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Evaluation the effect of coating a mixture of ceramic nano hydroxyapatite and magnesium chloride on osseointegration of implant in rabbits (Biomechanical and histological study)

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Abstract

Background: the ultimate gool of modern implantology is fine and fast osseointegration which is a major factor influencing the success of dental implantation, and its largely depend on the implant surface .High-quality osseointegration stand for an accelerated healing process, high stability, and durability of the dental implant .To achieve rapid and strong, durable osseointegration, various surface treatment methods have been investigated by altering the surface topography by coating with suitable biomaterials to increase bone implant contact.

Aims of the study : To evaluate the effect of the composite material coating which includes (ceramic nano hydroxyapatite & magnesium chloride) on the bone bonding strength to coated implant surface and tissue reaction .

Materials and Methods : In invitro part of the study, a plate of Commercially Pure Titanium (CpTi) was coated with (HA & $MgCl_2$) by Electrophoretic deposition (EPD) coating technique . In this technique , coating procedure was performed using different proportion of HA & $MgCl_2$ and different coating time and fixed voltage . Then analysis of coated surface was performed using : Optical microscopy ,X-ray diffraction (XRD), atomic force microscope (AFM),Scanning electron microscope (SEM) ,Energy Dispersive X-ray spectroscopy (EDX) respectively , Then sterilization of screws was performed by using gamma radiation .

In in vivo part ,the tibia of 10 white male New Zealand rabbits, were chosen as implantation sites of 40 screws .Both tibia of each rabbit received 4 implants 2 coated and 2 uncoated . Torque removal test was performed to measure bone bonding strength between implant and bone after 2 and 4 weeks healing periods(4 rabbits for each periods) . For each period of time 16 screws were tested for the torque required to remove the implant from the bone .

Two remaining rabbits were used for histological study (one rabbit for each period) mean 4 screws for each period.

Results : In in vitro part of study ,the results of Energy-dispersive X-ray spectroscopy (EDX) shows that 1.9 % of Mg and 32.4% Ca contain in Ti substrate . Analysis of coated surface was performed using : Optical microscop which show that 2 mintes is the suitable time used for coating screws at 30 volt ,X-ray diffraction (XRD) that shows strongest line of HA and $MgCl_2$ in coated layer , atomic force microscope (AFM) will analyze the surface roughness on nanometer scale which was 86.89 nm and grain size 128 nm ,Scanning electron microscope (SEM) shows numesous agglomerations of small spherical particles in nanometric scale between 5 nm and 100 nm of HA while a small particles size were observed for $MgCl_2$, Energy Dispersive X-ray spectroscopy (EDX) respectively , In biomechanical test, the torque mean value at bone – implant interface in coated implants were significantly higher than the uncoated implants at the two period of time (2 weeks and 4 weeks) after implantation and increase in bone formation around screws with time , also there was a sufficient bone formation as time of implantation increase. mean value after two weeks of coated dental implant 6.37 N.cm & mean value after 4 weeks of coated dental implant 11.40 N.cm . Also there was an increase in the torque mean values at bone –implant interface with time .In histological analysis, there was an interdigitating of well developed bone close opposing threads of coated implants after 2 and 4 weeks implantation .

Conclusion : Coating CpTi screws with mixture of (HA & $MgCl_2$) was efficient in increasing bone bonding strength to dental implant at bone implant interface than uncoated implant ,which was demonstrated by higher torque removal force and increase in bone formation around screw with time .