

Title: Evaluation of a Novel Bone Adhesive for Maintenance of Crestal Bone Around Implants in Canine Oversized Osteotomies

Purpose of the research: Tetranite (tetra calcium phosphate and O- phospho-L-serine) is an osteoconductive, biodegradable bone-adherent material. It is injectable and bonds to high surface energy substances, including living bone and metals such as titanium even in a wet environment. The adhesion to bone created by Tetranite is capable of bearing functional loads. It is postulated that the resorption rate of the Tetranite is slow enough, and the rate of deposition of new bone is fast enough to allow for continuous mechanical linkage between the native bone and the stabilized implant and that bone can replace the Tetranite without a significant change in alveolar structure. The purpose of the current study is to evaluate the maintenance of crestal bone/material level (no change in osseous crest) adjacent to the Tetranite by standardized radiographs.

Methods and Materials: This was a randomized, controlled, three arm, prospective study. The test material, Tetranite used in this study consisted of 61.5% tetra calcium phosphate and 38.5% phosphoserine mixed with water which was provided by the manufacture (LaunchPad Medical). One arm received commercially available bovine bone graft (Bio-Oss, Geistlich) and another arm served as a negative control and received no bone biomaterial along with implant placement (blood clot only). Twenty-six healthy mixed breed hound dogs were included in this study. Those animals were randomly assigned to 1 day, 10 day, 3-week, 4-month, 9-month, and 12-month cohort groups depending upon the timing of sacrifice after implant placement. Prior to implant placement, extraction of the mandibular second, third, and fourth premolars and first molar was performed bilaterally. The surgical sites were allowed to heal for at least 12 weeks. Three implants were placed on either side of the mandible with Tetranite (test material), bovine bone graft, or no biomaterial (negative control). Periapical radiographs (PAs) were taken immediately after implant placement and at every month until necropsy was performed. For all canines, attempts were made to standardize the PAs by utilizing custom made radiographic stents. Those PAs were assigned a random number allowing a blinded evaluation in regards to the time point and the material used for each specific surgical site. Digital medical imaging software (MiPACS Dental

Enterprise Viewer, Medcore Imaging) was used to analyze each PA. The vertical distance between implant platform to the first radiopaque material on both the mesial and distal surfaces were measured. All the measurements were calibrated based on the actual implant length provided by the manufacturer. Crestal bone/material level changes over 12 months were analyzed.

Results: There were no statistically significant differences found between test and bovine bone graft in terms of maintenance of crestal bone levels at any given timepoint. Additionally, both test and bovine bone graft showed statistically significantly better crestal bone level maintenance compared to negative control at any given timepoint except for at 20, 24 and 32 weeks.

Discussion: Previous in vitro studies showed that Tetranite placed in a 90 °C water bath for 7 days (equivalent to 1 year in 37 °C water bath) lost 20% its mass. It can be speculated that the radiopacity would decrease as Tetranite is dissolved over a year of the study period if there is no bone formation and replacement. The current study demonstrated continuous radiopacity around the implant stabilized with Tetranite and suggests that Tetranite is replaced by native bone as it is dissolved and that the crestal bone level is maintained. Moreover, histological analysis of the same cohort in this study confirmed that new bone formation penetrated into the Tetranite and along the implant surface. Although there is no statistically significant difference in terms of maintenance of crestal bone levels between Tetranite and bovine bone graft, bovine bone graft itself is a radiopaque material.

Conclusion: This study demonstrated that Tetranite maintained crestal bone levels and had a similar ability to maintain that level over one year compared to a bovine bone graft. Furthermore, this bone level was significantly greater than the reduced level found without a biomaterial. The similarity to this bone graft is very significant due to the biological mechanisms involved since bovine bone graft is inert and did not substantially turn over while Tetranite is resorbed and replaced with new bone. The continuous radiopacity observed in implant sites with Tetranite throughout the study period shows that resorption of the Tetranite and replacement with new bone occurs simultaneously and maintains the crestal bone level for up to one year.