

Clinical and Histological Evaluations of Tantalum Porous Dental Implants in a Canine Model

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Statement of Purpose: Successfully integrated dental implants are often challenged by the formation of pathogenic microflora around the neck of the implant, which can result in irreversible inflammatory processes in the adjacent soft and hard tissues.¹ Recently, tantalum (Ta) porous implants demonstrated stability and osseointegration during early healing,² but no direct comparison has been conducted with non-porous implants subjected to periimplantitis. The objective of this study was to evaluate the performance of Ta porous and conventional threaded implants in a canine model.

Methods: Surgical procedure: Two premolars and 2 molars in mandibular sockets were extracted bilaterally in 10 canines. Forty porous test implants (Trabecular Metal™ Dental Implants, Zimmer) and 40 threaded control implants (Tapered Screw-Vent® implants, Zimmer) were immediately placed after extractions (8 implants per canine). All implants used were 4.1mm wide by 13mm long. Twelve weeks post implantation, periimplantitis was induced by placing ligatures in the periimplantitis group (2 canines per group). **Histologic process:** Implants were retrieved *en bloc* after 2, 4, 12, 24 and 38 weeks. Specimen blocks were fixed in 10% formalin, dehydrated in ethanol, infiltrated, and embedded in PMMA for undecalcified sectioning. Sections were cut, ground (≈50 μm thick), polished, and stained with Sanderson and Van Gieson. The stained slides were examined using a microscopy (Olympus BH-2, Olympus Optical Co., Tokyo, Japan). **Crestal bone level measurement:** histologic slides were used to quantify the crestal bone level from the buccal and lingual aspects. Vertical distances from the implant shoulder to (1) the most coronal point of the crestal bone (IS-B), and (2) the most coronal aspect of osseointegration (IS-C) were measured. **Histomorphometric analyses:** To measure the amount of new bone, the region of interest was defined as the area encompassing the entire length of porous section (6mm long × 0.35mm deep) in the test implant and the corresponding threaded section in the control implant. **Histopathologic analysis:** Parameters examined included acute and chronic inflammation, fibrosis, bacterial infection, and soft tissue in contact with the implant. **Data analysis:** Paired t-test was used for crestal bone level, and ANOVA and Tukey post-hoc were for histomorphometric and histopathologic data ($\alpha = 0.05$).

Results: All implants were osseointegrated histologically and survived clinically. Thirty two implants revealed signs of periimplant lesions due to the placement of cotton ligatures. Higher crestal bone level was noted at lingual than at buccal site in both IS-B ($p < 0.05$ each time points except week 2 and 38) and IS-C aspects ($p < 0.05$ each time points except week 2). Also, higher crestal bone level was seen in the test than in the control group in both aspects, but was not statistically significant ($p > 0.05$). The bone levels measured at 24 and 38 weeks were as follows: Peri-control (IS-B: 3.382 and 6.128 mm, IS-C: 3.008 and

5.576 mm) ($p < 0.05$) and Peri-test (IS-B: 3.031 and 6.206 mm, IS-C: 2.769 and 5.212 mm) ($p < 0.05$). But, the Peri-control and Peri-test was not different at each time points ($p > 0.05$). This finding suggested that both implants underwent a similar response over the induction of periimplantitis due to progression of plaque formation. Also, the crestal bone level evaluation in the current study was consistent with findings of data in the spontaneous progression of canine periimplantitis model.³⁻⁴

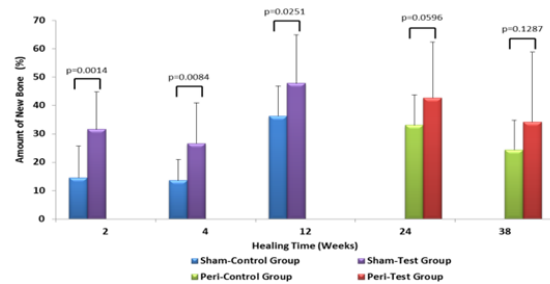


Figure 1. Histomorphometric new bone area (%)

Histologically, new bone formed at week 2 was substituted with the primary trabeculae of woven bone during the subsequent weeks, and eventually replaced with more mature bone tissue with parallel fibers and marrow, particularly evident at week 38. The amount of new bone formed in the test group was higher than that in the control group over 12 weeks of normal healing ($p < 0.05$) (Figure 1). Peri-test group had a higher mean value of new bone area than the Peri-control group at 24 and 38 weeks with no statistical difference ($p > 0.05$). A more pronounced severity of the periimplantitis was indicated at 38 weeks. The newly formed bone in the test group at 2 and 4 weeks was approximately twice that of the control group, indicating greater bone formation with Ta porous implant at early healing. It was postulated that the Ta-based porous implant may allow active osteogenic and angiogenic cells to migrate deep into the inner pores, possibly leading to more bone growth than non-porous implant. These histomorphometric observations were well correlated with crestal bone level data. Histopathological analysis showed minimal to mild incidence of acute and chronic inflammation but did not reveal any evidence of bacterial infection within peri-implant tissues or inside TM pores in any of the groups tested.

Conclusions: The Ta porous dental implant demonstrated better crestal bone preservation and greater bone formation in either normal healing or periimplantitis environment, and had an equivalent response when subjected to bacterial infection.

References: (1) Singh P. J Oral Implantol 2011;37:622-626. (2) Kim DG et al. Implant Dent 2013;22:399-405. (3) Albouy JP. Clin Oral Implants Res 2008;19:997-1002. (4) Albouy JP, Clin Oral Implants Res 2009;20:366-371.