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Study different nano surface modifications on CPTi dental implant using chemical and thermal evaporation methods: Mechanical and Histological Evaluation

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 owing to other characteristics such as surface properties.

Aims of the study: The goal of this study was to consider the role of nanoscale topographic modification of commercial pure titanium dental implant using a thermal deposition and chemical etching methods for the purpose of improving osseointegration.

Materials and methods: Commercial pure titanium rod was machined into 40 dental implants. Each implant was machined in diameter about 3mm, length of 8mm (5mm was threaded part and 3mm was flat part). Implants were prepared and divided into 4 groups according to the types of surface modification method used: 1st group (10 implant) machined surface i.e remained without nano surface modification (control),2nd group include (10 implant)etched with 15N H_2SO_4 and 30% H_2O_2,3rd group include (10 implant)were coated with nano CPTi powder by thermal evaporation deposition technique,4th group (10 implant)were chemically etched with H_2SO_4 and H_2O_2 method to obtain a nano feature then coated with nano powder of CPTi by thermal evaporation deposition technique.

Nano surfaces were characterized by scanning electron microscope (SEM), Xray diffraction (XRD), atomic force microscope (AFM), thickness measurement and microscopical examination for the invitro experiments.

For the invivo part of study, the tibia of 10 white New Zealand rabbits were chosen as implantation sites. The tibia of each rabbit received two screws. Biomechanical test was performed after two weeks healing periods. Implants

from eight animals were tested for the torque required to remove the implant from the bone and the other two animals were prepared for histological examination.

Results: For invitro results, scanning electron microscope showed that chemical etching of Ti substrate becomes highly porous and has surface consisting of nano_sized pits and the combination of chemical etching and thermal evaporation of nano Ti showed nano rod like structure. The results of removal torque means value after 2 weeks of implantation showed that, there was a gradual increase in the removal torque mean values in the studied groups as a follow (M±SD): 12.625 N.cm ± 0.517 machined surface, 30.500 N.cm ± 4.071 chemically etched, 46.875 N.cm ± 5.938 nano CPTi coating by thermal evaporation method, 51.250 N.cm ± 5.175 combination method of chemical etching and nano CP Ti coating. In addition, the histological analysis showed improved quality of bone in response to the nano surface modified screws, especially the combination treated implants show a well developed mature bone characterized by a well developed bony threads and haversian canal.

Conclusion: The biomechanical and biological properties of the bone-implant interface associated with the nano modified implants were improved comparing to the unmodified implants. All nano modified CP Ti seems 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 untreated implants.