Electrospay Coating of Metal Implants with Antibacterial Calcium Phosphate (Ag-HAP/TCP)

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Research and development studies in biomedical technologies and biomaterials science have become more important with the increasing factors that threaten human health. At the present time a large number of biomaterials are produced by hundreds of companies. The need for metal implants, the most preferred of these biomaterials, is increasing day by day. Even though the metal implants are the most common biomaterials, there are still things to do to improve their chemical resistance, biocompatibility and osseointegration. One of the best ways to improve the biocompatibility is to coat the surface of metal implants with synthetic hydroxyapatite which will have easy decomposition or integration with the natural bones.

One other important problem in these implant systems is the infections which can easily start and grow at the interface between metal implants and human bones. One of the solutions for preventing microbial activities on the surface of the implant, threatening the surface with organic (gentamicin, vancomysin) based antimicrobial materials. Other emerging technology is the silver based material which can be coated on the metal implant surface and can be implanted to the human body during the operation without creating another process issue. Organic based antimicrobial materials may have potential to create bacterial strain development. Up to now there is no evidence bacteria develop strain against the silver-based materials. Even tough, silver can be a remedy the bacteria-based infections, it may cause toxicity problem on human cells because it is a heavy metal. For that reason, it should be encapsulated and kept in certain amount to create antimicrobial activity without causing any toxic effects. There are various techniques can be used to cover the surface of the metal implant with silver ions; such as dip coating, sol-gel, electrophoretic deposition, plasma spray coating, high speed suspension flame spraying and pulsed laser deposition. Plasma spray coating is a well-known and widely used technique for implant industry. Nevertheless, it might have some stress and flake off on the implant surfaces, due to the high temperature difference between the plasma and the coated metals. Generally, the thickness of the plasma spray coating on metals is in the range of 100-200 um. That is one of the main reasons of flake-off problem.

We aimed to create Ag ion doped antimicrobial calcium phosphate based ceramic coating with 10-20 µm thickness on metal implant surfaces, in this investigation. It can be satisfied
by using electrospray deposition technique to achieve optimal HAP/TCP coating on the metal implant. We achieved 10-20 μm in thickness on metal implants by using pure HAP, pure TCP, bioglass and biphasic/three phasic systems. As well as we did similar kind of studies by implanting the silver ion inside these three phasic systems to create antimicrobial surface on the metal implants. In this study HAP/TCP particles in the range of 100-300 nm, manufactured by using wet chemical precipitation method. Pretreated surface of the metal implants coated with the synthesized nanoparticles by using electrospray deposition method. After drying the coated implants, heat treatment applied to systems to create consolidated coating on the metal surfaces. Integrity of the coating to the metal implants surface was tested by using scratch method and chemical stability of the coating surface was tested using leaching method in human blood plasma in certain period of time. After making in vitro experiments, in vivo studies were performed in collaboration with Orthopedics Department of Eskişehir Osmangazi University. Some of the results of surgical operations performed on the candidates will presented in this presentation. Detailed information of in vivo studies can be found in paper titled of “The Use Of Orthopedic Implants With Silver Ion-Doped Ceramic Coating In The Prevention Of Implant Related Infections” which will be presented by Prof. Dr. Nusret Köse.

Keywords: Electrospray, antimicrobial coating, metal implant.