A study of Electrophoretic Deposition of Alumina and Hydroxyapatite on Tapered Ti-6Al-7Nb Dental Implants: Mechanical and Histological Evaluation

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ABSTRACT

Introduction: The clinical success of implants has been achieved not only because of the mechanical strength or excellent biocompatibility of the implant material but also because of other characteristics such as surface properties.

Objective: This study was done to evaluate the effect of the various ceramic coatings including Hydroxyapatite (HA) and Alumina, mixing of both Alumina &HA and two layers (Alumina &HA)on the bond strength between the bone and implant, and cell compatibility of tapered screw-shaped Ti-6Al-7Nb dental implants.

Materials and methods: Electrophoretic Deposition technique (EPD) was used to obtain a uniform coating for each one of four types of ceramic layers on the screws (HA, Alumina, two layers and mixture of 50%HA and 50% Alumina). For examination of the changes occurred on the surface, structural and elemental analysis beside morphological investigations were carried out on the modified surfaces of the Ti-6Al-7Nb alloy using different techniques, namely X-ray diffraction (XRD), and Energy Dispersive X-ray Fluorescence (EDXRF).

The in vivo study was done by the implantation of 225 Iraqi new design tapered screw–shaped uncoated and coated implants of 3mm diameter, 8 mm length (the threaded part is 5 mm and the smooth part is 3 mm) and 0.5mm pitch height.The tibia of 45 white New Zealand rabbits were chosen as implantation sites. The right tibia of rabbit received three screws, (one uncoated and two coated) while the left tibia of rabbit received two coated screws. To understand the bone-implant interface, biomechanical test was

performed after 2, 6 and 18 weeks healing periods. 15 rabbits were sacrificed for each period. A removal torque was done for ten animals in each group, whereas the other five ones were used for histological testing with optical microscope.

Results: The results indicated that there was a faster reaction of bone towards the coated Ti-6Al-7Nb alloy implants compared to the uncoated one and more mature bone was observed after 6 weeks of implantation in screws coated with a mixture of Alumina and HA. The biomechanical test revealed that there was increased mechanical strength (torque value) of bone-implant interface with time, the highest increase in the bond strength was for implants coated with a mixture of 50% HA and 50%Alumina,also the bond strength of two layers coating was more than that of the HA.

Conclusion: The biomechanical and biological properties of the bone-implant interface associated with the coated implants were improved comparing to the uncoated ones, that all coated Ti-6Al-7Nb alloy seem to be well tolerated by the bone since no adverse tissue reaction was evident and they have better mechanical properties and excellent biocompatibility through the improved performance regarding the bone implant contact area than the uncoated implants. Coating by electrophoresis proved to be a valuable process to coat metallic implants with an osteoconductive material, and to form a uniform composite and multiple layer coating.