AAO Foundation Award Final Report

Type of Award: Biomedical Research Award

Principal Investigator: Sercan Akyalcin, DDS, MS, PhD

Title of Project: Evaluation of three-dimensional root surface changes and resorption following rapid maxillary expansion: A cone-beam computed tomography investigation

Period of AAOF Support: 07-01-2013 to 09-30-2014 (extension granted 06-30-14)

Amount of Funding: $25,000.00

Abstract:

Objectives - To evaluate root surface changes and resorption following rapid maxillary expansion (RME) using cone beam computed tomography (CBCT).

Setting and Sample Population - The Department of Orthodontics at The University of Texas Health Science Center. Twenty-four consecutively treated patients (mean age: 12.8 years) requiring maxillary expansion.

Material & Methods – An observational cohort included forty-eight CBCT images collected prior to (T1) and 4.8 months after (T2) RME from the study sample. Maxillary (study teeth) and mandibular (control teeth) first molars (n=48) and first premolars (n=48) were segmented and digitally registered using a 'best fit' algorithm. Linear surface and volumetric changes were evaluated.

Results - All study teeth had significant changes for the evaluation of maximum linear surface area and volumetric changes as compared to control teeth ($p<0.05$). On the average, premolars and molars in the study group experienced a root shortening of 0.36 to 0.52 mm ($p<0.05$). Color-coded diagrams demonstrated thinning and resorption occurring primarily at the apex and buccal aspects of the roots. Severity of these changes was individual-specific, as root resorption patterns were not deemed to be uniform.

Conclusion - Root volume loss and linear surface area changes of maxillary first molars and premolars are common findings with the use of tooth-borne RME therapy. Thinning/shortening of the roots also occur as a consequence.

Keywords - maxillary expansion, root resorption, three-dimensional imaging

Questions:

Specific aims:

(1) To analyze the degree of the root damage and long-term repair following RME therapy both quantitatively and visually

(2) To verify the applicability of the proposed method by including a group of control teeth and by comparing the findings to a validated technique.

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

Yes, we were able to quantitatively analyze the root surface changes of the anchored teeth following rapid maxillary expansion and to visually demonstrate these changes using color-coded diagrams. Furthermore, applicability/sensitivity of the proposed method was determined using a group of control teeth.

Most of the cone-beam CTs (CBCT) in the originally proposed cohort had motion artifacts and poor resolution. This affects the quality of the segmentation procedure. Since the targeted sample and the images had already been acquired as part of a

previous investigation, it was not possible to enhance these records. However, we were able to include patients with better CBCT scans from our clinic archives. The new sample had the same inclusion criteria but the long-term records (T3). Therefore, our findings elaborately reported the root resorption and surface changes between pretreatment and postexpansion (obtained four to six months after expansion) CBCT scans.

2. Were the results published? If not, are there plans to publish? If not, why?

'August 1, 2014 - September 30, 2014 – Final statistical analyses will be carried out. A manuscript will be drafted and submitted to an orthodontic journal.'

As indicated on our timetable, a manuscript was drafted and submitted to 'Orthodontics & Craniofacial Research' for the publication of our initial findings on August 29, 2014. The support from the AAOF was mentioned in the cover letter. With the help of the AAOF, we were able to develop a robust methodology. We are now working on a second paper that will compare the effects of conventional maxillary expansion to mini-screw supported maxillary expansion using the same technique. The results from the second paper will be submitted to the American Journal of Orthodontics and Dentofacial Orthopedics.

3. 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?

During a recent workshop (FASEB – 2014 Innovators' Workshop on Personalized and Precision Orthodontic Therapy partly funded by an AAOF Center Award to COAST), I was able to present the details of segmentation, surface registration and application of the research protocol to the study of root surface changes and resorption. However, the study has not been fully been presented yet. We are planning to submit the results to the upcoming 'World Federation of Orthodontists Meeting' in London.

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

I was recently promoted from Assistant to Associate Professor in my institution. I was very proud to list the AAOF support two times in the funding section of my resume. I believe that AAOF funding has made a huge change in my career development already.

AAOF's funding has assisted me develop my imaging lab and research. I have been able to work with the latest and most up-to-date software and to develop a protocol on image segmentation and registration. I will keep improving the methodology for use in our future projects. None of this would have happened without the AAOF support.

I was able to attend the Moyer's Symposium in Ann Arbor, AADR Meeting in Charlotte, FASEB Meeting in Itasca and present my current research activities that relate to the investigation of changes following rapid maxillary expansion with cone-beam CT (CBCT) technology. My productivity has increased significantly as can be seen in the below list. The funding has allowed me to share my experience and research findings with colleagues and orthodontic residents throughout the nation. As a result, I feel more accomplished compared to the previous year.

Changes to my resume through the funding period:

Honors and Awards:

2014 Journal of the World Federation of Orthodontists, Certificate of Excellence in Reviewing Award (for the year 2013)

2013 Southwestern Society of Orthodontists (SWSO) Annual Meeting Recipient, Faculty Research Award

Editorial Positions:

Reviewer Positions

2014 – Present	European Journal of Orthodontics
2014 – Present	PLOS ONE
2014 – Present	Orthodontics and Craniofacial Research
2014 – Present	Journal of Esthetic and Restorative Dentistry
2014 – Present	Progress in Orthodontics
2014 – Present	Computer Methods and Programs in Biomedicine
2014 – Present	Head & Face Medicine
2013 – Present	Journal of Dentistry
2013 – Present	Korean Journal of Orthodontics
2013 – Present	Journal of Imaging Sciences in Dentistry

Invited Presentations:

International

Nov 3-5, 2013	International Symposium of the Turkish Association of Orthodontists, Istanbul, Turkey "Three-Dimensional Update on Rapid Maxillary Expansion"

National

Sep 11-14, 2014	The Consortium for Orthodontic Advances in Science and Technology 2014 Innovators' Workshop, Itasca,IL "3-D surface imaging technology for orthodontic records"

Mar 7, 2014 — 40th International Conference on Craniofacial Research Symposium, Ann Arbor, MI
"Three-dimensional review of rapid maxillary expansion: research findings & clinical relevance"

Publications:

Refereed Original Articles in Journals

1. Sandifer C, English JD, Colville CD, Gallerano RL, **Akyalcin S.** Treatment effects of the Carrière distalizer using lingual arch and fullfixed appliances. Journal of World Federation of Orthodontists. 2014 June;3(2):e49-54. ISSN: 2212-4438
2. **Akyalcin S**, Frels L, English JD, Laman S. Smile esthetics: analysis of American Board of Orthodontics cases. Angle Orthod. 2014 May;84(3):486-91. PMID: 24160996
3. Ledingham A, English JD, **Akyalcin S**. Difference between primary stability of anodized vs. non-anodized mini-screws after subjection to repeated cycles of autoclave sterilization**.** Forum for Dental Student Research and Innovation. Spring;2(1):20-27, 2014.
4. **Akyalcin S**, Dyer D, English JD, Sar C. Comparison of 3-D dental models obtained from different sources - diagnostic accuracy and surface registration analysis. Am J Orthod Dentofacial Orthop. Dec;144(6):831-7, 2013. PMID: 24286906
5. **Akyalcin S**, Cozad BE, English JD, Colville CD, Laman S. Diagnostic accuracy of impression-free digital models. Am J Orthod Dentofacial Orthop. Dec;144(6):916-22, 2013. PMID: 24286915
6. **Akyalcin S**, English JD, Abramovitch KM, Rong XJ. Measurement of skin dose from cone-beam computed tomography imaging. *Head & Face Medicine* Oct 9;9(1):28, 2013. PMID: 24192155

Book Chapters

1. **Akyalcin, S.**, Kapadia, H., English, J.: Retention and Relapse in Orthodontics. Mosby's Orthodontic Review 2nd Edition. Mosby Elsevier. St. Louis, MI, 2014. In Press
2. **Akyalcin, S.**: 3-D Update on Clinical Orthodontic Issues. Mosby's Orthodontic Review 2nd Edition. Mosby Elsevier. St. Louis, MI, 2014. In Press

Respectfully submitted,

Dr. Sercan Akyalcin