

AAO Foundation Award Final Report

Type of Award

Biomedical Research Award

Name of Principal Investigator

Thorsten Grünheid, D.D.S., Dr. med. dent., Ph.D.

Title of Project

Orthodontic brackets coated with antimicrobial peptides to prevent formation of white spot lesions

Period of AAOF Support

07-01-14 to 06-30-16

Amount of Funding

\$25.000

Summary/Abstract

Objective: White spot lesions (WSL) are the most common complication of orthodontic treatment. WSL are caused by oral bacteria whose acidic byproducts cause enamel demineralization. The objective of this project was to develop bioactive coatings for orthodontic bracket materials to prevent the formation of WSL by directly attacking the causative oral microflora.

Methods: Titanium (Ti) and stainless steel (SS) discs and commercially available brackets were coated with GL13K, an antimicrobial peptide of human origin, after various methods of surface preparation. Dynamic water contact angle measurements, X-ray photoelectron spectroscopy, and fluorescent visualization were used to determine successful peptide-coating. *S. mutans* or *L. casei* were cultured on coated surfaces and colony forming units (CFU) compared to uncoated controls. Coated discs and brackets were subjected to mechanical, hydrolytic, and proteolytic challenges to simulate intraoral conditions.

Results: Successful GL13K coatings were obtained after etching Ti surfaces and sandblasting, descaling, and plasma cleaning SS surfaces. Activity analysis showed significantly fewer CFU of both *S. mutans* and *L. casei* after culture on peptide-coated discs and brackets in comparison to uncoated controls. Scanning electron microscopy revealed bacterial cell membrane disruption as GL13K's mode of action. Zone of inhibition tests showed little inhibition of bacterial growth away from the surface suggesting insignificant release of GL13K from the coating. There was only minimal peptide degradation after the mechanical, hydrolytic, and proteolytic challenges.

Conclusion: GL13K can be adhered to Ti and SS surfaces to form robust bioactive coatings, which have a sustained antimicrobial effect on *S. mutans* and *L. casei*.

Response to the following questions:

Were the original, specific aims of the proposal realized?

Yes.

Were the results published?

Results of this project were published as

1. Schnitt RA. Antimicrobial effects of GL13K peptide coatings on *S. mutans* and *L. casei*. [Thesis, M.S.]. Minneapolis: University of Minnesota, 2015. (Advisor T. Grünheid, Co-advisor C. Aparicio).
2. Afwerke HW, Stokfisz N, Weissend A, Aparicio C, Grünheid T. Bioactive coating for orthodontic appliances to prevent white spot lesions. *J Dent Res* 2016;95 (Spec Iss A):1041.
3. Aparicio C. Keynote address: Using oligopeptides and recombinamers to improve performance of dental biomaterials. *J Dent Res* 2016;95 (Spec Iss A):0938.

AAOF support was acknowledged in publications #1 and 2.

One more thesis for the degree of M.S. in Dentistry at the University of Minnesota is currently in preparation:

Weissend A. Orthodontic brackets coated with antimicrobial GL13K peptides to prevent formation of white spot lesions. (Advisor T. Grünheid, Co-advisor C. Aparicio).

Furthermore, the research team plans to submit a manuscript based on the results of this project for publication in a peer-reviewed scientific journal.

Have the results of this proposal been presented?

Results of this project were presented at professional meetings and conferences as

1. VanLaecken N, Schnitt RA, Chen R, Rudney J, Aparicio C, Grünheid T. Biofunctionalization of orthodontic appliances to prevent white spot lesions. 11th Annual Dean's Day, University of Minnesota School of Dentistry, Minneapolis, Minnesota, USA, February 27, 2015.
2. Afwerke HW, Stokfisz N, Weissend A, Aparicio C, Grünheid T. Bioactive coating for orthodontic appliances to prevent white spot lesions. 12th Annual Dean's Day, University of Minnesota School of Dentistry, Minneapolis, Minnesota, USA, March 4, 2016.
3. Afwerke HW, Stokfisz N, Weissend A, Aparicio C, Grünheid T. Bioactive coating for orthodontic appliances to prevent white spot lesions. American Association of Dental Research, Los Angeles, California, USA, March 16–19, 2016.
4. Aparicio C. Keynote address: Using oligopeptides and recombinamers to improve performance of dental biomaterials. American Association of Dental Research, Los Angeles, California, USA, March 16–19, 2016.

5. Weissend A, Afwerke HW, Stokfisz N, Aparicio C, Grünheid T. Bioactive coatings for orthodontic appliances to prevent white spot lesions. American Association of Orthodontists, Orlando, Florida, USA, April 29–May 3, 2016.

AAOF support was acknowledged in all presentations.

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

Funding from the AAOF has been invaluable for my development as an orthodontic academic. The current Biomedical Research Award allowed work on a translational research project combining disciplines, expertise, and techniques to pursue novel approaches in an important clinical area. The support provided not only boosted morale and provided recognition from the orthodontic community, but also allowed me to strengthen my research background and engage dental students and orthodontic residents in the project. As such, the AAOF support helped advance the body of knowledge in the field of orthodontics, develop the careers of various investigators, and benefit orthodontic education by providing research experiences and training at the pre-doctoral and post-doctoral levels.