THE BIOLOGICAL DEGRADATION OF PURE BONE CEMENT AND BONE CEMENT WITH NANOMETALS

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Introduction

Bone cement is a biomaterial widely used in various fields of medicine. Its main tasks are bonding and stabilizing implants with bone and as a filler of bone defects and spaces between the implant and the bone. It is characterized by biocompatibility and good mechanical properties, as well as it is easy to form. Thanks to the use of bone cement, better cell adhesion to the implant and osseointegration can be obtained.

The paper concerns pure bone cement and bone cement with the addition of nanometals. The samples were placed into a bacterial liquid (generated by one of the researchers) for 1,3 and 6 months. This liquid contains the five most common bacteria in the operating theatre. After that, it was examined by the scanning electron microscope and biological microscope.

The work aims to select the best material, so that in order to prevent bacterial adhesion and thus to counteract infection. The effect of bactericidal additives on bacterial adhesion and biofilm formation was also determined.

Materials and Methods

The samples were made of pure bone cement and with the addition of nanometals (silver, copper).

The samples were placed into a bacterial solution consisting of the 5 most common bacteria in the operating room, for a period of 1,3 and 6 months. After that the macroscopic observation was performed with the use of ZEISS biological microscope AXIO Observer.D1 (FIG. 1).

FIG. 1. The biological microscope Zeiss.

Results and Discussion

Microbial adhesion is the initial step in colonization and the formation of a biofilm – accumulated biomass of microorganisms and extracellular materials on a solid surface. Biofilms can be detrimental to both human life and industrial processes, causing infection associated with medical implants, pathogen interaction with host cells, periodontitis or dental caries, contamination of food from processing equipment, enhancement of metal corrosion, formation of marine biofilms on ships` hulls, and so on [1].

Biological tests on pure bone cement after 1 month in the bacteria liquid revealed single bacteria. However, after 6 months the surface was covered with biofilms (FIG. 2).

Bone cement with nanometals after 1 and 3 months did not show any bacteria on the surface. After 6 months there were single bacteria on nanosilver samples (FIG. 3).

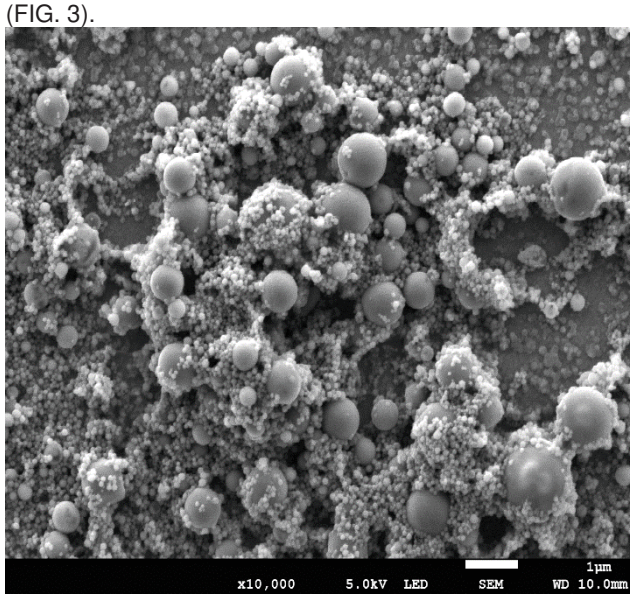

FIG. 2. Pure bone cement after 6 months staying in bacteria liquid.

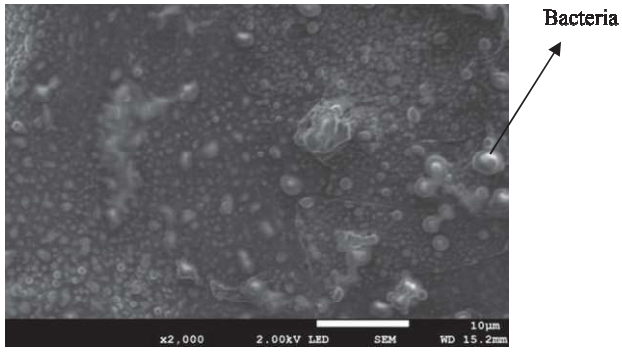

FIG. 3. Bone cement with silver nanoparticles after 6 months staying in bacteria liquid.

Conclusions

The paper shows, that nanoparticles can be used in bone cement to prevent infections. The results of the research prove, that nanoparticles are the alternatives to antibiotics, whose activity is gradually decreasing as a consequence of the rise in antibiotic – resistant microorganisms. Furthermore, the nanoparticles are effective also against bacterial strains already resistant to some of the common antibiotics used in bone cements.

References

[1] Hori K., Matsumoto S.: Bacterial adhesion: From mechanism to control. Biochemical Engineering Journal 48 (2010), 424-434