Academy of Osseointegration

21st Annual Meeting

Technological Breakthrough in Implant Dentistry

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ABI Prism 7700 Sequence Detection System and primers for each EP receptor. Relative expression versus 18S rRNA housekeeping gene was determined by the Pfaffl method. Experiments were performed twice and differences determined by ANOVA and post-hoc testing.
Results: EP1 was not expressed on the surfaces. EP2 expression was enhanced on both smooth (1.8-fold) and rough (1.4-fold) Ti, compared with plastic. In contrast, EP3 expression was only increased on rough Ti (2-fold), while EP4 expression was only increased on smooth Ti (1.7-fold). The effect of PGE_2 on receptor expression was dose- and surface-dependent. On plastic, PGE_2 dose-dependently increased EP2 expression by 2.5-fold over untreated control, while there was a 6-fold increase in EP3 expression, and no effect on EP4 expression. On smooth cpTi, 1 nM PGE_2 increased EP2 expression by 3-fold, EP3 expression by 15-fold, and EP4 expression by 1.7-fold. Higher prostanoid levels had variable effects. On rough cpTi, EP2 expression was increased by up to 2-fold with 10 and 100 nM PGE_2, EP3 expression was increased by 2-fold with 1 nM PGE_2 and 4-fold with 10 nM PGE_2 treatment, and EP4 expression was increased 1.6-fold with 1 nM PGE_2 but none of the other PGE_2 treatments.
Conclusion: EP2, EP3, and EP4 receptor expression was significantly affected by changes in PGE_2 in the media, and by the roughness of the titanium. It is known that EP2 and EP4 cause increases in cAMP, while EP3 decreases cAMP. Because cAMP serves as an intracellular second messenger, it becomes clear that the effect of PGE_2 on EP receptors plays a role in the inflammatory response and dental implant healing.

OS-05

In Vivo Bone Regeneration with Calcium Sulfate/PLLA Composites

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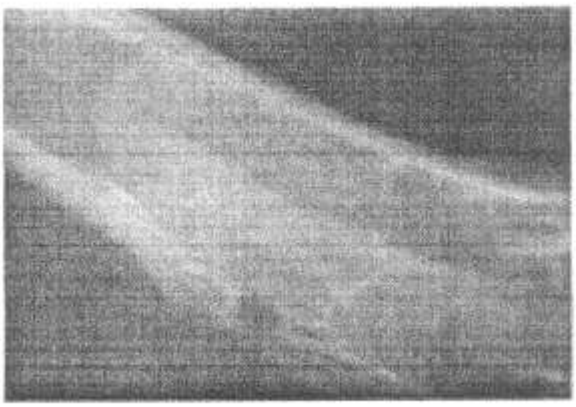
Introduction: Calcium sulfate (CS) is completely biodegradable, biocompatible, and osteoconductive. It also acts as a hemostat and a guided tissue regeneration membrane and has been shown to be angiogenic. However, it undergoes rapid degradation and in some cases, completely degrades before bone has grown into the defect area. Hence, we developed composites of CS and poly L (lactic acid) (PLLA) to time tailor the degradation rates. In vitro studies have shown that CS/PLLA composites undergo slower degradation than pure CS; the rate of degradation decreasing as the percentage of PLLA in the composite increases. This work presents the in vivo response to these composites.
Methods: 26 New Zealand white rabbits were used in this study. The animals were sacrificed at 4, 8, and 16 weeks. CS/PLLA composites with varying ratios of CS:PLLA (96:4, 93:7 and 87:13) were developed. The 7% and 13% materials are CS pellets coated with polymer. The 4% material is a co-precipitated composite. Defects were created in the tibial intramedullary canals and were packed with composite materials. Sections of the implanted bones were removed and imaged with a Faxitron x-ray system. The sections were further characterized by scanning electron microscopy, X-ray microprobe analysis and histological evaluation.
Results: CS/PLLA composite pellets underwent slower degradation in vivo than pure CS pellets utilized in previous studies. At 4 weeks, all of the composite materials demonstrated minimal to no degradation on x-ray. By 16 weeks, the co-precipitated composites with low PLLA fraction (96:4) underwent major degradation. A large volume of new bone formed in the defects.



Coated composites with low PLLA fractions (93:7) were completely degraded by 16 weeks with weak formation of new bone. Coated composites with high PLLA fractions (87:13) underwent only minimum degradation after 16 weeks. In general, it could be seen that composites with low PLLA fraction underwent faster degradation compared to those with high PLLA fraction. However, the co-precipitated composites produced a higher volume of new bone than did the coated composites. Histological evaluation demonstrated no adverse reaction to any of the composites.
Conclusion: CS/PLLA composites undergo slower degradation in vivo as compared to pure CS. No adverse reaction is observed to any of these composites in vivo. Bone formation is optimized in the defects filled with the co-precipitated composite.

OS-06

Biomechanical and Histometric Studies of Nanothick Bioceramic Coated Implants. A Study in Beagles

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Introduction: It is now accepted that nanotechnology may strongly influence the host response to biomaterials through various mechanisms. The purpose of this study was to investigate the bone response to nanothick coated implants (IBAD I and II method) versus a control group (alumina blasted and acid etched surface) in a beagle model.
Methods: Following coating characterization by SEM, EDS, XPS, XPS/ Ion-Milling (depth profiling), and Thin-Film X-ray Diffraction (TFXRD), where IBAD I and II were found to be of Ca and P elemental composition, 20-30nm (IBAD I) and 200-300nm thickness (IBAD II), and of amorphous crystallographic structure, 60 implants were placed in the proximal tibiae (5 per limb) of 6 beagle dogs. The balanced implant per location protocol yielded implants that remained for 3 and 5 weeks in-vivo. Following euthanization, the implants were torqued to failure in a universal testing machine. The implants were then reduced to nondecalcified thin sections, and the percent bone contact to the implant surface was determined for each group. Torque and percent bone contact to the implant surface (dependent variables) were subjected to analyses of variance at 95% level of significance with time in-vivo and surface type as independent variables.
Results: ANOVA showed a significant effect ($P<0.02$) of implant surface and no effect of time in-vivo in torque values. The torque values obtained in N.cm were 50.21 ± 13.19^a (C), 58.96 ± 12.49^a (IBAD I), and 79.63 ± 14.96^b (IBAD II). ANOVA did not show significant effects of the independent variables in percent bone contact to implant surface values. The percent bone contact to the implant surface values were 62.84 ± 9.6^a (C), 69.37 ± 9.95^a (IBAD I), and 71.39 ± 10.6^a (IBAD II).
Conclusion: According to the results obtained in this study, it was observed a thickness dependent increase in the biological response to nanothick Ca- and P-based coatings. The IBAD II implants presented significantly higher torque values compared to other groups despite the fact that no significant difference was found in percent bone contact to implant surface, indicating higher bone mechanical properties around IBAD II implants.

OS-07

Osseointegration Study of Ti-13Nb-13Zr Processed Via Powder Metallurgy with Different Porosity Degrees

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Introduction: Metallic porous implants has been extensively researched in the biomaterials field, since porous structures allow for bone ingrowth to biomaterials, providing mechanical stability. The aim of this work was to evaluate the osseointegration of Ti-13Nb-13Zr implants with different porosity degrees processed via powder metallurgy (P/M).
Methods: Cylindrical samples were produced by mixing metallic powders hydrides Ti-13Nb-13Zr (wt.%), uniaxially/cold isostatically pressing the powders, and sintering at 1000°C/5h, 1300°C/3h, and 1500°C/2h. The sintered samples were evaluated for density, crystalline phases (XRD) and microstructure (SEM/EDS). The implants were then surgically placed in rabbit tibias for a 8-week healing period. During postoperative periods, the animals received doses of fluorochrome labels (i.e., tetracycline, alizarin, and calcein green) at different times. The implants were retrieved and evaluated by SEM, EDS, and optical microscopy- histomorphometry evaluated (BIC, bioactivity, and mineral apposition rate).

Results: Scanning electron micrographs of the sintered samples indicated the presence of α and β-phases with the Widmastätten microstructure formation. However, on samples sintered at 1000 °C, sites with non-reacted Nb particles were observed. The (α +β) Ti-13Nb-13Zr alloy formation was confirmed by XRD. Samples sintered at 1300 °C and 1500 °C showed low porosity degrees around 10%. In contrast, samples sintered at 1000 °C revealed the highest porosity level at approximately 30%, presenting open and interconnected pores measuring around 50-100 µm. Regardless of sintering condition, the samples presented a significant BIC. Bioactivity analysis close to the interface (0 to 0.5 mm from implant surface) revealed bone modeling activity, not statistically different (P > 0.34) between the groups. The mean apposition rate (MAR) at control sites (> 2.0 mm from the implant surface) was quantitatively lower when compared to the MAR close to the implant surface. Bone ingrowth occurrence for samples sintered at 1000 °C was evidenced by SEM and verified by EDS. In addition, it was also observed that newly formed bone was able to adapt into the pores geometry.

Conclusion: From a biocompatibility standpoint, the results of this research demonstrate that P/M is an attractive process to obtain porous materials based on non-toxic elements for surgical implant applications.

OS-08

The Effect of Periosteal Cell on the Process of beta-Tricalcium Phosphate (TCP) Bone Formation

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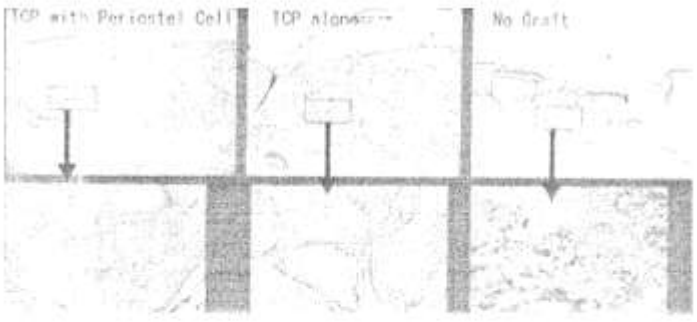
Introduction: Beta-TCP has the ability to facilitate bone induction and periosteal cells also have strong osteogenic potential in vivo and in vitro. In this study, we examined whether the osteoinductive potential of beta-TCP is enhanced by combination with periosteal cells in the rat calvarial defect model.

Methods: Artificial bone defects were created in rat calvaria (n=30) and the rats were divided into 3 groups (n=10 in each groups): beta-TCP with periosteum graft , beta-TCP graft alone, and no graft. The process of bone formation was evaluated histologically and by three-dimensional radiography at 15, 35, and 60 days post grafting.

Results: Significant differences in bone formation in the defect were observed within all 3 groups throughout the experimental period, with the most notable difference at 60 days post grafting. Histologically, beta-TCP with periosteum graft induced significantly greater amounts of bone formation ($p<0.01$) compared to the other groups, with the beta-TCP granules replaced by new bone induced from periosteal cells. The defect was totally filled with new bone. With the beta-TCP graft alone, some limited bone formation occurred around the beta-TCP granules. With no graft, no new bone was observed in the defect. Three-dimensional radiography revealed significantly more new bone formation with the beta-TCP with periosteum graft compared to the other groups.

Conclusion: These findings suggest that the supplementation of beta-TCP grafting with periosteal cells can be advantageous for bone formation of in calvarial bone defects.



OS-09

Stem Cells Derived from Periodontal Ligament Colonized Three-Dimensional Scaffolds and Produced Bone Nodules

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Introduction: Recent studies have shown that mesenchymal stem cells (MSCs) obtained from periodontal ligament are totipotent cells that could have similar features of the bone marrow mesenchymal cells. These cells are capable of proliferating and producing different types of tissue such as bone and tooth associated-tissues and can be used in associations with biomaterials for tissue engineering approach for bone regeneration and repair.

Methods: Human mesenchymal stem cells derived from periodontal ligament were expanded ex vivo under specific conditions and seeded in three-dimensional biocompatible scaffolds in six-well tissue culture, for 4 weeks. The scaffolds were periodically checked under a light microscope and finally analysed by scanning electron microscope (SEM) for monitoring cell growth and production of bone nodules.

Results: Our results displayed cells with morphological features similar to osteogenic cells with characteristic cytoplasmic extensions that produced spots of dark brown coloration recognized as bone nodules. The differentiated osteoprogenitors also express specific markers, such as alkaline phosphatase (ALP). Scanning electron microscopy observations showed extensive growth of cellular biomass partially covering the scaffold after 4 weeks of incubation in mineralization medium as compared to the control-unseeded scaffold. These findings indicated that periodontal ligament can be an efficient source of stem cells with capacity to differentiate in osteogenic cells producing bone nodules that can colonize and grow when seeded into three-dimensional biocompatible scaffolds.

Conclusion: It can be suggested that the use of MSCs derived from periodontal ligament for generating grafting biomaterials is advantageous for bone tissue engineering in regenerative dentistry.

OS-10

FEM Analysis on Deformation and Stress Distribution in Fixed Metal-Reinforced Provisional Restorations of Immediately Loaded Implants in the Edentulous Mandible

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Introduction: Rigid splinting for the temporization of multiple immediately loaded implants seems to have a significant impact on the peri-implant tissue response, since it is able to reduce the risk of micro-movements below a critical threshold. The objective of the present study was to evaluate the biomechanical effect of bite forces and mandibular functional flexure on stress build-up in implant-supported, fixed provisional restorations by finite element analysis.

Methods: 3-dimensional FEM mandible models of an implant-supported, cross-arch provisional restoration on four cylindrical, threaded implants (XiVE, DENTSPLY Friadent, Germany) with, and without titanium-bar-reinforcement was analyzed and compared. Two implants were placed in each quadrant of the mandible in the center of the mandibular crest, within the region of the canine and second premolar. Both prosthetic superstructures were conceived as fixed, acrylic resin, symmetrical bridges with a section of 7 by 9 mm. One model was reinforced by a metal framework, fabricated of temporary titanium implant abutments, welded to a titanium bar of 2 mm in diameter. FEM was carried out comparing van-der-Mises and maximum stresses levels obtained from the calculation, using average external loads of 300 N in the anterior-, and 900 N in the posterior region.

Results: The titanium-framework reinforced provisional restorations exhibited a reduction of maximum von-Mises-strain values of 400 to 500 ‰. With regards to the relationship between stress distribution and implant location along the mandibular arch, maximum stress values were located at the level of the most distal implants.

Conclusion: In comparison to mere acrylic superstructures, a significant reduction of deformation and strain within titanium-bar reinforced acrylic provisional restorations could be detected, allowing an adequate fixation and