Trabecular Bone Modeling and RAP Following Selective Alveolar Decortication

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Introduction

Selective alveolar decortication, when combined with orthodontic treatment, results in rapid resolution of malocclusion (Internat J Perio Restor Dent, 21:9-19, 2001). Decrowding and orthodontic finishing has been shown to be 3 to 4 times more rapid (Wilcko WM, et al. World J Ortho 4:197-205, 2003) than traditional orthodontic treatment alone

(after: Wilcko WM, et al: World J Ortho 4:197-205, 2003)

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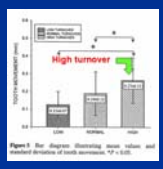
Selective decortication means an incision made into cortical bone. This minor out-patient surgery is done a few days after orthodontic appliances have been placed. The surgical incisions barely penetrate cortical bone and initiate a regional acceleratory phenomena (Frost HA, Orthop Clin of N Amer 12:725, 1981) and an increase in catabolic and anabolic bone turnover.

Bogoch (J Orthop Res 11:285-291, 1993) demonstrated a dramatic increase in apposition and resorption of rabbit tibia spongiosa adjacent to decortication cuts with 5X bone turnover and diminished bone density. However, little is known about the effect of decortication on alveolar bone spongiosa.
Verna (EJO 22:343, 2000) showed a significant increase in tooth movement rate when increased bone turnover was induced in rats.



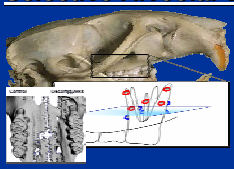
Objectives

The overall objective was to describe the alveolar response to decortication as a function of time and proximity to the injury site. Specifically, differences in catabolic and anabolic activities between control vs experimental arches were compared for: 1) trabecular bone, 2) PDL, and 3) 1st vs 3rd molars.

Methods & Materials

Selective Alveolar Decortication

The sample consisted of 21 CRL-CD male rats with a body weight of 400-450 grams. Under general anesthesia, maxillary buccal and lingual full thickness periosteal flaps were elevated adjacent to the upper left first molar and the selective decortication was performed with 5 palatal and 5 buccal bur marks (0.2mm) under sterile irrigation. The flaps were then repositioned with 6-0 sutures.



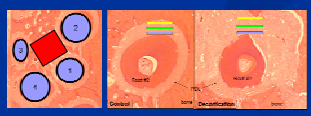
Tissue Preparation

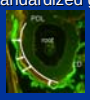
The animals were sacrificed in groups of three at 3, 7, and 11 weeks, and maxillas were removed, stripped, and prepared for decalified histology using TRAP or H&E stains. Bone modeling dynamics was histomorphometrically examined for osteoclast and/or precursor count (OC) within the geometric center defined by the 4 most distal 1st molar roots, the 2 mesial roots of the 3rd molar, and within the 1st molar PDL.

Data of Interest

Bone & PDL Surface - Transverse sections of 1st molars areas were analyzed using a standardized grid (15 mm²) and Olympus Micro Suite FIVE analysis software at 2.5 magnification.

Bone & PDL Osteoclast Count - Bone osteoclasts and/or precursors were counted in 1st & 3rd molar areas using a standardized grid (.07 mm²). Within each PDL region (M-D-B-L), three 0.02 mm² grids were used.





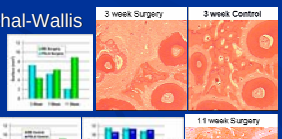
Lamina Dura Bone Apposition
Fluorescent staining of new bone formation:
1) total 3-week apposition width =
2) apposition length as percent of overall root perimeter =

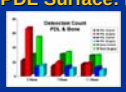
Results

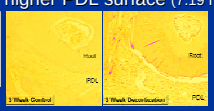
3 Week Surgery Group was significantly different (p<.05) according to Oneway ANOVA and Krushal-Wallis testing for the following study variables:

Bone Surface: less bone surface (4.40 mm²) than all other groups (7.35 to 9.04 mm²) except 7 week surgery (6.16 mm²).

PDL Surface: higher PDL surface (7.19 mm²) than all other groups (2.06 to 5.30 mm²)





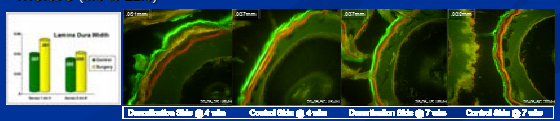


Bone OC: higher OC (56.9) than all other groups (28.1 to 30.1) except 7 week surgery (33.3)

PDL OC: higher OC (66.3) than control (22.5), other 1st molar groups (14.5 to 19.5) & 3rd molars (8.5 to 22.5)

LD Apposition Width: greater after 1st series @ 4 weeks (.051) than control (.037) and 2nd series @ 7 weeks (.032 and .038)

LD Apposition Length: no differences observed as a percentage of first molar root perimeters



Conclusion

Catabolic activities increased in osteoclast count about 2X in the medullary space and over 3X in PDL; likewise, bone surface decreased about 2X and PDL surface increased over 3X. Anabolic bone formation increased about 1.5X greater by post surgery week 4. Increased tissue turnover is a condition that favors rapid tooth movement. Moreover, RAP was clearly demonstrated in all study variables.

In conclusion, surgical injury to the alveolus induces a dramatic increase in tissue turnover by the 3rd week and dissipates to steady state by post-op week 11. The effect of the decortication injury on bone turnover is localized to the area immediately adjacent to the injury.