The effects of PROPEL Micro-Osteoperforations (MOPs) on Tooth Movement and Bone in the Beagle Maxilla
Orthodontic Treatment

• Non-EXT: 20 to 27 months
• EXT: 25-35 months
• Risks associated with longer treatment time include decalcification, root resorption, patient burnout, and others

Tooth Movement (mm / month)

- 100 g NiTi CCS
- 400-450 g Elas Mod
- 18 g Closing Loop
- 150-200 g NiTi CCS
- 60 g Closing Loop

1.08 mm / mo (Syst Rvw)

The Process

Corticotomies

↑ Bone Turnover  ↓ Bone Amt  ↓ Bone Density
Mandibular Tooth Movements

Experimental: 2.4 mm  Control: 1.3 mm

Sanjideh et al, 2010
Peak RAP = 3-4 weeks

Sanjideh et al 2010
Mostafa et al 2009
Cho et al 2007
Issues with Corticotomies

• Significant Procedure
  • Expensive
  • Surgical risk
  • Recession

• Flapless Corticotomies
  – Less invasive
  – Bur, Piezocision, Endo Tip…
  – PROPEL Device (MOPs)
Micro-osteoperforation (MOP)

- The small rat molar and the relatively high applied force do not scale to the human patient (equivalent of 5.5 pounds).

New York University filed a patent on microperforations when this study was completed. Propel Orthodontics Inc. licensed this patent from NYU. Bias?
MOP Studies - Rats

- 10 MOPs (same size as Teixeira et al 2010)

Rat studies of MOPs give mixed results.

* P < 0.05
MOP Studies - Dogs

- Flapless
- 25 bur perforations
- Depth of cortex
- Repeated monthly
  - 1\textsuperscript{st} Month – Faster
  - 2\textsuperscript{nd} Month – Same
  - 3\textsuperscript{rd} Month – Slower

Safavi et al 2012
Flapless Cortical Damage

- Bone awl
- 60 holes, 0.5 mm x 1.9 mm deep
- Reduced cortical bone volume & density
- No change in bone density or volume
- No difference in tooth movement

Swapp et al 2012
PROPEL Clinical Study

- Twenty Class 2 Div 2 Pts
- EXT U4s then heal 6 mo
- Set of 3 PROPEL MOPs
- U3 retraction for 1 month
- Results
  - 2.3x increase over control
  - Control ~0.6 mm
  - PROPEL ~1.3 mm

Alikhani et al 2013
Tooth Movement
(mm / month)

1.08 mm / mo (Syst Rvw)

Purpose

Evaluate how PROPEL MOPs effect bone and ultimately tooth movement in a large scale animal to help understand their effect in our patient population.

Effect on Bone? Significantly Faster?
Experimental Design

- Subject: Beagle (Maxilla)
- Split mouth:
  - Control (No PROPEL MOPs)
  - Experimental (PROPEL MOPs)
- 7 Subjects (sufficient statistical power)
- Randomized
- Blinded
Extractions / Appliances

- Extract 3\textsuperscript{rd} premolars
- Heal 1 month
- 8 MOPs on Exp side
- Retract 2\textsuperscript{nd} Premolars
- Collect LOTS of Data!
Data

- Caliper Measurements
- Radiographic Measurements
- Bone Density
- Bone Volume
- Histology
- Histomorphometry
Tooth Movements - Overall

Caliper Measurements
Difference = 0.05 mm

Radiographic Measurements
Difference = 0.27 mm

P > 0.05 means NOT significant
Conclusion #1

Overall increases in tooth movements produced with MOPs are small, indicating the extent of their effects are limited.
Tooth Movements - Early

Increased tooth movement in first 1 to 3 weeks

Sanjideh et al, 2010
Conclusion #2

MOPs may produce slight, early increases in tooth movements.
Bone Density and Bone Volume

Bone Density

Adjacent Alveolar Bone

Bone Volume

Adjacent Alveolar Bone

mg HA/cm³

p = 0.237

p = 0.398

Ctrl

Exp

 контролируемая экспериментальная

No difference in density or volume

No difference in tooth movements
Conclusion #3

MOPs placed three or more millimeters away do not increase tooth movements because they have no major effect on the amount or density of bone adjacent to the teeth being moved.
What happens near MOP?

Similar Microcrack Regions → Empty Lacunea

VanGemert et al. 2016
Major density effect < 1.5 mm away

VanGemert et al 2016
Histomorphometry

Control

Experimental

Ext Site

Root

MOP

Ext Site

MOP

Root

1 mm

P2

1 mm

P2
Conclusion #4

The effect of the MOP on bone density and turnover is limited to 1 to 1.5 mm from the edge.
Tooth Movements - Early

Increased tooth movement in first 1 to 3 weeks

Caliper

Radiographic
Slight Distant (up to 4 mm) Demineralization

Trabecular Bone Density After 2 Weeks of Healing

- Nerve
- Vein
- Artery
- Canaliculi
- Osteocyte in a lacuna
- Lamellae
- Central canal
- Lacunae

VanGemert et al 2016
Conclusion #5

The early, temporary increases in tooth movement must have been due to distant demineralization.
Clinical Implications

• This study suggests following PROPEL recommendations on MOP placement will not have a significant affect on tooth movements
  – MOPs are too far away
  – Injury is too minimal
**Orthodontics & Craniofacial Research**

Original Article

G Cohen  
PM Campbell  
PE Rossouw  
PH Buschang

Effects of increased surgical trauma on rates of tooth movement and apical root resorption in foxhound dogs

<table>
<thead>
<tr>
<th>Less Injury</th>
<th>More Injury</th>
</tr>
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<tbody>
<tr>
<td>Slower Movement</td>
<td>Faster Movement</td>
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Cohen et al, 2010
How does the amount of surgical insult affect bone around moving teeth?

(Am J Orthod Dentofacial Orthop 2014;145:S92-9)

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Mesial

RAP+ had less bone, and especially, less dense bone, than the RAP group.
Clinical Implications
Thank You!

Dr. Peter Buschang
Dr. Phil Campbell
Dr. Larry Tadlock
Dr. Lynn Opperman

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