

# Inter-pore New Bone Formation on Trabecular Metal™ Implants

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## Introduction

Trabecular Metal™ (TM) Implants incorporate a porous tantalum core to the midsection of threaded implants. This highly porous structure (up to 80% of porosity and 430 μm of mean pore size) enhances bone anchorage to the implant through “osseoincorporation” (i.e. bone ingrowth within the pores) whereas conventional threaded implants achieve bone anchorage only through “osseointegration” (i.e. bone bonding to and bone apposition growth with the implant surface features). In a pilot canine study, TM implants exhibited mineralized de-novo bone formation inside the porous tantalum core.<sup>1</sup> The current study evaluates such de-novo bone formation both histologically and histomorphometrically in fresh extraction sockets of canine dogs. Conventional, threaded implants were also investigated for comparison.

## Materials and Methods

A total of 64 implants (4.1mm D × 13mm L) were placed bilaterally in the premolar and molar fresh extraction sockets of 8 canines. Two groups of implants were used in this study (n=32 per group): 1) Trabecular Metal™ Implants (test group), 2) Tapered Screw-Vent® Implants (control group). To monitor calcium deposition over time, calcein was administered twice on days 4 and 11 before euthanasia at 2, 4, 8 and 12 weeks post-implantation period. Histological slides were prepared in the bucco-lingual plane from the central part of the harvested blocks. Histomorphometrical analysis was conducted at the region of interest (ROI) encompassing the entire length of the porous section (6 mm long × 0.35 mm deep) in the test group and the corresponding threaded region in the control group (Fig 1). Statistical analysis of data was conducted using General Linear Model (GLM) ANOVA and *paired t test*.

## Results and Discussion

At 2 weeks, immature woven bone formation was observed in both the porous and threaded regions of the implants. During subsequent weeks, increased amount of de-novo bone was seen in both groups. At 12 weeks, both woven bone and dense lamellar bone were observed inside the pores and within the threads (Fig A1,2). Fluorescence images identified new bone deposition at the interface and external perimeter of the implant as early as 2 weeks, which became more evident over subsequent healing periods for both groups. Stronger fluorescence intensity collected at the bone-implant interface in the test group compared to the control group was indicative of more mineralized bone (Fig B1,2). Histomorphometrical analysis revealed a significantly greater amount of newly formed bone in the test group as compared to the control group at all healing periods (paired t test) (Fig 2A).

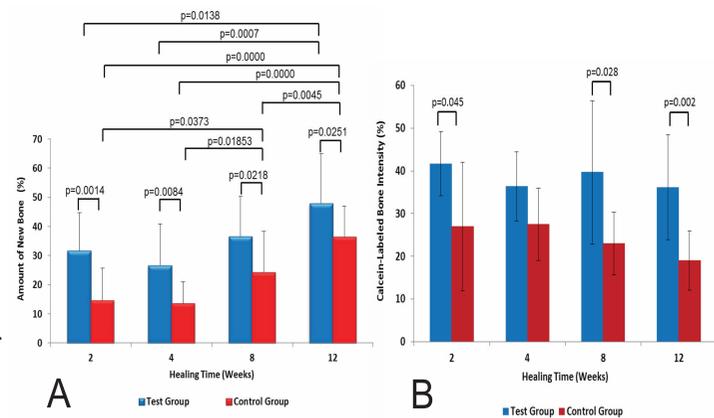


Fig 2: Histomorphometric data analysis showing (A) the amount of new bone measured; and (B) the intensity of fluorescence signal collected; in ROI of test and control groups over the healing period of 12 weeks (n=8).

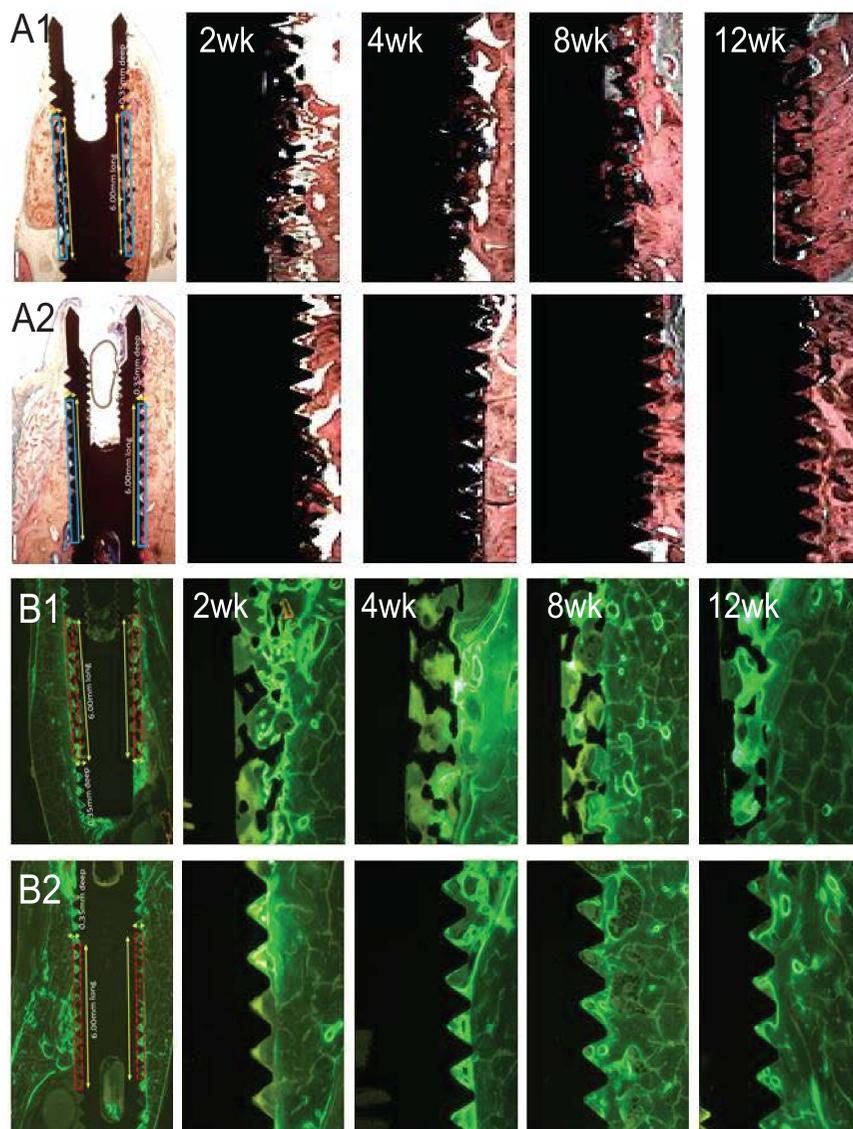


Fig 1: Representative light (Sanderson and van Gieson staining) (A1, A2) and fluorescence (calcein-green labeling) (B1, B2) microscopy images from test (A1, B1) and control (A2, B2) groups.

The amount of de-novo bone increased over time in both test and control groups. At each time point the test group demonstrated a significantly greater amount of bone (ANOVA) (Fig 2A). For the control group, a significant difference was observed at 12 weeks compared to 2, 4, and 8 weeks. For the test group, a significant difference was observed at 12 weeks compared to 2 and 4 weeks (but not 8). This suggests a slower bone formation in the control compared to the test group, as de-novo bone formation seems to have reached a plateau at 8 to 12 weeks in the test group, but still increased in the control group.

Histomorphometrical analysis of calcein-labeled slides revealed significantly higher intensity of fluorescence signal from the de-novo bone in the test group compared to the control group at all healing periods, except 4 weeks (paired t test) (Fig 2B). However, no significant differences in the signal intensity was observed for either groups over time (ANOVA). This means the degree of bone mineralization remained the same over time, however, a more mineralized bone was formed within the pores of the test group compared to the threads of the control group.

## Conclusion

Histomorphometric assessment of de-novo bone formation at the bone-implant interface in canine fresh extraction sockets demonstrated a greater amount of new bone with an increased degree of mineralization inside the porous region of TM Implant as compared to the thread region of the TSV® Implant.

1. Kim D-G, Huja SS, Tee BC, Larsen PE, Kennedy KS, Chien H-H, Lee JW, Wen HB, Bone Ingrowth and Initial Stability of Titanium and Porous Tantalum Implants: A Pilot Canine Study, *Implant Dentistry*, 2013;22(4):399-405.

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