Mechanical and Histological Evaluation of NanoZirconium Oxide coating on Titanium Alloy (Ti-6Al-7Nb) Dental Implants

A Thesis
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ABSTRACT

Background: Dental implants provide a unique treatment modality for the replacement of lost dentition . 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 has been done to evaluate the effect of nano ZrO_2 coating on the bond strength between the bone and implant, and cell compatibility of screw-shaped Ti-6Al-7Nb dental implants.

Materials and methods: Electrophoretic Deposition Technique (50 volt, 3 minute) was used to obtain a uniform coating of nano ZrO_2 layers on Ti-6Al-7Nb screws . In order to examine the changes occurred on the coating layer, X-ray diffraction (XRD), thickness measurement and microscopical examination was carried out on the modified surfaces of the Ti-6Al-7Nb alloy . The tibia of 12 white New Zealand rabbits were chosen as implantation sites. The tibia of each rabbit received two screws, (one coated and one uncoated). Biomechanical test was performed to understand the bone-implant interface, after 4 and 12 weeks healing periods. Implants from 10 animals (5 for each period) were tested for the torque required to remove the implant from the bone and the other 2 (one for each period) were prepared for histological examination.

Results: The results indicated that there was a faster reaction of bone towards the nano ZrO_2 coated Ti-6Al-7Nb alloy implants compared to the uncoated one. There was an increasing in the mechanical strength (torque value) of bone-implant interface with time and the mechanical test revealed that the mean removal torque values for the coated implants was significantly higher than those for the uncoated implants and over the two periods of time. In addition, the histological analysis showed improved quality of bone in response to the coated screws,that the coated implants shows a well developed mature

bone following the shape of the screw characterized by a mature osteons and active periosteium shows active proliferation of progenitor cells.

Conclusion: The biomechanical and biological properties of the bone-implant interface associated with the coated implants were improved comparing to the uncoated ones. Coating by electrophoresis proved to be a valuable process to coat metallic implants with an osteoconductive material, and to form a uniform composite layer coating .