ions[1,2]. However, due to its poor mechanical properties, BAG coatings on flat metal surfaces are inappropriate and therefore, porous titanium surface layer coated with BAG was proposed. To impregnate internal surface of the metal pores, sufficiently fine BAG powder was needed. Instead of melt-derived BAG, we used sol-gel synthesized BAG particles, which were then applied into the porous metal structure. The properties of the prepared BAG powder and coatings was tested *in-vitro* as well as *in vivo*.

Materials & Methods

Different compositions of BAG comprising oxides of Si, P, Ca and Na were prepared by particulate sol-gel method in basic conditions. The dissolution rate was estimated by measuring pH change on the surface of BAG discs using flat electrode. Ability to form hydroxyapatite was tested in simulated body fluid. BAG coatings were applied on and into the porous Ti-layer on the Ti6Al4V alloy by aid of vacuum infiltration and then sintered in vacuum furnace. Uncoated and BAG-coated samples were inserted into rabbit tibia. After ten weeks rabbits were sacrificed and explanted samples were examined under light and electron microscopes (SEM, TEM), EDS mapping was used to identify the phases. Bone-to-implant contact and bone within the pores were analyzed quantitatively by stereological analyses.

Results

Using particulate sol-gel technique nanosized (~100 nm) bioactive glass particles were produced. During thermal treatment the BAG coating partially crystallized. The newly formed Ti-silicide interphase layer was assumed to be responsible for good adhesion of the coating. For all the BAG compositions hydroxyapatite was formed within 5 days in SBF solution. Under static conditions, the pH by the BAG surface increased up to value of 8.

By *in vivo* test, good bone ingrowth into the porous titanium surface layer on the implants was confirmed: occupation of the pores with bone increased from 22 % for uncoated to 38% for the BAG-coated samples, while the increase in bone-to-implant contact was minor (45 % and 47 %, respectively). EDS analysis of the cross-sections revealed that after ten weeks BAG was completely replaced by new bone that indicates favorable kinetics of the BAG dissolution under physiological conditions.

Discussion

Bioactive coatings on porous titanium layer on Ti-based alloy were successfully prepared by infiltration of suspension of bioactive glass powder prepared by particulate sol-gel method. The coatings were well attached on the substrate and they promoted bone ingrowth, bioactivity and antibacterial properties. In vivo animal study of the coated porous Ti-layer in comparison to uncoated samples confirmed that the bioactive glass stimulates bone ingrowth and hence promote osseointegration.

References

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