

## AAO Foundation Award Final Report

Principal Investigator	Christine Hong
Co-Investigator	
Secondary Investigators	
Award Type	Orthodontic Faculty Development Fellowship Award
Project Title	<b>Alveolar Micro-perforation Using Mini-implants for Accelerated Tooth Movement in Animal Model</b>
Project Year	2012-2013
Institution	UCLA School of Dentistry, Section of Orthodontics
Summary/Abstract (250 word maximum)	<p><b>Aim:</b> The current techniques for accelerated tooth movement involve invasive procedures. This study uses a rat model to evaluate mini-implant (MI) facilitated corticotomy as a novel non-surgical protocol, which could provide a safe method of shortening orthodontic treatment duration.</p> <p><b>Methods:</b> Five male Sprague-Dawley rats were divided into 3 experimental groups: split-mouth corticotomy (3 rats), tooth movement alone (1 rat), and no appliance (1 rat). 25g springs were secured between maxillary incisor and first molar to move the first molar mesially for 21 days. Corticotomies were performed around the left first molar. The diastema between incisor and first molar was measured on days 0, 7, 14, and 21. After 21 days, the maxilla of each animal was analyzed by MicroCT and H&amp;E staining.</p> <p><b>Results:</b> The split-mouth corticotomy group showed tooth movement of 1.65mm and 1.37mm on the corticotomy and controls sides, respectively. H&amp;E staining showed differences in cellular activity between two sides. MicroCT analysis demonstrated similar bone mineral density (BMD) across all groups. Bone volume to tissue volume (BV/TV) was greater on the corticotomy side.</p> <p><b>Conclusion:</b> Orthodontic tooth movement occurred more rapidly on the corticotomy side. Similar BMDs between the corticotomy and control sides suggest that MI-facilitated corticotomy is relatively atraumatic. There may be greater BV/TV on the corticotomy side because of increased bone remodeling. This pilot study paves the way for a future study with a larger sample. This primes the future for an innovative and non-invasive device that will allow orthodontists to provide improved patient care with reduced treatment duration.</p>
Were the original, specific aims of the proposal realized?	<p>Yes. All of the below specific aims were achieved.</p> <ol style="list-style-type: none"> <li>1. Educational program aim: Dr. Hong was engaged in various orthodontic educational programs for both pre-doctoral and post-doctoral students. Dr. Hong taught</li> </ol>

	<p>research and orthodontic clinical courses to post-doctoral students and taught didactic courses to pre-doctoral and advanced standing students. In order to develop and enhance teaching skills, she received AAO's academy of academic leadership sponsorship program award and attended two phase academic leadership programs in 2012.</p> <ol style="list-style-type: none"> <li>2. Research: Dr. Hong has been actively involved in various research projects and has established her own lab. She has published two papers in orthodontic journals and presented at IADR/AADR, WIOC, and AAO meetings.</li> <li>3. Clinical program: In order to develop clinical skills and patient care, Dr. Hong achieved board certification through ABO in 2012. She has changed the resident comprehensive exam formats to follow ABO formats and she teaches and helps residents in achieving board certification.</li> </ol>
<p>Were the results published? If not, are there plans to publish? If not, why not?</p>	<p>The results will be submitted for publication by Dec, 2013. The statistical significance was not found with this pilot study. The protocol for tooth movement in rats has been established with this pilot study. The study with a larger sample size will begin Sept, 2013.</p>
<p>Have the results of this proposal been presented? If so, when and where? If not, are there plans to do so? If not, why not?</p>	<p>Yes. It was presented at IADR/AADR in Seattle, March, 2013. The poster for this presentation is included as an attachment.</p>
<p>To what extent have you used, or how do you intend to use, AAOF funding to further your career?</p>	<p>The AAOF funding was very helpful in travels for presentations. The funding was used as a supplement support to Dr. Hong's salary. AAOF funding makes Dr. Hong's academic career dream a possibility!</p>

# MI-facilitated Micro-perforation for Accelerated Tooth Movement in Rats: Pilot Study

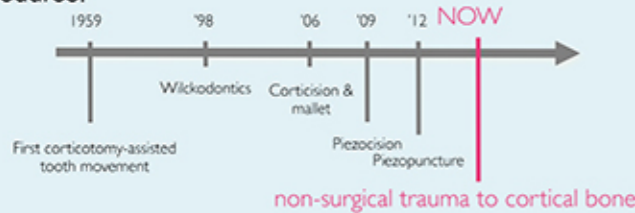
Cheung TL, Park JY, Hourfar A, Yen S, Lawson G, Jalali P, Asatrian G, Chung C, Moon W, Hong C

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## INTRODUCTION

Accelerated tooth movement (ATM) is important because it reduces orthodontic treatment time, number of appointments, and social discomfort associated with braces. Since 1959, it has been established that mechanical trauma to bone can facilitate tooth movement. However, these techniques cause significant trauma due to incisions, raising flaps, and excessive tissue disturbance. There is a need for less invasive procedures.

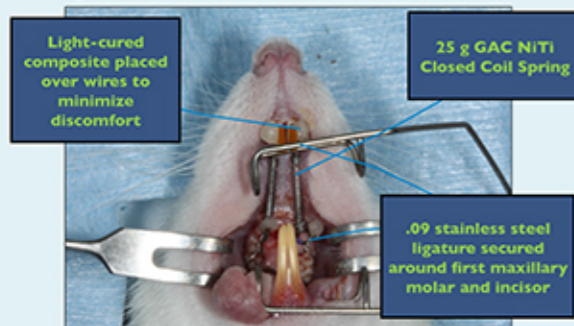


## AIMS

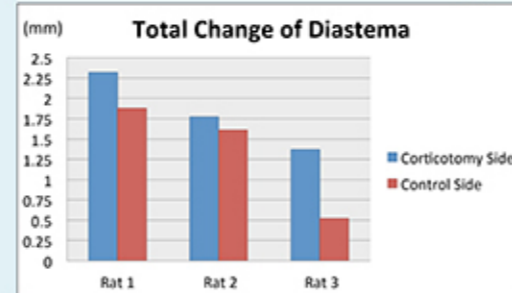
- To use a rat model to evaluate mini-implant (MI) facilitated corticotomy as a novel minimally invasive protocol of creating mechanical trauma in accelerated tooth movement.
- To provide a safe method of shortening orthodontic treatment duration.

## METHODS

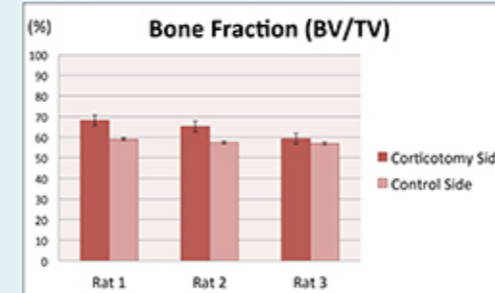
- Five 300 g male Sprague-Dawley rats were divided into 3 corticotomy groups: split-mouth corticotomy, tooth movement alone, and no appliance.
- 25 g NiTi close-coiled springs were secured between the maxillary incisor and the first molar on the right and left sides in order to move the first molar mesially for 7 days for 1 split-mouth corticotomy rat and 21 days for the others.
- Corticotomies were performed around the left first molar with a 1.2 mm diameter and 6 mm length implant with an automated implant driver using 30 RPM and torque of 90 Ncm.
- The diastema between the incisor and the first molar was measured prior to sacrifice.
- The maxilla of each animal was analyzed by MicroCT and H&E staining.



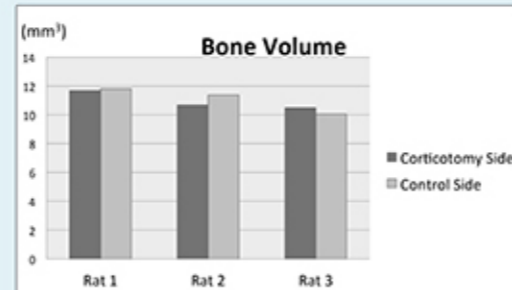
## RESULTS



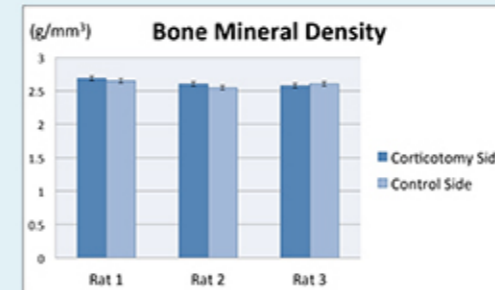
**Fig. 1 Total Change of Diastema:** Tooth movement was greater on the corticotomy side compared to the control side. Distance was measured from the lingual of the incisor to the mesial of the first molar with a digital caliper accurate to .01 mm.



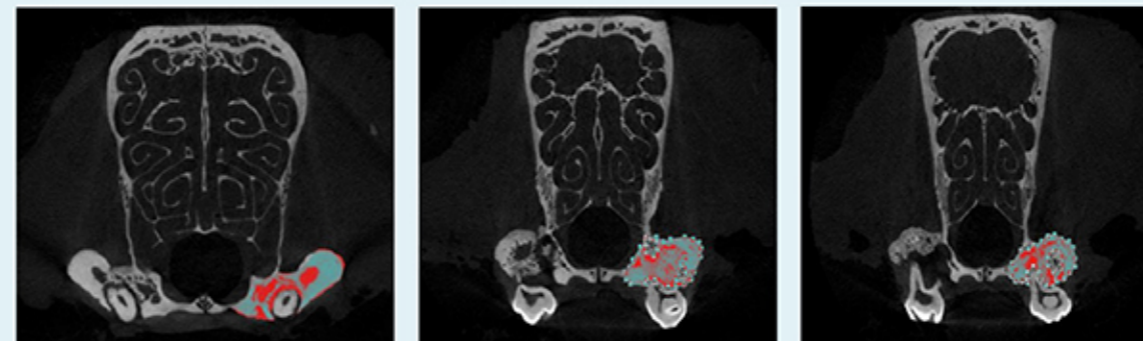
**Fig. 2 Bone Volume to Tissue Volume (BV/TV):** BV/TV greater on the corticotomy side than the control side. BV/TV is important because it can be used to evaluate relative changes in bone volume following a given treatment.



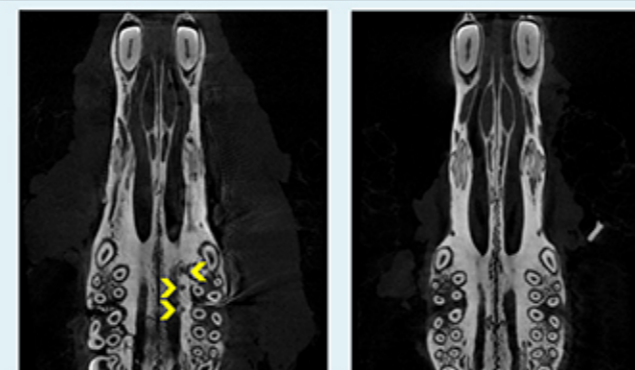
**Fig. 3 Final Bone Volume (BV):** Final BV on corticotomy side greater for rat 3 than rat 1 and rat 2.



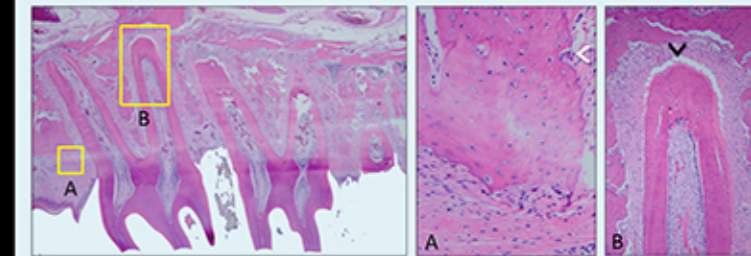
**Fig. 4 Final Bone Mineral Density (BMD):** Final BMD on corticotomy side greater for rat 1 and 2 than rat 3.



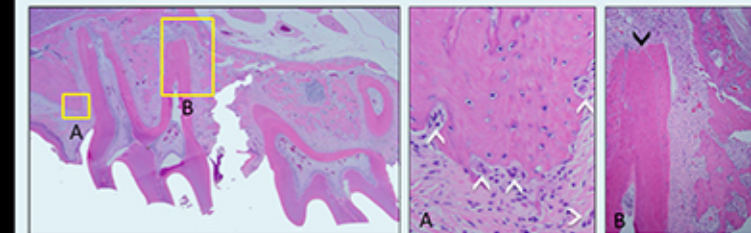
**Fig. 5 Segmenting of Alveolar Bone for MicroCT Measurements in DataViewer:** The region of interest was defined manually to enclose interradicular bone and alveolar bone enclosing the first molar (red = soft tissue, blue = bone). 102 slices were generated for volumetric analysis. The grey threshold value was set at 80-255.



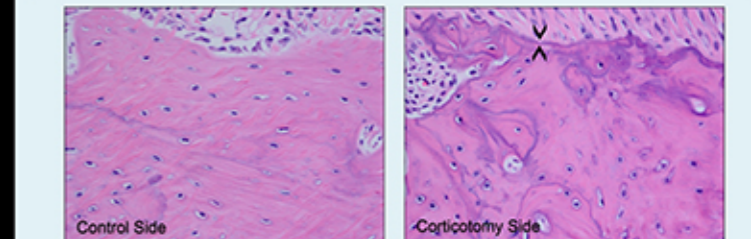
**Fig. 6 MicroCT Evaluation of Corticotomies:** A) Corticotomies detected at 1 week post-treatment (yellow arrows). B) Apparent healing of corticotomies at 3 weeks.



**Fig. 7 Control Side:** Interradicular trabecular bone height appears normal indicating minimal bone loss. A) Mild numbers of osteoclasts (white arrow) detected on the compression side. B) Root apex is well-defined (black arrow) indicating no root resorption.



**Fig. 8 Corticotomy Side:** Interradicular trabecular bone height appears shortened indicating moderate bone loss. A) Increased number of osteoclasts (white arrows) detected on the compression side. B) Root apex is blunted (black arrow) due to moderate root resorption.



**Fig. 9 Corticotomy Side Bone vs. Control Side Bone:** Dark blue lines (black arrows) in the corticotomy side represents "new" or woven bone, which is a sign of increased bone metabolic activity. Woven bone is less organized than the mature, lamellar bone, which predominates in the control side.

## CONCLUSIONS

- Greater tooth movement occurred on the corticotomy side compared to the control side.
- MicroCT demonstrated greater BV/TV on the corticotomy side due to increased bone remodeling and consequently greater amounts of bone deposition.
- MicroCT demonstrated that corticotomies are present at 1 week and healed at 3 weeks.
- H&E demonstrated greater numbers of osteoclasts on the compression (mesial) side of the corticotomy side compared to the control side. Presence of dark blue lines on the corticotomy side represent a mineralization front.

## REFERENCES

Ren Y, Malha JC, Kuijpers-Jagtman AM. The rat as a model for orthodontic tooth movement—a critical review and a proposed solution. *Eur J Orthod* 2004;26(5):483-90.

Sebaoun JD, Surmenian J, Dibart S. Accelerated orthodontic treatment with piezocision: a mini-invasive alternative to conventional corticotomies. *Orthod Fr* 2011;82(4):311-9.

Teixeira CC, Khoo E, Tran J, Chartres I, Liu Y, Thant LM, et al. Cytokine expression and accelerated tooth movement. *J Dent Res* 2010;89(10):1135-41.