

AAO Foundation Award Final Report

Principal Investigator	Dawei Liu DDS MS PhD
Co-Investigator	n/a
Secondary Investigators	n/a
Award Type	Orhan C. Tuncay Teaching Fellowship Award, American Association of Orthodontists Foundation (AAOF)
Project Title	Roles of mechanical factors in external apical root resorption (EARR) during orthodontic tooth movement
Project Year	07/08 – 06/09
Institution	Marquette University School of Dentistry
Summary/Abstract (250 word maximum)	<p>External apical root resorption (EARR) occurs in 75-80% of patients undergoing orthodontic treatment. Mechanical loading has been shown to be largely contributive to the formation of EARR, however its mechanism remains unknown. Cementum, the shielding layer covering dental root, bears a dynamic mechanical load during orthodontic tooth movement. Cementoblasts secrete mineral matrix and ultimately become cementocytes embedded in cementum, resembling the morphology and functions of osteocytes in bone matrix. Comparable to osteoblasts and osteocytes, which have been found to play an active role in modulating bone metabolism, we hypothesize that cementoblasts actively respond to mechanical loading and thus play a pivotal role in the control of cementogenesis and cementum repair. To investigate whether and how cementoblasts respond to mechanical loading in vitro, cells of OCCM-30, an immortalized murine cementoblastic cell line, were subjected to a physiological level of 12 dyne/cm² fluid shear stress (FSS) for 30 minutes and 1 hour. To study the early signaling events after the onset of flow, medium was sampled at 5 minutes to test ATP and 15 minutes to test PGE₂ releases. To investigate the functional protein changes, OCCM-30 cells were lysed to test mitogen-activated protein kinase (MAPK) activation after 30 minutes of FSS and 1 hour of FSS followed by 6 hours of post incubation to examine cyclooxygenase (COX)-2, osteopontin (OPN), osteoprotegerin (OPG) and Receptor Activator of NFκB Ligand (RANKL) productions. FSS increased ATP at 5 minutes and PGE₂ release at 15 and 60 minutes. FSS also increased COX-2 and OPN production. Different from osteoblasts, both ERK1/2 and p38 were phosphorylated within 30 min by FSS in</p>

	<p>cementoblasts. Blocking either ERK1/2 or p38 signaling pathway inhibited FSS-induced increased release of PGE₂ and OPN production. Furthermore, FSS reduced RANKL in cementoblasts, which was dependent on ERK1/2 MAPK signaling pathway. The data suggest that, like osteoblasts, cementoblasts are mechanosensitive. Both cell types activate similar signaling pathways upon mechanical loading. A physiological level of FSS might be a promising anti-resorptive factor, which strongly implies a potential role of cementoblasts in the adaptation of cementum to mechanical load as occurred in EARR during orthodontic tooth movement.</p>
<p>Were the original, specific aims of the proposal realized?</p>	<p>Yes.</p>
<p>Were the results published? If not, are there plans to publish? If not, why not?</p>	<p>Based on the results obtained, a manuscript was submitted to the European Journal of Orthodontics (currently under review).</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>D Liu. (2009) Interaction between mechanical loading and oxygen in orthodontic tooth movement – a cellular approach in vitro. 109th American Association of orthodontists, May 1-5, Boston, MA, USA</p> <p>D Liu. (2009) Interaction between mechanical loading and oxygen in orthodontic tooth movement – a cellular approach in vitro. 38th American Association of Dental Research, April 1-4, Miami, FL, USA</p> <p>D Liu. (2009) Orthodontic Root resorption – From Bench to Chair side. 36th Moyer’s Symposium, University of Michigan, February 27-March 1, Ann Arbor, MI, USA</p> <p>D Liu. (2008) Low Intensity Pulsed Ultrasound (LIPUS) Synergistically Modulates SOST and OPG/RANKL in Osteocytes in Vitro. 30th American Society of Bone and Mineral Research, September 16-20, Montreal, Canada</p> <p>D Liu. (2008) Does Oxygen Tension Determine the Metabolic Responses of Osteocytes to Fluid Shear Stress? 38th International Sun Valley Workshop on Skeletal Tissue Biology, August 3-6, Sun</p>

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