AAO Foundation Award Final Report

Please prepare a report that addresses the following:

Type of Award

Biomedical Research Award

Name(s) of Principal Investigator(s)

Monica Schneider DDS MS

Title of Project

Accelerated Orthodontic Tooth Movement in Adult Patients by Micro-perforations of Cortical Bone

Period of AAOF Support

07-01-13 to 07-30-17

Amount of Funding

$25,000

Abstract

Objective - To determine whether micro-osteoperforation of cortical bone produces accelerated tooth movement in adult patients.

Materials and Methods - Ten healthy adults requiring maxillary first premolar extractions participated in this split-mouth study. Research subjects were recruited from University of Maryland Department of Orthodontics and Pediatric Dentistry- graduate orthodontic clinic. Temporary Anchorage Devices (TADs) were placed bilaterally for anchorage control. Micro-osteoperforations with the Propel device were performed unilaterally and maxillary canines were distalized using sliding mechanics. Cone Beam Computed Tomography (CBCT) and digital models were taken before canine distalization (T0) and three months later (T2).

Results - Study subjects showed varied amount of canine retraction. For the measurements performed on CBCTs, the mean on the experimental side was 0.44 mm less than control for "TAD-U3D" (TAD - upper canine distal) and 0.30 mm greater than control for "U5M-U3D" (upper

second premolar mesial - upper canine distal). For the measurements performed on digital models, the measurements on the experimental side were 0.14mm greater than control for "U3 Cusp Tip- U5 Cusp Tip", 0.24mm less than control for "U5M-U3D" (upper second premolar mesial - upper canine distal), 0.24mm greater than control for "U2 Midpoint- U3 Cusp Tip", and 0.18mm greater than control for "U6 MP Cusp Tip- U3 Cusp Tip".

Conclusion - Overall, the amount of canine retraction on the experimental side was not statistically significant compared with the control side for any of the six measured variables (P>0.05). Fifty percent of the subjects showed faster canine retraction on the experimental side; however, this difference was not statistically significant.

Response to the following questions:

Specific aims

- Aim 1: to determine whether micro-osteoperforation procedures accelerate tooth movement during space closure using the Propel device

- Aim 2: to identify the effects of a second micro-osteoperforation procedure on the rate of tooth movement using the Propel device

1. **Were the original, specific aims of the proposal realized?**

This interventional prospective study took more time to complete than originally anticipated due to the challenges we had in the recruitment of patients that qualified the inclusion criteria and that completed orthodontic treatment at the University of Maryland – Department of Orthodontics graduate clinic. We recruited 20 patients for the study; five of our patients either moved out of state or had a change in the orthodontic treatment plan that disqualified them to participate in the study.

Specific aim 1

Even though recruitment of patients has been challenging specific aim 1 was completed. In this split-mouth study we were able to quantify the amount of space closure and make comparisons between the experimental side and the control side when performing a single micro-osteoperforation using the Propel device. We employed CBCTs images and digital models to measure the amount of space closure using Anatomage Invivo 5 3D software and OrthoCAD 3.5 Cadent™.
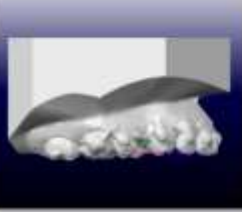
The measurements used to assess canine tooth movement during space closure are summarized below

	Abbreviation	Measurement
Anatomage Invivo 5 3D	TAD-U3D (mm)	The distance from the TAD to the most outer point of the distal curvature of the maxillary canine
	U5M-U3D (mm)	The distance from the most outer point of the mesial curvature of the maxillary 2nd premolar and the distal most outer point of the curvature of the maxillary canine
OrthoCAD 3.5 Cadent ™	U3 Cusp Tip-U5 Cusp Tip (mm)	The distance from the cusp tip of the maxillary canine to buccal cusp tip of maxillary 2nd premolar
	U5M-U3D (mm)	The distance from the distal wall of the maxillary canine to the mesial wall of the maxillary 2nd premolar
	U2 Midpoint-U3 Cusp Tip (mm)	The distance from a midpoint on the incisal edge of the maxillary lateral incisor to the maxillary canine cusp tip
	U6 MP Cusp Tip-U3 Cusp Tip (mm)	The distance from the mesio-palatal cusp tip of the maxillary first molar to the cusp tip of the maxillary canine

The figure below shows the CBCT measurements performed on unilateral cephalograms using Anatomage Invivo5 3D at T0 and T2

	Right Buccal	Left Buccal
Initial Ceph (T0)		
Final Ceph (T2)		

The figure below shows the four measurements performed bilaterally on digital models using OrthoCAD at T0 and T2

	Right Buccal	Occlusal	Occlusal	Left Buccal
Initial (T0)				
Final (T2)				

All the acquired data was analyzed using the STATA software version 10. Skewness and Kurtosis for normality were examined for each of the six measurements (two CBCT measurements and four digital model measurements) and all the parameters showed normal distribution. In addition, intra-examiner reliability and inter-examiner reliability was tested for each of the six measurements performed by each examiner using Student t-tests to compare the compatibility between their measurements. Paired Student t-tests were performed for the six measurements to compare the average rate of space closure in the experimental side of the mouth, the side treated with micro-osteoperforations using the Propel device, and the control side. One- tailed P values were also calculated and $P<0.05$ was determined to be as the level of statistical significance. A group difference was expressed by mean ± 1 standard deviation (SD).

The table below summarizes the statistical analysis for all 6 measurements

	CBCT Measurements				Digital Model Measurements							
	TAD-U3D(mm)		U5M-U3D(mm)		U3 Cusp Tip-U5 Cusp Tip(mm)		U5M-U3D(mm)		U2 Midpoint-U3 Cusp Tip(mm)		U6 MP Cusp Tip-U3 Cusp Tip(mm)	
	Control T0-T2	Propel T0-T2	Control T0-T2	Propel T0-T2	Control T0-T2	Propel T0-T2	Control T0-T2	Propel T0-T2	Control T2-T0	Propel T2-T0	Control T0-T2	Propel T0-T2
N	10	10	10	10	10	10	10	10	10	10	10	10
Mean	2.25	1.81	2.36	2.66	2.83	2.97	2.55	2.31	1.96	2.20	2.84	3.02
t	0.92		-0.62		-0.40		0.68		-0.80		-0.53	
p-value	0.19		0.72		0.65		0.25		0.77		0.69	
Degrees of Freedom= 9						Not Significant (p≥0.05), *= Significant (P<0.05)						

The results of specific aim 1 were utilized for the thesis dissertation of Dr. Tina Mahmoudi, third year orthodontic resident at University of Maryland Dental School- Department of Orthodontics and Pediatric Dentistry where I was the mentor of the project. She defended her thesis successfully on April 28, 2016 to earn her Master of Science in Biomedical Sciences degree.

Specific aim 2

We have 5 patients enrolled to address the objectives in specific aim. Here we are evaluating if a second micro-osteoperforation will have any effect on canine movement during space closure. Our IRB is current (HP-00055763) until October 2017 and we are planning on renewing it to be able to complete treatment in all patients recruited. Three patients have completed the research protocol; two other patients are currently under orthodontic treatment and started the protocol. I am mentoring Dr. Robert Laraway rising third year orthodontic resident at University of Maryland Department of Orthodontics and Pediatric Dentistry; he is working on specific aim 2 as his thesis dissertation and has been involved in the project since he was a dental student at University of Maryland Dental School. At this time we are collecting and analyzing the data of the 3 patients we have completed. This 3 patients show a variable amount of tooth movement when comparing the control and the propel side. One of the patients showed a 2.5 fold increase of tooth movement on the propel side however for other two patients the difference between the control side and propel side was minimal. We will finish our data analysis once all 5 patients have completed the protocol.

Even though thus far the overall results of the study showed no statistically significant differences between the experimental side and the control side, the results of this split mouth study indicated a promising trend since half of the study subjects showed more space closure during canine retraction on the experimental side when compared to the control side. It has been shown that micro-osteoperforations can cause an inflammatory response in the cortical bone; however, there is variable response between patients. Additional research studies are necessary to evaluate and confirm micro osteoperforations effect on the rate of tooth movement in the orthodontic treatment of adult patients in order to make evidence based decisions when recommending this procedure to adult patients. The AAOF Award has been instrumental by providing the funds to answer this clinically relevant question. From our results we recommend that orthodontists should use the technique with caution when introducing micro-osteoperforations of the bone to their adult patient as an effective method to decrease treatment time.

2. **Were the results published?**

The results of specific aim 1 are part of Dr. Mahmoudi's Master Thesis presentation that was approved March 28th 2016. University of Maryland School of Dentistry- Department of Orthodontics and Pediatric Dentistry. The results of specific aim 2 will be part of Dr. Robert Laraway's Master Thesis presentation.
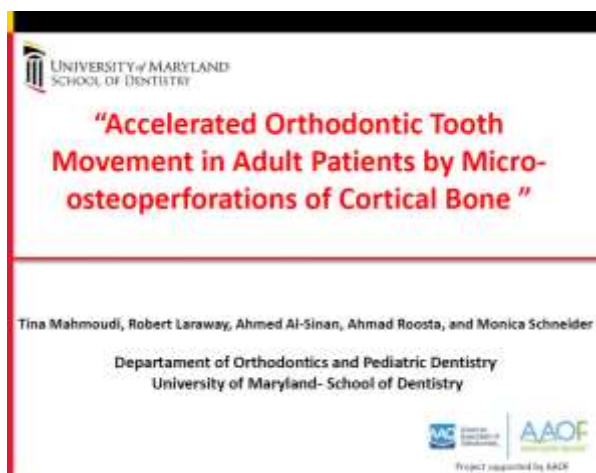
We anticipate a publication in an orthodontic journal including the results from specific aims 1 and 2. With the help from AAOF Award we were able to develop a novel research project that used the cutting-edge devices for accelerated tooth movement and a sound methodology utilizing up to date software to analyze the data.

3. **Have the results of this proposal been presented?**

The results have been presented within the Department of Orthodontics and School of Dentistry as a whole at the thesis dissertation defense of Dr. Mahmoudi. This work has been also presented by Dr. Schneider at the Department of Orthodontics, University of Chicago at Illinois, School of Dentistry in August 2016.

We also participated with an electronic poster at the 2017 AAO Annual Meeting San Diego, CA.

> Mahmoudi T, Laraway R, Al-Sinan A, Roosta A, **Schneider M**. Accelerated Orthodontic Tooth Movement in Adult Patients by Microosteoperforations of Cortical Bone. (E-poster) 2017 American Association of Orthodontists Annual Session. 2017 April 21-25. San Diego, CA

UNIVERSITY of MARYLAND
SCHOOL OF DENTISTRY

"Accelerated Orthodontic Tooth Movement in Adult Patients by Micro-osteoperforations of Cortical Bone "

Tina Mahmoudi, Robert Laraway, Ahmed Al-Sinan, Ahmad Roosta, and Monica Schneider

Department of Orthodontics and Pediatric Dentistry
University of Maryland- School of Dentistry

Project supported by AAOF

The AAOF funding was acknowledged in all presentations.

4. **To what extent have you used, or how do you intend to use, AAOF funding to further your career?**

I would like to express my sincere gratitude to the AAOF for providing the award. As required by my institution for promotion the AAOF award has provided the opportunity to develop essential scholarly activities such as research and mentoring. Regarding research the AAOF award provided funding necessary to undertake a very interesting and clinically relevant research project and assisted me to work with up to date software that was used other projects, which is pivotal to further an academic faculty career. In regards to mentoring I had the opportunity to mentor several orthodontic residents, dental students and international students and present the results of specific aim one as an e- poster at 2017 AAO annual session. The AAOF funded project served as a thesis project for two of our residents one of them completed in 2016. In addition, this experience gave me the tools to be also the primary mentor for two other orthodontic residents pursuing their Master's degree. We anticipate to present the results of these projects as a poster presentation at 2018 AAO Annual session Washington DC, even though these projects were retrospective studies and did not need funding as the software purchased with the AAOF funds was used to analyze the data and complete the statistical analysis.

AAOF funding has been essential for my career as an orthodontic academician. Most of all, my experience as Faculty member has been continuously enriched through my constant interactions with other Faculty, students, staff and patients. I hope this will remain as such for many more years to come.