Guided bone regeneration around titanium plasma-sprayed, acid-etched, and hydroxyapatite-coated implants in the canine model

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BACKGROUND: Endosseous dental implants with rough surfaces have been designed to improve early healing, especially in areas of poor bone or insufficient bone quantity. The aim of this study was to histomorphometrically assess the bone-to-implant contact on 3 different rough-surfaced implants following guided bone regeneration.

METHODS: Mandibular premolars and first molars were extracted in 12 dogs, and healing was allowed for 6 months. Six implant osteotomy sites were prepared, 3 per side, followed by the creation of 7.3 mm wide by 5 mm deep surgical defects in the coronal section of the osteotomy sites. Ten-mm long titanium screw-type implants with titanium plasma-sprayed (TPS), hydroxyapatite-coated (HA), or acid-etched (AE) surfaces were placed; the surrounding defects were filled with canine demineralized freeze-dried bone allograft; implants/grafts were covered with expanded polytetrafluoroethylene membranes; and the tissue was closed. Following a healing period of 4 months, the animals were sacrificed and mandibular blocks were harvested for histomorphometric analysis.

RESULTS: The mean percentage of bone-to-implant contact in the defect and non-defect areas for the different implant surfaces was: AE 16.24% defect, and 28.78% non-defect; TPS 25.08% defect, and 16.96% non-defect; and HA 48.25% defect and 26.60% non-defect. Within the defect, the mean difference in the bone-to-implant contact was significant for HA compared to TPS (P < 0.0001) and HA versus AE (P < 0.0001); TPS versus AE was not significant (P = 0.063). In the non-defect areas, the mean difference in the bone-to-implant contact was significant for AE versus TPS (P = 0.010); all other comparisons were not significant. There were 18 membrane exposures in the 72 implant sites. Data were analyzed again to assess the impact of membrane complications. Using a 1-way analysis of variance, the bone-to-implant contact was compared between the sites with and without membrane complications. No significant
differences were seen in the defect areas or in the non-defect areas between the sites with and without membrane complications.

**CONCLUSION:** In this study, the bone-to-implant contact in regenerated bone was greatest when an HA-coated implant was used.

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**Radiographic evaluation of dental implants with different surface treatments:**

An experimental study in dogs

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**PURPOSE:** The aim of the study was to radiographically measure the bone density at the peri-implant region after osseointegration and to compare the relative bone density achieved by different surface-treated implants.

**MATERIALS AND METHODS:** Four different types of implant surfaces were compared, using five young-adult male mongrel dogs. The first, second, third, and fourth lower premolars were extracted. Ninety days after removal, four 3.75-mm diameter and 10-mm long screw implants (Paragon) were placed with different surface treatments in the lower hemiarches. The dogs received two implants each of the following surface treatments: 1) smooth (machined); 2) titanium plasma spray; 3) hydroxyapatite coating; and 4) sandblasting with soluble particles. The implants were maintained unloaded for 90 days. After this period, the animals were killed and the hemimandibles were extracted and radiographed. The grey level of the bone adjacent to implants was measured with a specific software tool (line histogram) and the relative bone density was calculated.
RESULTS: The four different surface treatments promote different numeric levels of bone density around the dental implants (sandblasting with soluble particles, 52.45 +/- 2.95; titanium plasma spray, 53.98 +/- 3.67; machined, 55.78 +/- 3.06, and hydroxyapatite coating, 58.2 +/- 2.71). Therefore, the implants can be ranked in terms of relative bone density from high to low as follows: sandblasting with soluble particles, titanium plasma spray, machined, and hydroxyapatite coating.

There were no statistically significant differences in bone density among the four groups (P = 0.1130, analysis of variance).

CONCLUSION: Surface treatments that add roughness to the implant show numerically higher bone density when compared with machined surfaces. The findings of radiographic density analysis suggest that the soluble blasting media-treated surface provides a greater bone density at the peri-implant region.

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In vitro corrosion behavior of bioceramic, metallic, and bioceramic-metallic coated stainless steel dental implants

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OBJECTIVES: The most common metals and alloys used in dentistry may be exposed to a process of corrosion in vivo that make them cytotoxic. The biocompatibility of dental alloys is primarily related to their corrosion behavior. The aim of this work was to evaluate the corrosion behavior and thus the biocompatibility of the uncoated and coated stainless steels and compare the effect of type of coatings on corrosion behavior.
METHODS: Three types of coatings, hydroxyapatite (HA), titanium (Ti), and a double-layer HA/Ti on AISI 316L stainless steel were made. HA coating was produced using plasma-spraying technique and Ti coating was made using physical vapor deposition process. In order to perform a novel double-layer composite coating, a top layer of HA was plasma-sprayed over a physical vapor deposited Ti layer on AISI 316L stainless steel. Structural characterization techniques including XRD, SEM and EDX were used to investigate the microstructure, morphology and crystallinity of the coatings. Electrochemical potentiodynamic tests were performed in physiological solutions in order to determine and compare the corrosion behavior of the coated and uncoated specimens as an indication of biocompatibility.

RESULTS: Double-layer HA/Ti coating on AISI 316L SS had a positive effect on improvement of corrosion behavior. The decrease in corrosion current densities was significant for these coated specimens and was much lower than the values obtained for uncoated and single HA coated specimens. Ti coating on AISI 316L SS also has a beneficial effect on corrosion behavior. The results were compared with the results of corrosion behavior of HA coated commercially pure titanium (cpTi) and uncoated cpTi.

SIGNIFICANCE: These results demonstrated that the double-layer HA/Ti coated 316L SS can be used as an endodontic implant and two goals including improvement of corrosion resistance and bone osteointegration can be obtained simultaneously.

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A comparison of hydroxyapatite (HA) -coated threaded, HA-coated cylindric, and titanium threaded endosseous dental implants

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PURPOSE: The purpose of this study was to compare the success of hydroxyapatite (HA) -coated and machined titanium (Ti) implants in a 5-year randomized, controlled clinical trial conducted at 2 centers.

MATERIALS AND METHODS: Each of 120 edentulous patients received HA-coated threaded, HA-coated cylindric, and machined Ti threaded implants in a randomized design using 5 or 6 implants. Digital radiographs allowed for yearly measurements of bone loss. Calibrated clinicians also measured mobility, Gingival Index, Plaque Index, probing depth, and recession. A Kaplan-Meier analysis was used to compare the proportion of ailing implants (defined as less than 2 mm of alveolar bone loss over 5 years) for each type of implant design. The criteria employed to assess implant outcome included the need for successful implants to lose less than 2 mm of bone support over the 5 years following placement of the prosthesis.

RESULTS: This analysis revealed that 95.2% of machined Ti threaded implants and 97.92% of HA-coated threaded implants were successful, while 99.0% of HA-coated cylindric implants experienced less than 2 mm of bone loss (P < .06).

DISCUSSION: All types of implants placed in this study had success rates above 95%.

CONCLUSION: Over 5 years, the success rate tended to favor HA-coated implants.

Publication Types: Clinical Trial, Randomized Controlled Trial

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Evaluation of hard tissue replacement composite graft material as a ridge preservation/augmentation material in conjunction with immediate hydroxyapatite-coated dental implants

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BACKGROUND: Immediate placement of dental implants (DI) in fresh extraction sockets is associated with remaining voids around the DI and often a partial dehiscence or thin facial alveolar plate. Bone replacement grafts are often used to correct these problems. This study evaluated the use of a layered composite of PMMA (poly-methyl-methacrylate), PHEMA (poly-hydroxyl-ethyl-methacrylate), and calcium hydroxide grafts (HTR) as a ridge preservation/augmentation material used in conjunction with an immediate DI placement technique.

METHODS: Twenty-three patients requiring 1 or 2 extractions that were treatment planned for immediate DI placement received 4.0 or 3.25 mm diameter hydroxyapatite-coated cylindrical implants in the extraction sockets. HTR was used to fill the remaining socket void and enhance the facial ridge width. A collagen hemostatic was placed to cover the DI sites, flaps released, and primary closure attempted with sutures. DI uncovering was performed at about 6 months. Measurements were taken to the nearest 0.5 mm of the internal socket width and total ridge width at DI placement and uncovering.

RESULTS: Thirty DIs were placed in the 23 patients. Mean initial internal socket width was 6.9 mm. The total ridge width showed a mean change from 9.1 mm to 8.4 mm; 60% of the areas showed a net increase or no change, while 40% showed a decrease in overall ridge width. DI success rate was 97% out to 6 months of loading.

CONCLUSION: The results of this study suggest that HTR is a useful adjunct in the placement of immediate DIs for filling of socket voids and preservation of ridge width.
Evaluation of the interface between bone and titanium surfaces being blasted by aluminium oxide or bioceramic particles


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The surface structure, in particular the surface roughness, and the surface chemistry of titanium implants influence their anchoring in bone. The aim of this study was to analyse metal-bone contact (MBC) after modification of the implant surface, using different materials for blasting. The surface modification of titanium was produced by blasting it with particles made of Al2O3 or bioceramics. The biological effects were then investigated experimentally using 27 rabbits, analysed after 7, 28 and 84 days after the implantation of titanium cylinders treated accordingly. The MBC showed a tendency for more bone after bioceramics were used as a blasting material, compared to Al2O3.
Effects of hydroxyapatite-coated and commercially pure titanium oral implant surfaces on compound nerve action potentials

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The aim of this study was to investigate the effects of hydroxyapatite-coated and commercially pure titanium oral implants on nerve conduction. Isolated rat sciatic nerves were placed between two suction electrodes in a bath containing a tyrode solution. The implants were brought into intimate contact with the nerves and evoked compound action potentials (cAPs) were recorded before and after contact with the implants. The commercially pure titanium implants did not cause any change in cAPs. A gradual reduction in cAPs was observed for hydroxyapatite-coated implants. However, this reduction was < 50% after an application time of 120 min. Recovery of the cAPs in this group was recorded after approximately 60 min. We conclude that, although intimate contact with hydroxyapatite-coated implants leads to a reduction in cAPs in nerves in vitro, neither this surface nor a commercially pure titanium surface leads to irreversible neurotoxic effects.

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Bone response to zirconia ceramic implants: an experimental study in rabbits

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This study analyzes the bone response to zirconia ceramic implants inserted in New Zealand white mature male rabbits. The implants were inserted into the tibia, and each rabbit received 4
implants. All the animals were euthanatized after 4 weeks. A total of 20 implants were retrieved. Implants and surrounding tissues were immediately fixed in 4% paraformaldehyde and 0.1% glutaraldehyde in 0.15 molar cacodylate buffer at 4 degrees C and pH 7.4 to be processed for histology. The specimens were processed to obtain thin ground sections with the Precise 1 Automated System. The slides were observed in normal transmitted light under a Leitz Laborlux microscope. A great quantity of newly formed bone was observed in close contact with zirconia ceramic surfaces; in some areas, many osteoblasts were present directly on the zirconia. Percentage of bone-implant contact was 68.4% +/- 2.4%. Mature bone, with few marrow spaces, was present. Small actively secreting osteoblasts were present in the most coronal and apical portions of the implant. No inflamed or multinucleated cells were present. This study concluded that these implants are highly biocompatible and osteoconductive.

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The experimental study on nano-HA-ZrO2 ceramic as dental implant materials

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Objectives: It is not found that any HAp compound ceramic product has been widely used as dental implant all over the world. A combination of materials properties is thus expected to give a bioactive hydroxyapatite-containing implant material with improved mechanical properties in this study. Methods: Applying a novel consolidation technique-SPS (Spark plasma sintering), we obtained nano-HAp-ZrO2 ceramic (with two constitutions 4:6 and 5:5). The cubage density, the ratio of pores was determined. To evaluate its mechanical properties, its flexural strength, fracture toughness and hardness was also measured. In order to evaluate the preliminary biological properties of nano-HAp-ZrO2 ceramic, two tests were taken up according to ISO standards including in vitro cytotoxicity test and acute hemolysis test. Animal implanting test has been done to put ceramics in the hole of the rabbit femur orderly. The Ti based with HAp coating implants was used as positive control group. During the 1 month, 3month, 6month the implant parts were taken X-ray photos separately, and were made hard tissue undecalcified sections in
each group, by Von Gieson staining. The biological properties of two ceramics were compared and evaluated. Results: 1, The HAp-ZrO2 ceramic did not contain any phases other than hydroxyapatite and the tetragonal modification of zirconia. It is fully densified thus free of pores. 2, There were no obvious statistic differences between cubage density and theoretic density of each group. 3, The toxicity grades of all groups were 0 or 1. 4, Histomorphometric comparison were made the sequence of the extent of material-bone combination: Ti-HAp group > (5:5) group > (4:6) group. Conclusions: Dense nano-hydroxyapatite-zirconia ceramic showed better mechanical properties than pure hydroxyapatite, no cytotoxicity, and good combination with bone tissue around implant area. The larger amount of composition of HAP is contained, the better biocompatibility of compound ceramic is, but with the lower mechanical properties.

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**Dental implant materials. II. Preparative procedures and surface spectroscopic studies**

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The tissue response to an implant may involve both physical and chemical factors. There is little reliable information on the effects of these parameters and the associated ionic release on the cell-material interaction because the majority of studies have not fully characterized the implant material. In this work surface spectroscopy using ISS, ESCA, and SIMS was carried out on Ti6A14V, Co-Cr-Mo, A12O3, and hydroxyapatite dental implant materials that had been subjected to six commonly used preparative procedures. The results showed that each procedure generated an individualistic composition for the outermost surface of each material. These differences could be significant in cellular and tissue response. Improved understanding of these factors requires defined and reproducible surfaces.