Osseointegration Evaluation of Laser Deposited Titanium Dioxide Nanoparticles on Commercially Pure Titanium Dental Implants

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ABSTRACT

Background: The nanostructured Titania coatings have been specifically used to improve titanium dental implant surfaces. However, coating the implants by using different coating techniques and parameters can provide different Titania film properties and therefore can affect differently on the bone tissue response.

Aim of the study: To evaluate and compare the structural, mechanical and histological characterization of nano-titania films produced by modified laser and dip coating techniques on the commercially pure titanium implants.

Materials and methods: Coating characterization of the deposited Titania films produced by laser deposition techniques on grade (II) commercially pure titanium samples were evaluated by using X-ray phase analysis, micro - morphological analysis, Atomic Force Microscope , Vickers micro-hardness measurements, Scanning Electron Microscope and for material characterization by Energy-Dispersive X-ray investigations. Then, these films were compared with the coating films produced by the dip coated technique (controls).

For the in vivo experiments, forty screw-designed dental implants were coated by Titania nanoparticles. Twenty implants, which represent the control group, were coated by dip coating technique. The other (20), which represent the experimental group, were coated via laser deposition technique. Then, all the coated implants were sterilized by plasma sterilization technique and were implanted in the tibiae of (20) white New Zealand rabbit's bone. One coated implant from each group was implanted in the right tibia of each rabbit.

Finally, the implants were evaluated biomechanically (by using the removal torque test) and biologically (by using histological examination) after 2 and 4 weeks healing intervals. From each implants group, (8) implants were examined by the removal torque test and (2) implants by histological observations from each healing interval.

Results: By comparing with dip coating technique, the modified laser technique provides a higher quality thin coating film with an improvement in the surface microhardness values. Histologically, this technique appeared to provide more favorable coating for the implants surfaces that enhanced and promoted osseointegration, while mechanically, these implants showed a significant difference in the removal torque values after 2 weeks of implantation and a highly significant difference after 4 weeks of implantation; as compared with the corresponding implants coated by dip coating technique.

Conclusions: The biological and biomechanical properties of the bone-implant interface associated with nano-titania coating film which deposited by using the modified laser coating technique were improved, as compared with dip coated one.