Effects of Hydroxyapatite-Coating vs. Hydrophilic Surface on Early Healing of Dental Implant in an Ovine Model

Jin Whan Lee, Hai Bo Wen, Jeffrey Bassett
Zimmer Dental Inc., 1900 Aston Avenue, Carlsbad, CA 92008, USA

Statement of Purpose: A pressurized, hydrothermal, post-plasma-sprayed hydroxyapatite (HA) coating has been used to enhance the biocompatibility and integration of dental implants. HA-coated implants healed more rapidly with a greater percentage of bone-to-implant contact (%BIC) than those of sand blasted with alumina and acid etched[1]. Other documented benefits of HA coating in comparison to uncoated implant surfaces included significantly higher survival rates[2]. Roughened surfaces can also achieve faster bone integration, as well as a higher %BIC and greater removal torque values (RTV) than machined surfaces[3]. One such surface is fabricated by sequentially sandblasting the surface with large grit, acid-etching the roughened surface, treatment with nitrogen gas, and final storage in a saline solution (cmSLA). However, evaluations seldom have been performed between cmSLA and other surfaces, such as HA. The objective of the study was to compare the bone tissue response and stability of implants with two different surfaces, cmSLA and HA coating during the early stages of wound healing in an ovine femoral condyle model.

Methods: Surgical Procedure: A total of 60 implants (4.1 mm x 10 mm) with MP1® HA-coated surface (Tapered Screw-Vent® implant with MP-1® HA surface, Zimmer) (n=30) and chemically modified, sand blasted and acid-etched surface (SLActive® surface, Bone Level Implant, Straumann) (n=30) was randomly placed bilaterally in the femoral condyles of ovine(6 implants per ovine). Implant stability Assessment: Implant stability quotients (ISQ) using resonance frequency analysis (Osstell® Mentor, Integration Diagnostics AB, Göteborg, Sweden) and mechanical torque device (Sturtevant Richmont, Carol Stream, IL) connected to data acquisition (MESURgauge, version 1.5, Mark-10, Copiague, NY) were measured at implant placement (as a baseline), 3 and 6 weeks of healing. Histologic and histomorphometric evaluation: After being dissected, specimen blocks were fixed in 10% formalin, dehydrated in ascending solutions of EtOH, infiltrated, and embedded in PMMA for undecalcified sectioning. Sections were cut (Makro Trennsystem; Exakt Apparatebau AG, Norderstedt, Germany), ground, and polished. The sections (≅50µm) were stained with toluidine blue and basic fuchsin, and examined using light microscopy (Olympus BH-2, Olympus Optical Company, Japan) to analyze %BIC. Statistical analysis: TheSatterthwaite method was used to compute the DF for F test and p values, followed by the Tukey post-hoc test.

Results: There were no implant failures and all samples harvested at 3 and 6 weeks exhibited no adverse tissue responses. The difference in ISQ (n=15) values between 0 and 3 weeks was -0.5±6.6 for HA and 3.0±4.0 for cmSLA (p=0.3251). The difference in ISQ (n=15) values between 0 and 6 weeks was 2.7±7.1 for HA and 5.2±5.9 for cmSLA (p=0.8409). No significant treatment effect (P>0.05) was found from the ISQ measurement. Greater RTV (n=9) was found for implant with HA-coated surface as compared with cmSLA surface (p<0.01 at 3 or 6 weeks, respectively) (Figure 1). The torque values for HA were 39% and 21% higher than for cmSLA at 3 and 6 weeks, respectively.

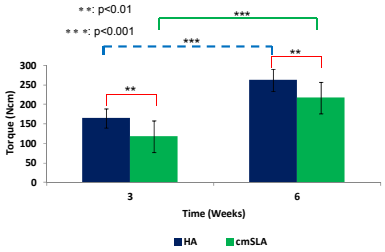

Figure 1. Comparison of RTV

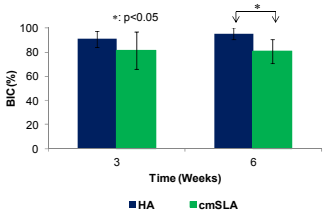

Figure 2.Comparison of %BIC

HA and cmSLA showed similar histological features. At 3 weeks, a thin layer of newly mineralized bone formation, predominately in a woven bone state, was apposed to the implant surface in both implants. At 6 weeks, the newly formed trabecular bone appeared thicker and bone density had increased owing to the apposition of new bone. Histomorphometric data (n=6) showed that HA exhibited a greater %BIC than cmSLA surface at 6 weeks (p<0.05) (Figure 2). The present study noted no correlation between ISQ and RTV. However, the consistency between RTV and histologic evaluation was found, similarly seen in previous reports for HA or roughened surface[4-5]. Furthermore, as compared to cmSLA, higher RTV and %BIC of HA was corroborated by a rabbit tibia model[6] using backscattering scanning electron microscopy and energy dispersive x-ray microanalysis. These findings implied that the better results obtained with HA were not only due to the roughened surface, but also to its structural and chemical similarity to the mineral content of natural hard tissues in the body.

Conclusions: A higher level of implant stability as demonstrated by RTV and bone apposition was achieved with an HA coated surface than a cmSLA surface during the early stage of healing for up to 6 weeks.

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