



**Tufts**  
UNIVERSITY

School of  
Dental Medicine

**CELEBRATING EXCELLENCE  
AND ACHIEVEMENT IN RESEARCH**

**2016–2017 Research Abstracts**



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## HISTORY OF BATES-ANDREWS DAY

Since the 1930s, this day is held annually to honor George A. Bates, an alumnus of Tufts University School of Dental Medicine (TUSDM), who taught Tufts medical and dental students. He was regarded by his students as an inspiring instructor in histology. Bates Day at TUSDM helps to promote student research and thereby enhance the opportunities for professional growth of our students, alumni, and faculty.

The Robert R. Andrews Society is a student-run organization formed in 1921 in honor of Dr. Andrews, an outstanding researcher and distinguished dental surgeon. The Andrews Society seeks to promote dental research and to honor those who excel in it.

## MESSAGE FROM THE DEAN

Welcome to Bates-Andrews Day 2017, a showcase of our predoctoral and postgraduate students' research activities. This year's event will feature 65 student poster presentations. We appreciate your attendance and support of our students' efforts.

We are honored to have as our keynote speaker **Robert Milman, M.D.**, from the Alan Alda Center for Communicating Science® at Stony Brook University. His interactive plenary is titled "Distilling Your Message." Dr. Milman is a retired diagnostic radiologist from Austin, Texas, who presents regularly on diagnostic imaging, clinical decision support, health communication, medical litigation, and risk management. He is currently senior clinical advisor at the Center for Health Communication at the University of Texas at Austin and holds additional academic appointments at the Texas A&M University College of Medicine, the UT Austin School of Nursing, and the UTMB-Galveston School of Medicine.

I look forward every year to Bates-Andrews Day because it gives our students the chance to share with the rest of the Tufts community their accomplishments in fields of special interest. I applaud them for their initiative, hard work, and achievements.

Returning this year is the "Bring Your Own Device Peer Engagement" activity in which visitors can give students' posters direct feedback online using a smart phone, tablet, or laptop. This is an exciting aspect of our Bates-Andrews Day event, and I hope people will participate. Jennipher Murphy in Academic Affairs deserves appreciation for her efforts to make this happen again this year.

Strengthening and increasing research activity and creating an environment that encourages and supports student participation in research are integral parts of the School's strategic plan. Student research is also a key accreditation standard for all dental education programs.

I appreciate the dedication of the faculty advisors for their mentorship. Special thanks go to the judges and the participation of the commercial exhibitors who help make this event possible. Finally, Eileen Doherty's guidance as director of predoctoral student research and Dr. Gerard Kugel's leadership as Associate Dean for Research are highly valued, as their expertise enhances our students' research experiences.

**Huw F. Thomas, B.D.S., M.S., Ph.D.**  
*Dean and Professor of Pediatric Dentistry*

## MESSAGE FROM DR. KUGEL

The research mission of Tufts University School of Dental Medicine promotes integration of innovative studies in basic science, clinical practice, and public health. This book is evidence of the progress we have made and will continue to make at the Dental School.

TUSDM welcomes the valuable partnerships and contributions of corporations, foundations, the NIH, and the NIDCR. Working together, we have the means to perform ethical, meaningful research in oral and general healthcare that can be applied for the benefit of the scientific community and the public at large.

Researchers at TUSDM conduct studies in many areas, including bench and clinical studies in dental materials, devices, and pharmaceuticals. We are presently pursuing groundbreaking techniques in many areas, including tissue engineering, bone remodeling, and Sjögren's syndrome. Our dental school is widely recognized as a leader in public health dentistry both in the United States and worldwide. Tufts University School of Dental Medicine also provides a wealth of opportunities for interdisciplinary research with our schools of nutrition, biomedical sciences, veterinary medicine, and engineering.

The combination of disciplines and talent at Tufts University provides the ideal environment for collaborative research and materials testing. Our record of contributions to the sciences and our potential to influence the future of dental medicine are extensive.

As we continue to promote oral health and improve the quality of life for the general population, we remain aware that strategic partnerships are vital to our efforts. We recognize the power of shared knowledge and are always looking to share resources and ideas. The pages that follow reveal a sample of our achievements thus far.

**Gerard Kugel**, D.M.D., M.S., Ph.D.  
*Professor and Associate Dean for Research*

## ACKNOWLEDGEMENTS

### *Corporate Partners*

We would like to recognize and thank the following organizations or individuals that support us:

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### *Special thanks to the following Tufts faculty and students:*

#### Research Committee

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*Dr. Shuchi Dhadwal*

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*Dr. Natalie Jeong*

*Dr. Gerard Kugel*

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#### Bates Student Research Group and Andrews Society Officers

*Kathryn Weber, President*

*Sama Abdul-Aziz, Vice President*

*Alisha Anand, Secretary*

*Kanupriya Tewari, Treasurer*

*Andrew Lum, PR/Community Service Representative*

# BATES-ANDREWS DAY 2017

Wednesday, March 8, 2017

## SCHEDULE OF EVENTS

11:00 am – 3:00 pm	Predoctoral and postdoctoral student posters on display Commercial Exhibitors
3:30 pm – 5:00 pm	Keynote Speech
5:00 PM	Awards Presentation and Reception

## KEYNOTE ADDRESS

### *“Distilling Your Message” Interactive Plenary*



**Robert Milman, M.D.**

*Senior Clinical Advisor, Center for Health Communication  
Moody College of Communication  
University of Texas at Austin*

Rob Milman, M.D., is a retired diagnostic radiologist and former partner in the Austin Radiological Association in Austin, Texas. Dr. Milman has a deep interest in promoting effective health communication and is the senior clinical advisor at the Center for Health Communication at the University of Texas at Austin. He received advanced health communication training at the Alan Alda Center for Communicating Science at Stony Brook University. Dr. Milman is the medical communication coordinator for Merlin Works, an applied improv company in Austin, Texas. Dr. Milman has led numerous health communication workshops for medical and advanced practice provider students, medical school faculty, private practice medical groups, and hospital systems. Dr. Milman holds additional academic appointments with the Texas A&M University College of Medicine, the UT Austin School of Nursing, and the UTMB Galveston School of Medicine. He presents regularly on diagnostic imaging, clinical decision support, health communication, medical litigation, and risk management. Dr. Milman and his wife Wendy are the proud parents of two daughters.

# BATES-ANDREWS RESEARCH DAY 2017





## **BATES-ANDREWS DAY 2017 AWARDS**

### **Best Postgraduate Poster Presentation**

**Dr. Pooyan Refahi**—“Comparison of Autogenous Graft and Soft Tissue Alternatives: Case Report”

### **Best Scientific Research Presentation by a Senior (Andrews Society Award)**

**Kanupriya Tewari**—“Effect of Material and Storage Temperature on Sealant Microleakage”

### **ADA/DENTSPLY Student Clinician Award for Best Overall Predoctoral Table Clinic**

**Yusuf Sheikh**—“Retrospective Analysis of Tooth Loss following Periodontal Regeneration: 196 Patients”

### **Second Place Award for Predoctoral Table Clinic**

**Lauren Gerkowicz**—“Identifying Stress-Related Variables: Building Effective Programs to Reduce Student Burnout”

### **Third Place Award for Predoctoral Table Clinic**

**Harsh Patwari**—“Prevalence of Medical Emergencies at TUSDM”

### **Research Committee Award for Basic Science Research**

**Arietta Rigopoulos**—“Tumor Cell Energy Metabolism in Basal Cell Carcinoma Development”

### **Massachusetts Dental Society and ASDA Public Health Award**

**Houda Hamze**—“Knowledge and Awareness of Boston Public School Nurses on the Emergency Management of Dental Trauma”

### **Omicron Kappa Upsilon (OKU) Hilde Tillman Award**

**Stephanie Phillis and Sarah Schuback**—“Silk Fiber Films for the Localized Release of Antibiotics”

### **Dr. Chad Anderson Family Award for Innovative Methodology and Research**

**Michelle Ta**—“Microleakage Evaluation of Elevated Temperatures in Combined Adhesives and Restoratives”

### **Esthetic Dentistry Award**

**Timothy Reichheld**—“Observational Staining Properties of Silver Fluoride on Dental Materials”

### **Scientific Merit Award for First-Time Presenters**

**Syed Hussain**—“Color Stability of Three Restorative Materials: An *In Vitro* Study”

### **Oral Health Disparities Award**

**Tuvy Phan**—“Phase II: Testing an Oral Health Educational Booklet on the Appeal, Readability, and Usefulness with Students and Patients in the TUSDM Predoctoral Clinic”

### **Bates Student Research Group “Peer-Reviewed” Award**

**Holly Fadie**—“Opportunities for Speech-Language Pathologists to Incorporate Oral Health in Practice”

### **ADEA Student Group Educational Research Award**

**Meghan Kelley**—“ADEA Hack-a-Thon Suggests Interprofessional Education Most Vital to Academic Success”

### **Procter & Gamble AADR Traveling Fellowship Award**

**Sahar Mostafavi**—“Early Flexural Strength of Temporary Crown and Bridge Materials”

### **AA DR Student Research Day Award**

**Andrew Lum**—“Lateral Wall Thickness among Schneiderian Membrane Perforations: A CBCT Study”

### **Multicultural Award for the Advancement of Dental Research**

**Sangita Murali**—“Extrinsic Stain Removal: A Power Toothbrush vs. Manual Toothbrush Study”

## PREDOCTORAL STUDENT PRESENTATIONS

*Note: If required, the Tufts University Health Sciences Institutional Review Board (IRB) reviewed and approved the study or determined that it was not human subject research..*

**Sama Abdul-Aziz, D18** (p. 22)

Identifying Diagnostic Salivary Biomarkers for Sjögren's Syndrome

**Daria Ameri, D19** (p. 24)

Wear Resistance Comparison of Glass Ionomer Materials

**Alisha Anand, D18** (p. 25)

Depth of Cure and Esthetics of Bulk-Fill Composites

**Aarthi Balasubramaniam, DIS17** (p. 27)

Prevalence of Periodontal Bone Loss in Patients with Joint Replacement

**Kelly Barbera, D18** (p. 28)

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## STUDENT PRESENTATIONS AND ABSTRACTS

Note: Names marked with an asterisk denote presenter of paper.

## PREDOCTORAL STUDENT PRESENTATIONS

### Identifying Diagnostic Salivary Biomarkers for Sjögren's Syndrome

Sama Abdul-Aziz,<sup>1\*</sup> Wanlu Qu,<sup>2</sup> Dillon Hawley,<sup>1</sup> Arwa Farag,<sup>1</sup> Noe Duenas,<sup>1</sup> Britta Magnuson,<sup>1</sup> Elizabeth Tzavaras,<sup>1</sup> Athena Papas,<sup>1</sup> Markus Hardt,<sup>2</sup> and Driss Zoukhri<sup>1</sup>

<sup>1</sup>Tufts University School of Dental Medicine; <sup>2</sup>The Forsyth Institute

**OBJECTIVES:** Although Sjögren's syndrome (SjS) is a prevalent autoimmune disorder, confirming the diagnosis remains difficult to achieve due to the lack of definitive diagnostic methods. Development of a protein biomarker profile would allow for a highly sensitive and specific diagnostic method. By comparing the proteomes of individuals with and without SjS, alterations in the composition of the salivary proteome can be observed and potential biomarkers identified. The purpose of this study was to determine which proteins could be considered as biomarkers for SjS diagnosis.

**METHODS:** Twenty-one SjS patients and 18 age-matched healthy controls were recruited. Stimulated whole saliva was collected. One hundred  $\mu$ g of protein was trypsin-digested and alkylated. Digests were desalted for proteomics analysis using nano LC-MS/MS. Multiple search algorithms were used for protein identification.

Label-free quantitative analysis was performed using Sieve 2.2 software. For validation, 10  $\mu$ g of 9 SjS and 9 healthy samples were separated by SDS-PAGE followed by transfer to PVDF membranes for Western blotting. Immunoreactive bands were visualized and quantified using the Odyssey<sup>®</sup> Infrared Imaging System.

**RESULTS:** SjS and healthy subjects' demographics are summarized in Table 1. Unstimulated and stimulated salivary flow rates were lower for patients diagnosed with SjS compared to healthy subjects. Using nano-LC-MS/MS, over 1,057 proteins were identified across the samples at a 1% false identification rate. Multiple search engines boosted the identification rate. After chromatographic alignment, MS-features were detected and their peak areas were determined. Thirty-five protein candidates showed significant differences between SjS and healthy samples.



**Table 1.** Summary of patients' characteristics

	SjS (n=24)	Healthy (n=18)
Age <sup>1</sup>	57±10 (35–67) <sup>#</sup>	54±7 (45–68) <sup>#</sup>
Sex (F/M)	(24/0)	(18/0)
Disease Duration <sup>2,3</sup>	8±5 (2–20) <sup>#</sup>	N/A
Salivary flow rate <sup>4</sup>		
Unstimulated	0.264±0.286	0.735±0.339
Stimulated	0.949±0.816	2.178±0.896

<sup>1</sup>Median (years)±SD<sup>2</sup>Since diagnosis.<sup>3</sup>Mean (years)±SD<sup>4</sup>Mean (mL/min)±SD<sup>#</sup>Range (years)

**CONCLUSION:** Candidate proteins were identified that differ in their abundance in stimulated saliva samples collected from SjS and healthy patients. Select candidate proteins are currently being validated by Western blotting to verify whether these proteins can be included in the development of a protein biomarker profile to be used as a non-invasive method of SjS diagnosis.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California.*

*Abstract #1640.*

## Wear Resistance Comparison of Glass Ionomer Materials

Tyler Brady, Jeffrey Daddona, Katie Dunn, Daria Ameri,\* and Ronald Perry

**OBJECTIVE:** We aim to show that 4 different glass ionomer materials will vary in their toothbrush wear significantly over time, affecting clinical indications for the restorative purposes.

**METHODS:** Five samples (n=5) of 4 different GI materials were tested, totaling 20 samples. The disc samples measured approx. 10mm thick with a 10mm diameter. They were submersed in 5 mL of artificial saliva (KH<sub>2</sub>PO<sub>4</sub> + NaN<sub>3</sub> + KCl + CaCl<sub>2</sub> + MgCl<sub>2</sub>) for 1 week. The materials were IonoStar® Plus, VOCO (IS); GC Fuji IX GP®, GC America (F); Ketac™ Molar, 3M ESPE (KM); and ChemFil® Rock, DENTSPLY (CFR). An Oral B® Pro 3000 electric toothbrush was used with 25nm of pressure applied by a universal testing machine (Instron®5566A) to brush each sample for 2 min (~16,000 strokes). After, each sample was measured with an Ironton® electronic calipers in mm. It was put through this procedure 2 times (~32,000 strokes), and the 4 types of GI were compared to see if there was significant difference of wear between the 4 sample types.

**RESULTS:** Using an ANOVA one-way data analysis, it was found that CFR had significantly higher wear than IS, but not for the other 2 materials tested throughout the assay. The results are shown in Table 1 below.

**Table 1.** Measurements in mm at 32,000 strokes

Material	Mean	Std Dev	Minimum	Maximum
F	-0.1580000	-0.0920326	-0.2500000	-0.0400000
KM	-0.2040000	-0.0364692	-0.2600000	-0.1700000
IS	-0.1480000	-0.0506952	-0.2100000	-0.0800000
CFR	-0.3040000	-0.1038268	-0.4300000	-0.2000000

**CONCLUSIONS:** The findings suggest that there are possible advantages of working with specific GI materials in regard to lifespan when considering mechanical wear durability. The materials that had less mechanical wear over time will likely perform better in temporizing preparations in bruxers and environments where a stronger material is indicated. Dentists working with GI with greater wear resistance may have greater chance of successful temporization and caries prevention in patients with need of higher strength materials. These results may influence dentists in the selection of which GI they would prefer to use in their clinical practice.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #2603.*





## Depth of Cure and Esthetics of Bulk-Fill Composites

Alisha Anand,\* Sarah Pagni, Gerard Kugel, and Ronald Perry

**OBJECTIVES:** To achieve the depth of cure (DoC) required, bulk-fill composites typically have a lower contrast ratio (CR) and yellow ( $b^*$ -value) than universal composites. The yellow pigment competes with yellow photo-initiators for the blue-curing light, making it difficult for the composite to cure at full depth. The aim of this study was to relate the DoC of bulk-fill composites to shade level using shade vector (SV) where  $SV=(CR^2+b^{*2})^{1/2}$ .

**METHODS:** Eleven bulk-fill composites were compared ( $n=3$ ) (See Table 1). DoC was measured according to ISO4049-7.10 using a 20s cure with the Elipar™ DeepCure-S (3M). Additionally, CR and color ( $L^*a^*b^*$  values) were measured before and after light cure using Color i™7 Spectral Photometer (x-rite®) for all composites. Disk-shaped specimens were prepared (height=1.00 mm, diameter=30 mm) and flattened ( $1.00\pm 0.02$  mm). CR and  $b^*$  were measured before and after 20s light cure with an LED array  $1000\text{mW}/\text{cm}^2$ , CF2000, Clearstone Technologies, Inc.

**RESULTS:** Tukey's Pairwise Comparison was used to group DoC. There is a significant difference between the groups with a DOC of ~4 mm when comparing SV (one-way ANOVA,  $p<0.001$ ). When a post hoc pairwise comparison of the ~4mm products' SV was done using Tukey's HSD, both experimental products (EXD-942) were found to be statistically different from the other commercially available ~4mm products (all  $p<0.05$ ). However, the DoC between both EXD-942 and the other ~4mm products were not significantly different ( $p=0.07$ ). Both EXD-942 showed the highest CR increase during cure, while most commercial materials showed a decrease (Table 1).

**Table 1.** Shade Vector, Depth of Cure, and  $\Delta$ Contrast Ratio for bulk-fill composite used in this study as well as the new experimental material.

Material (Abbreviations)/Shade	Manufacturer	Depth of Cure (20s)	Shade Vector	$\Delta$ CR
X-tra fil (XF-U)	VOCO	5.2±0.0 <sup>A</sup>	39.6±0.1	-8.6±0.3
Filtek™ Bulk Fill Posterior Restorative (FFB-A1)	3M Oral Care	4.6±0.2 <sup>*B</sup>	45.8±0.2	-4.6±0.0
Filtek Bulk Fill Posterior Restorative (FFB-A3)	3M Oral Care	4.6±0.2 <sup>*BC</sup>	43.7±0.1	-6.3±0.0
Tetric EvoCeram® Bulk Fill (TE-IVB)	Ivoclar-Vivadent®	4.4±0.1 <sup>*BCD</sup>	43.7±0.2	-0.7±0.1
Beautiful Bulk Restorative (BB-A)	Shofu®	4.3±0.0 <sup>*CD</sup>	48.7±0.0	1.0±0.1
3M Experimental Material (EXD-942-A1)	3M Oral Care	4.3±0.1 <sup>*CDE</sup>	53.4±0.1	2.5±0.4
Tetric EvoCeram Bulk Fill (TE-IVB)	Ivoclar-Vivadent	4.2±0.2 <sup>*DE</sup>	45.0±0.3	-0.2±0.5
3M Experimental Material (EXD-942-A3)	3M Oral Care	4.0±0.1 <sup>*E</sup>	54.5±0.3	2.4±0.1
Admira Fusion x-tra (AFX-U)	VOCO	4.0±0.0 <sup>*E</sup>	48.6±0.2	-9.1±0.1
Sonic Fill 2™ (SF-2-A1)	Kerr™	3.3±0.1 <sup>F</sup>	55.9±1.0	-2.4±0.2
Sonic Fill 2 (SF-2-A3)	Kerr	3.2±0.1 <sup>F</sup>	58.8±0.2	-2.4±0.1

\* denotes 4mm group

ABCDEF denotes grouping from Tukey's Test

**CONCLUSIONS:** Both EXD-942 had increased CR and a significantly higher SV when compared to commercially available bulk-fill composites of the same DoC. Instead of decreasing CR, they became more opaque hence the greatest positive  $\Delta$ CR (Table 1). The results support the higher esthetics of these composites while maintaining the high DoC, increased shading and opacity.

*Sponsored in part by 3M Oral Care.  
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Francisco, California. Abstract #0684.*



## Predoctoral Student Presentations

**Prevalence of Periodontal Bone Loss in Patients with Joint Replacement**

*Aarthi Balasubramaniam,\* Paul Levi Jr., Matthew Finkelman, Zuhair Natto, Gayathri Shenoy, and Robert Gyurko*

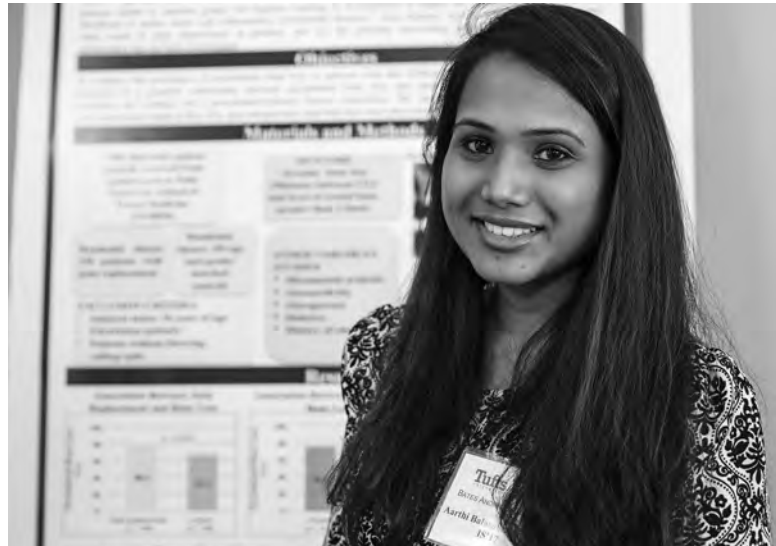
**OBJECTIVE:** Joint and periodontal diseases are among the most common diseases affecting bone. Joint diseases such as rheumatoid arthritis and osteoarthritis often result in joint replacement in patients, and yet the potential association between periodontitis and joint replacement has not been investigated. This cross-sectional study compares the prevalence of periodontal bone loss in patients with and without joint replacement.

**METHODS:** Periodontal bone loss in bitewing radiographs was evaluated in AxiUm® records of TUSDM patients with history of joint replacement and compared to those without joint replacement. Five hundred patient records (250 patients with joint replacement and 250 age- and gender-matched controls) were evaluated. The distance between the cemento-enamel junction to the alveolar bone crest as seen on bitewing radiographs of maxillary and mandibular molars and premolars was digitally measured and values greater than 2.5 mm were considered to have bone loss. The statistical analysis was done using chi-square test, and logistic regression.

**RESULTS:** Eighty percent of the subjects in the joint replacement group and 67% of the subjects in the control group exhibited periodontal bone loss on radiographs ( $p=0.0008$ ). There was a statistically significant association after adjusting for age and gender (OR=2.38, 95% CI 1.50–3.77). Sixty-six percent of the patients with joint replacement had a contributory history of osteoarthritis and 11% had a history of rheumatoid arthritis. A history of osteoarthritis was associated with bone loss (OR=1.84, 95% CI 1.08–3.13), while rheumatoid arthritis was not.

**CONCLUSION:** This study revealed that patients with prosthetic joint replacement have more alveolar bone loss compared with age-matched patients without joint replacement in the TUSDM patient population.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3483.*



## Endodontic vs. Implant Treatment Outcomes in Sjögren's Syndrome Patients

Kelly Barbera,\* Tamar Roomian, and Athena Papas

**OBJECTIVES:** The aim of this record review study was to compare failure rates of root canal treatment (RCT) versus dental implants amongst Sjögren's syndrome patients (SSP), and assess factors associated with failure. By comparing survival rates of RCT and implants in SSP, the goal was to determine how best to manage care of SSP impacted by hyposalivation and increased caries susceptibility.

**METHODS:** Dental records of SSP seen in the Oral Medicine Clinic at TUSDM were compiled and their radiographs reviewed to identify which SSP had RCT and/or implant placement. Of 240 records reviewed, 59 RCT (n=59) and 51 implant (n=51) patients were identified. Using radiographs, date of the procedure (RCT/implant) and date of the most recent radiograph were noted and evaluated to determine treatment success/failure. Treatment success was defined as the tooth being functionally present. Factors potentially impacting failure for each treatment modality were recorded, including age, tooth number, restoration type, pre-operative proximal contacts, stimulated and unstimulated saliva flow, sialogogue usage, preventative oral hygiene aid usage, and fluoride varnish use.

**RESULTS:** RCT teeth had a failure rate of 66.1%, while implants had a failure rate of 5.88%, which is a statistically significant difference ( $p=0.0107$ ). The odds of a RCT tooth failing was 36.02x larger than the odds of an implant failing (95% CI [2.29, 564.44]). In terms of factors impacting failure, patients taking sialogogue (Cevimeline) showed lower odds of RCT failure (odds ratio=0.039). Stimulated saliva flow below 1.5 mL/min was statistically significant in predicting RCT failure. For all other potentially contributing factors, analysis failed to find statistically significant differences in predicting failure.

**CONCLUSIONS:** It was confirmed that RCT is associated with higher failure rate than implants in SSP. Continued investigation and increase in sample size is necessary to determine which factors contribute most to treatment failure for RCT and implants.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3318.*



## Predocctoral Student Presentations

### Student Clinical Confidence and Experience after Global Service Learning

Elizabeth Betances,\* John Morgan, Leopoldo Correa, Tamar Roomian, and Britta Magnuson

**OBJECTIVE:** Previous studies have shown that students participating in community-oriented dental education programs had higher restorative scores on licensing exams and higher clinical productivity when compared to students who did not participate in similar programs. This study was done to determine whether a global service learning (GSL) program improved clinical confidence and cultural and community awareness.

**METHODS:** Predocctoral students participating in the GSL program to the Dominican Republic at TUSDM were administered pre- and post-surveys evaluating confidence levels in a variety of clinical procedures and community service. Using a Likert scale (1: strongly agree to 5: strongly disagree), students were asked 12 questions on confidence in specific clinical procedures and 5 questions on community service involvement in the pre-trip survey. Post-trip surveys included an additional 2 community service questions. Mann-Whitney *U* test results were calculated as well as descriptive statistics.

**RESULTS:** Of 24 students attending, 7 completed the pre-trip and 10 completed post-trip surveys. A statistically significant increase of confidence was found in performing a cavity preparation (pre-test median: 2.0; post-test median: 1.0; *p*-value=0.03) and using composite as restorative material (pre-test median: 2.0; post-test median: 1.0; *p*-value=0.03). In post-trip questions regarding community service, all students either strongly agreed or agreed that service-learning improved ability to communicate with dental patients from diverse cultural and linguistic backgrounds (median: 1.5; IQR: 1.0) and that service-learning improved ability to apply triage, diagnostic, and treatment planning skills for individuals in a variety of community settings (median: 1.5; IQR: 1.0).

**CONCLUSION:** The GSL program increased confidence in cavity preparation and use of composite. Students reported post-trip improvement in confidence in communicating with individuals from diverse backgrounds and treatment planning in a variety of community settings. Use of this survey tool to assess GSL programs shows promise.



Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California.  
Abstract #0779.

## The Use of Caffeinated Substances for Cognitive Enhancement among Oral and Maxillofacial Surgeons

Mina Boulos,\* Archana Viswanath, Matthew Finkelman, and Morton Rosenberg

**OBJECTIVE:** To investigate the use of coffee, caffeinated drinks, and caffeine tablets for cognitive enhancement among oral and maxillofacial surgeons.

**BACKGROUND:** Cognitive enhancement (CE) is the pharmaceutical augmentation of mental abilities (e.g., learning or memory) without medical necessity. Oral surgeons have demanding workloads, and the resulting fatigue and concentration deficits can lead to medical errors. Stimulants, such as caffeine, have been shown to increase things such as psychomotor vigilance and test speed. These are essential when dealing with emergencies. In the academic setting, OMFS attendings and residents can be on call after a long day of seeing patients dealing with emergencies throughout the night. The dependence on caffeinated substances may be an issue in the OMFS profession due to high demand of performance over a long interval of time. Overuse of caffeinated substance is problematic. It can have detrimental effects on one's health. The results of heavy caffeine use are insomnia, nervousness, restlessness, irritability, upset stomach, fast heartbeat, and muscle tremors. Our hypothesis is that some oral surgeons use cognitive enhancement substances that promote wakefulness to counteract these effects.

**METHODS:** A prospective study was conducted by sending an anonymous self-report questionnaire to randomly selected oral surgeons nationwide. Nineteen survey questions asked respondents about the use of, type of, and reason for using caffeinated substances for cognitive enhancement. Additional demographic questions such as type of practice, gross income, and marital status were also included.

**RESULTS:** The survey was sent out to 711 oral surgeons and 68 responded. Of these, 53.13% reported using caffeinated substances for CE. The most prevalent reason stated for using caffeinated beverage was to cope with fatigue (75.86%). Other reasons were to enhance mood (41.38%), increase concentration (31.03%), excessive working hours (20.69%) and studying (20.69%). Coffee (91.8%) was the most frequently reported beverage used for CE.

**CONCLUSIONS:** Surgeons often use caffeinated substances to cope with fatigue and long working hours. Coffee use was more prevalent than the use of caffeinated drinks and caffeine tablets.

*Presented at the 2017 ACOMS and CAOMS Joint Annual Conference in Vancouver, British Columbia, Canada.*



## Predocctoral Student Presentations

### Orthodontic Application of Monobond Plus on Ceramic Materials

Timothy Reichheld, Gregory Monfette, David Cardaropoli,\* Ronald Perry, Matthew Finkelman, and Gerard Kugel

**OBJECTIVES:** This study assessed the ability of Monobond Plus® to increase adhesion between bracket and ceramics and its potential use as an orthodontic bonding resin.

**METHODS:** A total of 140 samples were used (n=35 per group). Group 1: IPS e.max® CAD rods (Ivoclar Vivadent) treated with Assure PLUS® (Reliance Orthodontics, USA); group 2: IPS e.max CAD rods treated with Monobond Plus® (Ivoclar Vivadent); group 3: Jensen XT zirconia rods (Jensen Dental) treated with Assure PLUS; group 4: zirconia rods treated with Monobond Plus. For group 1, the surface was sandblasted, treated with silane porcelain conditioner, control resin, cement, and a bracket. For group 2, the surface was etched using IPS® Ceramic Etching Gel (5% HF) (Ivoclar Vivadent) for twenty seconds, washed, brushed with experimental resin and allowed to react for 60 seconds followed by cement and a bracket. For group 3, the surfaces were sandblasted, control resin was applied and light cured for 10 seconds, followed by cement and a bracket. Group 4 was sandblasted followed by application of experimental resin, which reacted for 60 seconds, cement, and a bracket. Transbond XT® (3M Unitek, USA) was used as cement, and all brackets were light cured for twenty seconds. The samples were allowed to sit for 24 hours before being tested with an Instron® Universal Testing Machine (Instron, USA).

**RESULTS:** The shear bond strength of group 1 was significant greater statistically than group 2 (p=0.006). When comparing groups 3 and 4, the differences were not significant (p=0.083).

**CONCLUSION:** Group 2 had significantly less bond strength compared to group 1 and requires a hydrofluoric acid etch. Thus it is not recommended for orthodontic application of brackets to porcelain. Clinically, however, group 4 is still a reasonable choice for dentists trying to bond brackets to zirconia.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3874.*



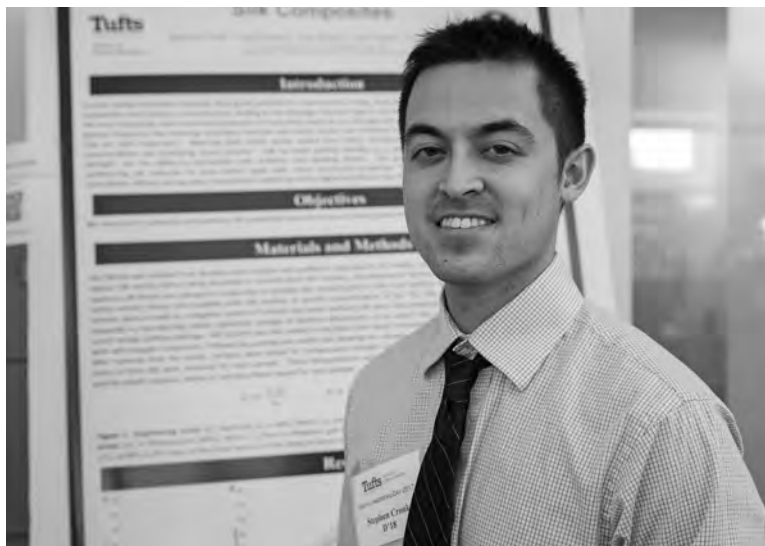
## ***In Vitro* Characterization of Dental Restorative Silk Composites**

Stephen Cronk,<sup>1\*</sup> Chiara Ghezzi,<sup>2</sup> David Kaplan,<sup>2</sup> and Gerard Kugel<sup>1</sup>

<sup>1</sup>Tufts University School of Dental Medicine, Boston; <sup>2</sup>Department of Biomedical Engineering, Tufts University, Medford, Massachusetts

**OBJECTIVE:** Current dental composite materials have great potential for improvement in long-term durability. Traditional Bis-GMA/GEGDMA-based composites suffer from several limitations, mainly due to polymerization shrinkage leading to postoperative sensitivity, microleakage, and caries. Our group has previously demonstrated success in producing silk biomaterials that are biocompatible, set rapidly, and possess robust mechanical properties. We now aim to synthesize and optimize silk composite materials for use in dental restorations.

**METHODS:** Silk fibroin was isolated from *Bombyx mori* cocoons and purified. Briefly, cocoons were cut into fragments, boiled to extract fibroin before being dissolved in LiBr solution, and dialyzed to remove LiBr, resulting in an aqueous silk fibroin solution. The silk fibroin solution was then combined at specific concentrations with various resin and glass ionomer dental materials until homogeneous. To reproducibly obtain identically sized samples of each silk-restorative combination while allowing removal of the cured restorations without damage, silicone rubber molds were prepared. Each combination of silk-restorative material was packed into molds to create cylinders of equal dimensions before curing according to manufacturer instructions. After removal from the molds, samples were tested for compressive strength using an Instron machine. Measurements of stress and compressive strain were obtained for each sample.



**RESULTS:** At increased silk content, samples underwent greater strain before deforming non-elastically than conventional resin, glass ionomer, or RMGI materials. Conventional materials resisted the highest stress. Silk (7%) combined with Ketac glass ionomer cement displayed the highest compressive strength of any silk-restorative sample tested.

**CONCLUSION:** These results are promising, as the amount of silk fibroin can be used to fine-tune the physical properties of a restorative material to more closely mimic natural dentin and enamel. In the dental setting, improvements to composite materials will have a great impact on the lifespan of composite restorations, reduce clinician time replacing failed restorations, reduce patient cost, and improve treatment outcomes.



## Predoctoral Student Presentations

## Are Dental Schools in the United States a Consumer Resource for Oral Health?

Ise d'Angelo,\* Meredith Epstein,\* Tofool Alghanem, and Nicole Holland

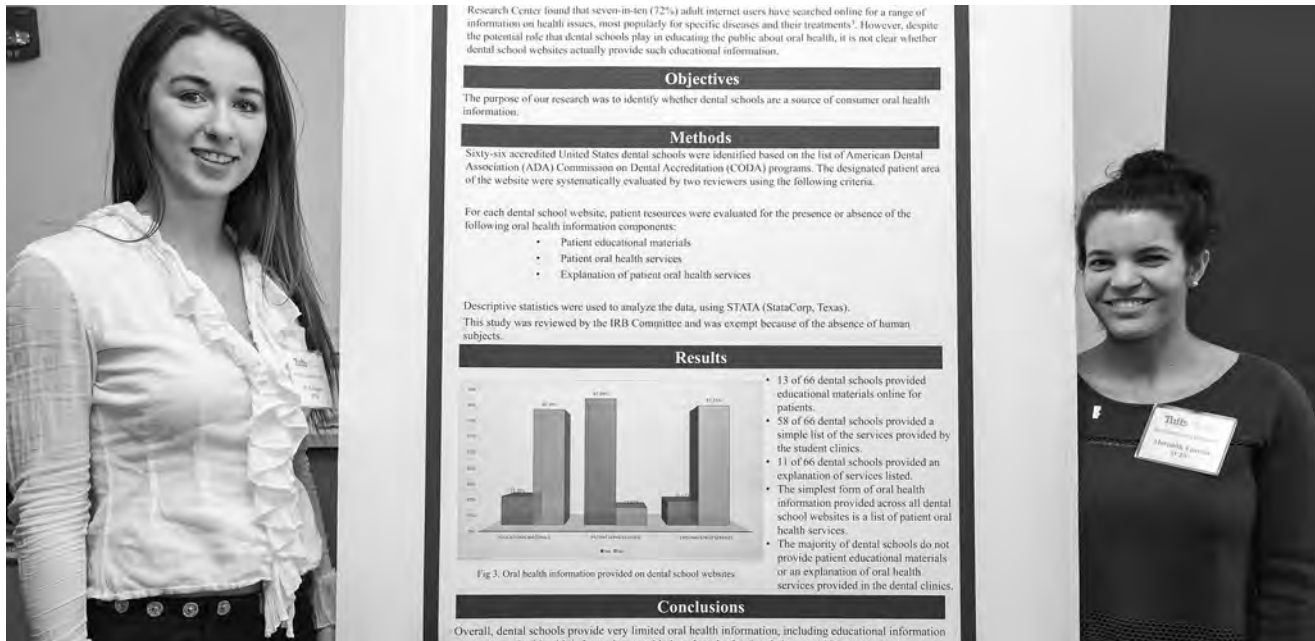
**BACKGROUND:** The importance of educational materials for patients is crucial in order to maintain successful oral health. These materials should be easily accessible to the general public on dental school websites throughout the country. Patients that become part of the clinics should be receiving factual information on prevention and care.

**PURPOSE:** The purpose of our research was to identify whether dental schools are a source of oral health information and have it readily available on their websites.

**METHODS:** We performed an e-scan on the 65 websites of U.S. dental schools. During the scan, we evaluated the designated patient area of the website and analyzed what resources are outlined for patients' use. We used the following criteria to evaluate the patients' resources: access the dental school website, click on the patient care section, and navigate to find an information library with general oral health information. We will then record whether information is available or not and organize the data in graphs and tables.

**RESULTS:** Out of 65 dental schools' websites, only small percentage offer consumer resources for oral health on their patient website platforms. For example, University of Pennsylvania offers a patient information library including: cavities 101, dentures 101, and periodontal treatment basics. On the other hand, New York University School of Dental Medicine provides information on becoming a patient, but not oral health educational materials.

**CONCLUSION:** Based on the results of this study, dental schools' websites in their current state are not a sufficient source for patients' dental educational materials.



## Hydraulic Conductance of Human Dentin Treated with Silver Fluoride

Jacob Donohue,<sup>1\*</sup> Timothy Reichheld,<sup>1</sup> M. Luo,<sup>2</sup> Gerard Kugel,<sup>1</sup> and Ronald Perry<sup>1</sup>

<sup>1</sup>Tufts University School of Dental Medicine, Boston; <sup>2</sup>Monash University, Melbourne, Australia

**OBJECTIVES:** This study compared the hydraulic conductance of human dentin disks treated with silver fluoride to assess reduction in dentinal sensitivity.

**METHODS:** Five groups of human dentin disks were analyzed for hydraulic conductance (Lp). Dentin disks (1.0±0.10 mm, n=7) were assigned to the following treatments: silverdiamine fluoride (SDF-A) (Riva Star Step 1, SDI Limited, Australia); SDF-A+ potassium iodide (SDF-A+KI) (Riva Star Step 1 & 2); silver fluoride (AgF) (Trial Material); AgF+KI (Trial Material and Riva Star Step 2); and SDF-B (Advantage Arrest™, elevate™ Oral Care). Disks were etched and stored in artificial saliva (pH 6.00) (modified Fusayama solution). The disks were placed into a chamber device and connected to a fluid reservoir bag on one end and millimeter tubing on the other end. Time and distance of the fluid flow was recorded for 30 minutes for the control group. Each dentin disk was removed, dried, treated with the respective material per manufacturer instructions, dried, rinsed with DI water, and returned to the chamber device. After the disc was treated, measurements were recorded at 60 minutes. The dentin disks were removed from the chamber and stored in artificial saliva. Lp (Figure 1) and percent change between the control and post-treatment were calculated and statistical results were analyzed using a pairwise *t*-test.

$$Lp = \frac{Q}{A (P_1 - P_2)}$$

**Figure 1.** Hydraulic Conductance Equation

**Table 1.** Percent Change of Lp

Treatment	Comparison	Percent Change Lp Mean ±SD	P
SDF-A	SDF-A+KI	65.48±15.48	0.012
	AgF		0.009
	AgF+KI		0.003
	SDF-B		0.180
SDF-A+KI	AgF	89.39±6.09*	0.330
	AgF+KI		0.460
	SDF-B		0.070
AgF	AgF+KI SDF-B	85.17±9.97*	0.600 0.220
AgF+KI	SDF-B	87.19±5.60*	0.090
SDF-B		77.20±10.31	---

N=7 per group; \*P<0.05 compared to SDF-A

## Predocctoral Student Presentations

**RESULTS:** A higher percent change of Lp from control to post-treatment was noted with SDF-A+KI compared to SDF-A ( $p<0.05$ ), AgF compared to SDF-A ( $p<0.05$ ), and AgF+KI compared to SDF-A ( $p<0.05$ ). Both SDF-A+KI and AgF+KI showed a greater percent change compared to SDF-B, however not statistically significant ( $p>0.05$ ) (Table 1).

**CONCLUSIONS:** Results of this study indicate that the use of KI (Riva Star Step 2) with SDF-A (Riva Star Step 1), AgF alone, and AgF with KI significantly decreased the Lp. Clinically, the use of KI may offer better reduction in dentinal sensitivity.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California.*

*Abstract #3290.*



**Treated with Silver Fluoride**  
 Johnnie<sup>1</sup>, T. Reichheld<sup>1</sup>, M. Luo<sup>2</sup>, G. Kugel<sup>1</sup>, and R. Perry<sup>1</sup>  
<sup>1</sup>Tufts University School of Dental Medicine, Boston, MA  
<sup>2</sup>Georgia Institute of Technology, Atlanta, Georgia

**Introduction**  
 Dentin hypersensitivity is a common problem for many people. Hypersensitivity is due to exposed dentin that is initiated by thermal, tactile, chemical, or osmotic stimuli and can occur in the absence of pain. The most acknowledged reason for dentin sensitivity is the permeability theory, which is the displacement of fluid within the dentinal tubules causing a fluid flow that stimulates the pulpal nerve endings<sup>1</sup>. Many products have shown varying degrees of relief, however a new product may be more beneficial. Silver diamine fluoride in combination with potassium iodide may offer a greater reduction in dentinal sensitivity.

**Objectives**  
 To evaluate the hydraulic conductance of human dentin disks treated with silver diamine fluoride and potassium iodide to determine the reduction in dentinal sensitivity.

**Materials and Methods**  
 Ten dentin disks were analyzed for hydraulic conductance (Lp). Dentin disks were assigned to the following treatments: Silver diamine fluoride (SDF-A) (SDI Limited, Australia), SDF-A+ potassium iodide (SDF-A+KI) (Riva Star fluoride (AgF) (Trial Material), AgF+KI (Trial Material and Riva Star Step 2), age Arrest<sup>TM</sup>, elevate<sup>TM</sup> Oral Care). Disks were etched and stored in artificial saliva (acidified Fusayama solution). The disks were placed into a chamber device connected to a fluid reservoir bag on one end and millimeter tubing on the other. The rate of the fluid flow was recorded for 30 minutes for the control group. Each disk was removed, dried, treated with the respective material per manufacturer instructions, rinsed with DI water, and returned to the chamber device. After the disk was returned, the fluid flow was recorded at 60 minutes. The dentin disks were removed from the chamber and placed in artificial saliva. Lp (Figure 2) and percent change between the control and treated groups were calculated and statistical results were analyzed using a pair-wise t-test.

## Fluoride Release of Dental Restoratives When Brushed with Fluoridated Toothpaste

Nancy Epstein\* and Ronald Perry

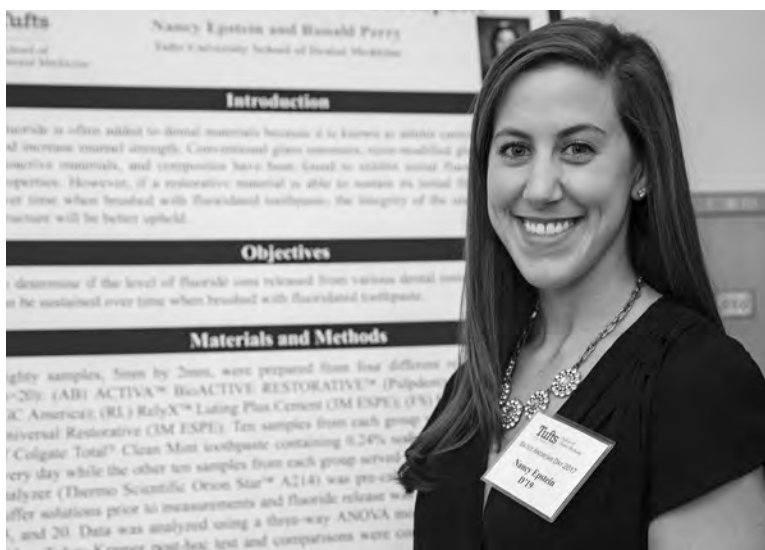
**OBJECTIVES:** Fluoride is often added to dental materials because it is known to inhibit caries progression and increase enamel strength. The purpose of this study was to determine if the level of fluoride ions released from various dental restorative materials could be sustained when brushed with a fluoridated toothpaste.

**METHODS:** Eighty samples, 5 mm × 2 mm, were prepared from 4 different restorative materials (n=20): group 1, ACTIVA™ BioACTIVE RESTORATIVE™ (Pulpdent); group 2, Fuji IX GP® (GC America); group 3, RelyX™ Luting Plus Cement (3M ESPE); group 4, Filtek™ Supreme Ultra Universal Restorative (3M ESPE). Ten samples from each group were brushed with 0.25 g of Colgate Total® Clean Mint toothpaste containing 0.24% sodium fluoride for 2 minutes every day while the other 10 samples from each group served as the control. A fluoride ion analyzer (Thermo Scientific Orion Star™ A214) was pre-calibrated with 1-, 2-, and 10ppm buffer solutions prior to measurements and fluoride release was measured on days 1, 5, 10, 15, and 20. Data was analyzed using a three-way ANOVA model of log transformed data with a Tukey-Kramer post hoc test, and comparisons were considered to be significant at  $p < 0.05$ .

**RESULTS:** The control groups that were not brushed with toothpaste generally displayed significant decreases in fluoride release throughout the study. When brushed with toothpaste, groups 1 and 4 significantly sustained fluoride release with group 1 releasing more fluoride ions each day except for day 5. Group 2 had a significant decrease in fluoride release until days 15 to 20. Group 3 sustained fluoride release between adjacent measurement days but had significant decreases overall.

**CONCLUSIONS:** This study demonstrated that the bio-active restorative is able to sustain fluoride release over time when brushed with fluoridated toothpaste compared to other restorative materials.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #1254.*



## Opportunities for Speech-Language Pathologists to Incorporate Oral Health in Practice

Holly Fadie,\* Jane Steffensen, Sarah Pagni, and John Morgan

**OBJECTIVE:** Speech-language pathologists (SLPs) have knowledge of the mouth and treat individuals with intellectual and developmental disabilities (IDD)—a population with oral health disparities. This study aimed to identify opportunities/challenges promoting interprofessional collaborative practice (IPCP) among oral health professionals and SLPs.

**METHODS:** A 32-item questionnaire was adapted from previously validated surveys. A panel of dental-hygienists (4), dentists (3), and SLPs (4) provided face and content validity. A convenience sample of SLPs were surveyed by a self-administered questionnaire via Qualtrics. The survey queried oral health attitudes, knowledge and experiences regarding individuals with IDD. Likert scales provided ordinal and count responses (5: strongly agree to 1: strongly disagree; 5: always to 1: never; 5: very comfortable to 1: very uncomfortable). Chi-square and Wilcoxon rank-sum test tested associations.

**RESULTS:** Preliminary data from 79 respondents reported 51% of SLPs never received oral health training; 88% reported requiring oral health knowledge/experience; 45% reported  $\geq 60\%$  patient caseloads with IDD. A majority of 55% reported oral health impacted their treatment/evaluation at least sometimes; 70% had interest in assessing oral health. More SLPs performed oral examinations who provided feeding/swallowing services versus those providing other services, e.g., language/articulation (2: frequently vs. 3: sometimes),  $p < 0.03$ . Also SLPs providing feeding/swallowing services were more likely to assess dietary habits (2: frequently vs. 3: sometimes),  $p < 0.001$ . SLPs serving more individuals with IDD were less likely to perform oral examinations compared to those with lower IDD caseloads (3: sometimes vs. 2: frequently),  $p = 0.02$ . Lack of oral health resources/information as a barrier was associated with SLP caseloads of  $>60\%$  patients with IDD,  $p = 0.04$ .



**CONCLUSION:** The majority of SLPs surveyed reported oral health of their patients impacted practice, expressed limited knowledge of oral health, and were interested in oral health IPCP. SLPs treating feeding/swallowing disorders have more oral health related experiences. SLPs with caseloads of mostly persons with IDD reported oral health information as a barrier to IPCP.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3315.*

## Enamel Surface Changes Observed in Gel vs. Light Activation Whitening

Anthony Falone,\* Jeffrey Daddona, Yoon Kang, and Aikaterini Papathanasiou

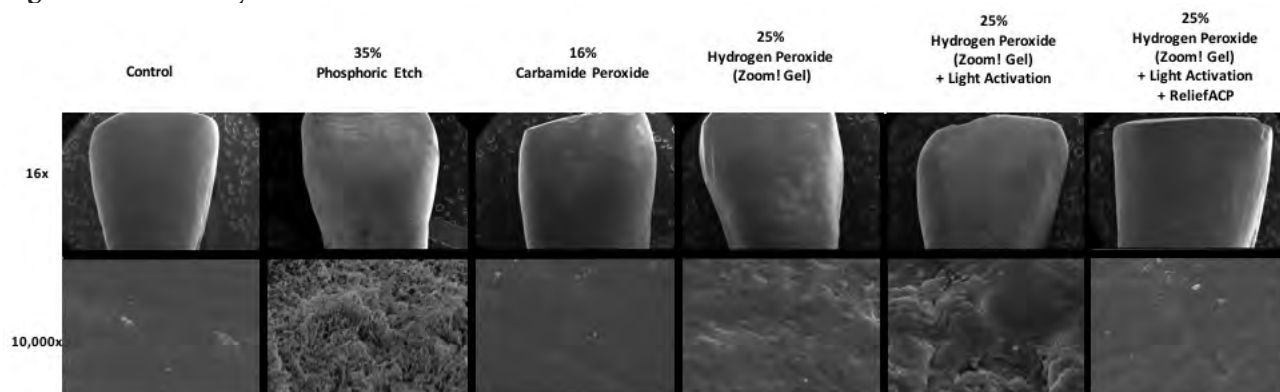
**OBJECTIVE:** Observational study to detect micro-structural enamel surface changes of gel-based versus light activation whitening.

**METHODS:** Six human extracted mandibular incisors in distilled water were assigned to 1 of 6 groups: CON=control, PE=35% phosphoric etch, CP=16% carbamide peroxide gel, HP=25% hydrogen peroxide (Philips Zoom!® gel), HP+LA=HP plus light activation (Philips Zoom! WhiteSpeed®, medium intensity), and RELACP=HP+LA with ReliefACP® gel (Philips). PE was applied for 30 seconds, CP for 4 hours/day x 7 days, HP, HP+LA and RELACP for 1 hour with gel replacement every 15 minutes, and ReliefACP applied for 30 minutes to RELACP post-whitening. Color analysis was obtained using Olympus Crystaleye Spectrophotometer with L\*a\*b\* values averaged over 3 trials per condition both before and after treatment. Crown body overall color difference ( $\Delta E$ ) was calculated subtracting post-treatment L\*a\*b\* values from pre-treatment L\*a\*b\* values (standard). Posttreatment samples were imaged using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) to determine structural morphology of the enamel surface changes.

**RESULTS:** All whitening conditions demonstrated color differences compared to CON (Table 1). SEM images showed spot-like enamel changes in HP compared to CON, but CP did not. HP+LA demonstrated homogenous enamel micro-structural changes compared to CON, but RELACP application showed morphological improvement from HP+LA.

	Control	35% Phosphoric Etch	16% Carbamide Peroxide	25% Hydrogen Peroxide (Zoom! Gel)	25% Hydrogen Peroxide (Zoom! Gel) +Light activation	25%Hydrogen Peroxide (Zoom! Gel) +Light activation +ReliefACP
( $\Delta E$ ) Crown Body	1.5	7.2	9.0	5.1	2.0	11.3

Figure 1. SEM Analysis



## Predocctoral Student Presentations

**CONCLUSION:** Gel-based and light activation whitening alters quantitative color, but SEM qualitative imaging demonstrates changes of depressions and porosities in enamel microstructure. However, ReliefACP treatment reduced enamel surface degradation, although a study with an increased sample size is needed to determine preliminary data significance.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California.  
Abstract #1940.*



## Adhesive Bonding Agent Film Thickness Influence on Microleakage

Jesse Feuerstein,\* Matthew Coletti, Sarah Pagni, Steven Eisen, and Gerard Kugel

**OBJECTIVE:** This study aims to evaluate the correlation between clinical radiographic film thickness and microleakage allowed by current adhesive bonding agent systems.

**METHODS:** Sixty-five third molars were selected at random for Class II mesial-occlusal cavity preparations. Divided into 5 groups of 13, each received a unique adhesive bonding agent per manufacturer instructions. Control group did not receive bonding agent; the remaining 4 groups received 1 of the following bonding systems: Clearfil™ SE Bond (Kuraray Medical; CF), ExciTE®-F (Ivoclar-Vivadent; EF), Peak® Universal Bond (Ultradent; PU), and Ace® All-Bond SE® (BISCO; AB). Preparations were filled with Filtek™ Supreme Ultra Universal Restorative (3M) and thermocycled for 10,000 cycles between 5°C and 55°C with a dwell time of 1-minute. Samples were immersed in 2% methylene blue for 24 hours, embedded in acrylic resin, and sectioned mesio-distally at the midline. Using an optical light microscope (Olympus-SZX16®), microleakage was rated at the tooth-restoration interface following the dye-penetration scale: 0=no penetration, 1=penetration less than one-third, 2=penetration beyond one-third, 3=penetration to axial wall. Dye-penetration was measured in micrometers with Buehler OmniMet 9.0 software. The median of the microleakage was compared using Kruskal-Wallis test with Dunn's test and the Bonferroni correction for pairwise comparisons.

**RESULTS:** The statistical median microleakage for AB and EF expressed higher values ( $p=0.0341$ ,  $p=0.003$ ) but did not provide statistical significance when compared to CF and PU ( $p=0.001$ ,  $p=0.003$ ). All adhesive agents expressed statistical significance when compared to the control ( $p>0.0001$ ). The statistical median of microleakage in increasing order: CF, PU, EF, AB, control. CF and PU are not statistically different in preventing microleakage.

**CONCLUSION:** Statistical evidence shows there is no direct correlation between microleakage and adhesive agent film

thickness. Therefore clinical radiographs showing a radiolucent region from adhesive bonding agent neither infers the presence of microleakage nor indicates the replacement of composite restorations.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3277.*





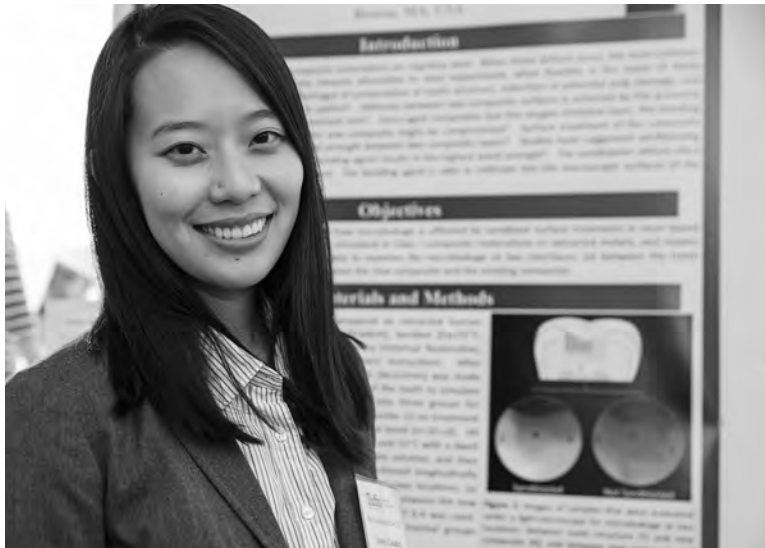
## Effect of Sandblast Surface Treatment on Microleakage of Repaired Composites

Sunny Gaudet,\* Steven Eisen, Sarah Pagni, and Gerard Kugel

**OBJECTIVES:** To investigate how microleakage is affected by sandblast surface treatment in resin-based composite restoration repairs.

**METHODS:** Thirty Class I ( $4 \times 4 \times 3$  mm) preparations were prepared on extracted human molars. All teeth were etched (Ultra-Etch®, Ultradent), bonded (Excite®F, Ivoclar Vivadent), and restored (Filtek™ Supreme Ultra Universal Restorative, 3M Oral Care). All steps followed the manufacturers' instructions. After storing the samples in water for 3 weeks, a notch ( $4 \times 2 \times 2$  mm) was made between the tooth structure and the composite in all of the teeth to simulate defects. The samples were then randomly assigned into 3 groups for different surface treatments prior to repairing with composite: (1) no treatment (control), (2) etch and bond, and (3) sandblast, etch, and bond (n=10). All samples were thermocycled for 5,000 cycles between 5°C and 55°C with a dwell time of 30 seconds, immersed in ammoniacal silver nitrate solution, and then exposed to a photo-developing solution. They were evaluated for microleakage in 2 locations: (1) between the tooth structure and the new composite and (2) between the new composite and the existing composite. A microleakage scale of 0–4 was used. Differences in microleakage scores between the 3 experimental groups were analyzed using the Kruskal-Wallis test.

**RESULTS:** Group 2 (etch and bond) showed a statistically significant higher microleakage dye penetration score between the new composite and the existing composite than group 3 (sandblast, etch, and bond) ( $p < 0.001$ ). There was no statistically significant difference in microleakage between the tooth structure and the new composite in the 2 groups.



**CONCLUSIONS:** Sandblast surface treatment prior to etching and bonding significantly reduced microleakage between new composite and existing composite in resin-based composite restoration repairs. Future studies with larger sample sizes will need to be done to confirm the findings.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #2597.*

## Identifying Stress-Related Variables: Building Effective Programs to Reduce Student Burnout

Lauren Gerkowicz,\* Sarah Pagni, and Ellen Patterson

**OBJECTIVES:** Multiple published studies document a high prevalence of stress and burnout in dental students. However, it is unclear how dental schools can best identify effective, targeted student interventions. To address these questions, a longitudinal survey research study was designed to explore multiple measures of perceived stress and variables related to stress resilience and academic performance. The aims of the study were to identify variables associated with higher levels of perceived stress, type and prevalence of activities used to manage stress, and relationships between stress symptoms, life events, and academic performance. This data will inform development of programs that identify and assist students at highest risk for stress-related problems, create tools and resources to promote stress resilience, and enhance dental school curricula to promote student wellness as integral to professional development and optimal patient care.

**METHODS:** The online voluntary survey included multiple validated measures of perceived stress as well as socio-demographic information, type and frequency of relaxation/stress management activities, and multiple additional variables linked to stress. The survey was administered twice (fall 2015 and spring 2016). Survey responses were matched and linked to students' academic records, then de-identified to protect student confidentiality. A \$10 gift card incentive was offered for completing each survey.

**RESULTS:** With the online tool, 125 D1 students completed both surveys. Statistically significant associations included decreased perceived stress at the second survey and the finding that students who used alcohol, marijuana, or sedatives at least once a week showed higher levels of stress, depression, and anxiety. No statistically significant associations were found between academic performance and the following variables: commute length, undergraduate major, being a caretaker of children, and time spent on active vs. passive stress-reduction activities. Of the total, 65% of D1 students believed that significant life events impacted their academic performance.

**CONCLUSION:** Preliminary data analysis demonstrates that stress-related symptoms are common and students report a wide range of activities to self-manage their symptoms. This ongoing study will provide data regarding modifiable variables associated with stress and its impact on dental students' academic performance and represents an important step toward the development of effective interventions to promote student wellness and stress resilience.

*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*



## Knowledge and Awareness of Boston Public School Nurses on the Emergency Management of Dental Trauma

Houda Hamze,\* Tarunjeet Pabla, Tamar Roomian, and Kathy Dolan

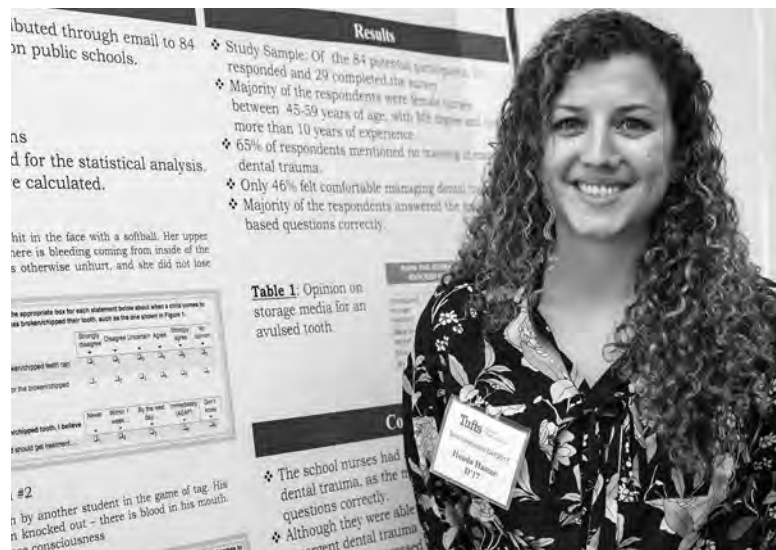
**BACKGROUND:** Traumatic dental injuries are widespread and a serious public health concern. The immediate action taken at the time of trauma can have a significant impact on the prognosis of dental health.

**PURPOSE:** The purpose of this study is to assess the knowledge, attitude, and awareness of school nurses in Boston on treating emergency dental trauma in school-age kids.

**METHODS:** A survey questionnaire was sent to randomly selected public schools. The questionnaire consisted of questions regarding background, training, knowledge, and attitude toward dental trauma.

**RESULTS:** The results determined that dental trauma among school nurses was adequate. Of the total, 45% felt comfortable in managing dental trauma and 65% expressed their desire to obtain further knowledge on treating dental trauma.

**CONCLUSION:** The school nurses had adequate knowledge in training dental trauma but would benefit from additional continuing education training to increase their confidence.



## Evaluating Students' Motivations to Pursue Dental Public Health: Questionnaire Design

Isaac Hong,\* Soo-Woo Kim, John Morgan, Tamar Roomian, and Britta Magnuson

**OBJECTIVES:** Dental public health (DPH) is a dental specialty that focuses on improving the oral health of a population. There is limited literature that assesses dental students' determining factors to pursue advanced education and eventually a career in DPH. This study was done to develop a questionnaire that can be used to help identify the primary motivational factors involved in deciding DPH as a future career choice.

**METHODS:** A questionnaire comprised of 41 questions was designed based on concepts in the literature and assessing intrinsic, extrinsic, social norm, attitude, and involvement factors. Face validity testing was done with 3 students to see the extent to which the survey design looked valid to the intended audience. Content validity testing was done with 3 dentists who have expertise in DPH to evaluate whether test items assessed defined content. Test/retest reliability was done with 3 students to measure the consistency of test results over time in the intended audience. Percent concordance for nominal variables and percent agreement within 1 point for Likert scale questions was calculated.

**RESULTS:** Face validity showed the questionnaire was easy to understand. Content validity testing showed the majority of questions pertained to the topic; some questions were adjusted according to expert suggestions. For test/retest reliability, the percent concordant value for the 26 Likert scale questions was 100% for all except 3 questions, which had a value of 66.7%. The percent concordant value for 15 nominal questions was 100% except for 5 questions, 4 had a value of 66.7%, 1 had a value of 33.3%. All discordant questions were then reevaluated.

**CONCLUSIONS:** After validity testing, the questionnaire was adjusted as suggested and then reliability testing found it overall reliable. For a future study, the questionnaire will be distributed to dental students to collect data on their motivational factors.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #1404.*



## Color Stability of Three Restorative Materials: An *In Vitro* Study

Syed Hussain,\* Tamar Roomian, Gerard Kugel, and Steven Eisen

**OBJECTIVE:** To evaluate the effect of 4 beverages on the color parameters of 3 composite resins.

**METHODS:** Filtek™ Supreme Ultra Universal Restorative-3M (FS), Bulk EZ-Danville (BEZ), and ACTIVA™ BioACTIVE-RESTORATIVE™-Pulpdent (AB) of A2 shades were evaluated. Sixty disc-shaped specimens of 8 mm in diameter and 2 mm in thickness were prepared (n=20 each). Color coordinates ( $\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$ , and  $\Delta E^*$ ) were recorded using Olympus Chrystal Eye unit after 24 hours of storage in distilled water (baseline) and after 1 day, 1 week, and 3 weeks of storage in green tea, black coffee, red wine, or water (control) (n=5). Color changes ( $\Delta E^*$ ) were analyzed using two-way ANOVA analysis, with  $p < 0.05$  as significance level. Results were adjusted for multiple comparisons using Tukey's HSD. Data was transformed to achieve homoscedasticity.

**RESULTS:**  $\Delta E^*$  ranged between 0.4 and 44.06 after 1 day, 1 week, and 3 weeks of staining.  $\Delta E^*$  for composites in all the beverages except water continuously increased from day 1 to 3 weeks. Red wine caused the most staining, followed by black coffee, green tea, and water except after 3 weeks when there was no statistical difference between the staining effect of coffee and green tea. Until 1 week, staining effect was independent of the composite material; however, by 3 weeks FS had stained significantly more than BEZ in green tea ( $p=0.0089$ ).

**CONCLUSIONS:** All the materials used in this study displayed clinically unacceptable color changes in red wine at all times. Staining due to black coffee and green tea was visually unnoticeable after day 1 but became noticeable after 1 week while still being clinically acceptable ( $\Delta E^* > 3$  but  $< 8$ ). BEZ was more color stable than FS after 3 weeks in green tea.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #1946.*



## One Institution's Experience with Medication-Related Osteonecrosis of the Jaw

*Robert Johnson III,\* Ray English III, Archana Viswanath, and Daniel Oreadi*

**PURPOSE:** The objective of this study was to describe the experience of TUSDM Department of Oral and Maxillofacial Surgery with medication-related osteonecrosis of the jaw (MRONJ) from January 2006 to June 2016.

**METHODS:** The investigators retroactively analyzed cases of MRONJ seen in the Department of Oral and Maxillofacial Surgery and at Tufts Medical Center. Several risk factors for MRONJ have been identified in the literature and were of principal concern to this study. Risk factors included tobacco use, chronic steroid use, diabetes, invasive dental procedures, age, and sex. The study also evaluated treatment performed and location of lesions.

**RESULTS:** Of the total, 14 patients were identified in the timeframe of interest. Prevalence of risk factors included 28.6% (n=4) of patients were smokers, 21.4% (n=3) chronic steroid use, 0% (n=0) diabetic, 71.4% (n=10) female, and mean age was 69 at time of treatment; in addition, 50% (n=7) were located in the right mandible, 35.7% (n=5) left mandible, 7.1% (n=1) bilateral mandible, 7.1% (n=1) left maxilla, and 7.1% (n=1) right maxilla. Of the total, 42.9% (n=6) of patients were treated conservatively (debridement and/or pharmacologically) and 57.1% (n=8) of patients were treated surgically (marginal or segmental resection).

**CONCLUSION:** MRONJ continues to be a rare condition that inflicts severe morbidity upon patients who are receiving bisphosphonate therapy for other severe conditions. The TUSDM experience with MRONJ can contribute to the literature examining MRONJ risk factors to better equip clinicians in rendering prognosis and treatment options.



## Faculty Development Initiatives in the Academic Environment: A Systematic Review

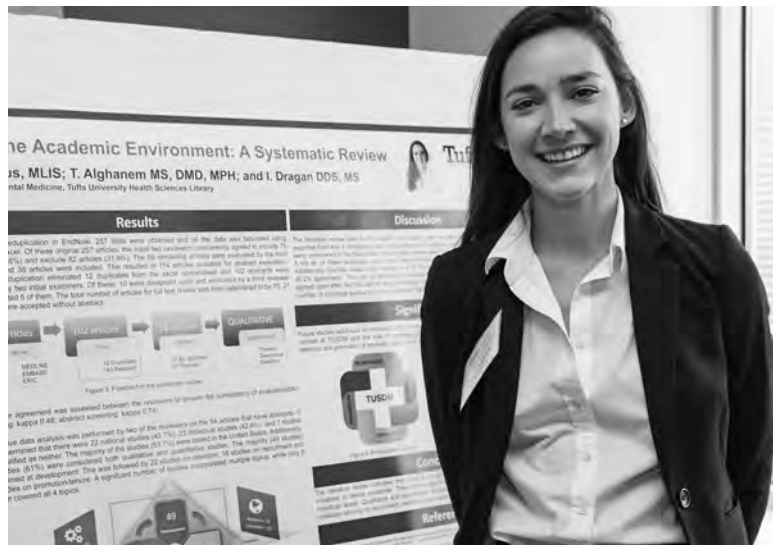
Chelsea Johnston,\* Natalie Jeong, Amanda Nevius, and Irina Dragan

**OBJECTIVE:** This systematic review aimed to evaluate the available literature focusing on the impact of faculty development initiatives in the dental academic setting.

**METHODS:** The current systematic review queried 3 different databases: MEDLINE via PubMed, EMBASE via Ovid, and ERIC via ProQuest from 1976 to November 2016. The MeSH terms included were: “staff development,” “faculty, dental,” and “organization and administration.” Additionally, the controlled vocabulary “personnel management,” “dental education,” and “dental schools” were included. The search was saved on all queried databases for future use and duplicated in EndNote. Qualitative and quantitative studies in the English language were selected for inclusion. Following an approved protocol, 2 reviewers independently examined the titles of the selected articles. A third reviewer was recruited to examine the titles and facilitate an agreement when needed. Counts and percentages were used to calculate the agreement between the 2 examiners.

**RESULTS:** Following deduplication in EndNote, 257 titles were obtained and all the data was tabulated using Microsoft Excel. During the title screening, an acceptable agreement analysis was noted between the 2 initial examiners. Furthermore, 114 articles were selected for the abstract evaluation. Of these original 257 articles, the initial 2 reviewers concurrently agreed to include 76 articles (29.6%) and exclude 82 articles (31.9%). The 99 remaining articles were evaluated by the third reviewer and 38 articles were included. Following the same protocol as for the title screening, abstract and full-text evaluation will be performed.

**CONCLUSION:** Our literature review indicates that there is a high interest in incorporating professional development initiatives in dental academia. Most of the publications are presenting 3 different fields available for faculty development: teaching, service, and research. More institutions are facilitating programs that support faculty members at different levels of their teaching career.



## ADEA Hack-a-thon Suggests Interprofessional Education Most Vital to Academic Success

Meghan Kelley,\* Jennifer Towers, and Irina Dragan

**OBJECTIVE:** The aim of this study was to assess group presentations developed by participants of the 2015 and 2016 New England Curriculum ADEA Hack-a-thon. During the event, students created presentations describing core components of fictitious dental schools. Each group identified curricula and values deemed most vital to academic success. Presentation requirements encouraged students to develop a curriculum in which graduates would be competent in essential areas of dentistry.

**METHODS:** In this IRB-approved study, 9 PowerPoint presentations were reviewed (5 from 2015; 4 from 2016) for the following themes: public health, community service, research, health and wellness, inter-professional education, integrating technology, dental academia, business, evidence based dentistry, pass/fail curriculum, problem based learning, systems based learning, and flipped classroom. Each presentation was de-identified prior to any data analysis. Mentions of key words/themes (listed above) were counted/tabulated for each presentation and averaged for each year and then compared by year.

**RESULTS:** Nine presentations suggested students feel interprofessional education is most vital to a successful dental curriculum. Of all themes presented in the 2016 event, interprofessional education was ranked highest (17.6%), slightly less than in 2015 (22.6%). Dental research was a recurring theme seen in presentations, 14.1% (2016) and 16.5% (2015). For 2016 themes, dental research was followed by community service and public health, compared with the 2015 themes, when problem-based learning and community service were commonly identified.

**CONCLUSION:** Common themes identified reveal some dental students feel collaborative practice along with community events are most preferred education tools. Students' participation in development of dental curricula might encourage academic careers. Aim 2 of this study, which includes key informant interviews of event participants geared to provide qualitative data to explain presentation choices, is underway.

*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*

...e based dentistry 17% and ... of each year (Table 2).

of theme (2016)	% of theme (2016)	p-Value
14.1	5.0	0.7
7.6	4.7	0.31
2.0	3.5	0.20
8.0	4.5	0.10
7.8	4.9	0.16
1.7	2.4	1.00

...ational education is most vital ... ce, and integrating technology, ... health and wellness in top ... righ informative interviews of ... service, health and wellness, ... riculum (Table 4)

**Discussion**

Students may place a stronger emphasis on interprofessional education, health and wellness, and community service/public health. Figure 4. Faculty may place a stronger emphasis on technology, research and focus on wellness when considering the dental curriculum. There may be a disconnect between what dental students and faculty members find to most vital to academic success. Results may be based upon limitations of the study, including: a small sample size and the investigators presence during data gathering.

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## Predoctoral Student Presentations

### Trends of Hospitalization and Cost of Dental Disorders

Zarina Khan,\* Nauman Siddiqui, Nadeem Karimbux, and Ronald Perry

**INTRODUCTION:** Although dental or oral health care in the United States is typically administered in the ambulatory setting, there are large number of patients that will require hospitalization for care of oral diseases. The need for hospitalization can arise from both emergent and non-emergent dental conditions that can range from traumatic maxillary fractures to elective repair of dentofacial anomalies. We felt it necessary to look at the inpatient admissions of patients requiring oral and dental care.

**METHODS:** We performed analysis of national inpatient sample (NIS) from 2002 to 2013, which is a part of health care utilization project. We used International Classification of Diseases, Ninth Revision, Clinical Modification ICD-9-CM codes (520.XX–529.XX) to identify primary admissions for all oral and dental diseases. We used SAS 9.4 for statistical analysis; frequency and mean were computed using SurveyFREQ; and SurveyMean and TRENDWT (discharge-level weight) were used for estimating at national level.

**RESULTS:** From 2002 to 2013, there were 563,468 admissions primarily for dental and oral disorders, of which 54% were females and 46% were males. The overall mean age was 41.5 years; mean age of females admitted was around 44 years while for males it was 39 years. The overall length of stay was 3.36 days. Patients with diseases of oral soft tissue had highest length of stay (4.50 [95% CI 4.45–4.56]) days while nonspecific diseases of teeth and supporting tissue had lowest length of stay (1.74 [95% CI 1.62–1.86]). The care for the diseases of jaws was most expensive, and the average hospital charges for each admission was \$33,760. While there was a modest increase in the length of stay, the cost of hospital stay has more than doubled over this period of time.

**CONCLUSION:** In conclusion, the cost of care of oral and dental disorders shows a significant rising trend. Efforts should be made to identify the factors that are driving the rising cost, and steps should be taken to contain this rise in the cost of care.



## Comparative Analysis of Diabetic and Non-Diabetic Patients with Periodontal Disease

Elizabeth Kim,\* Tamar Roomian, Ange Brome, Kanchan Ganda, and Gulsun Gul

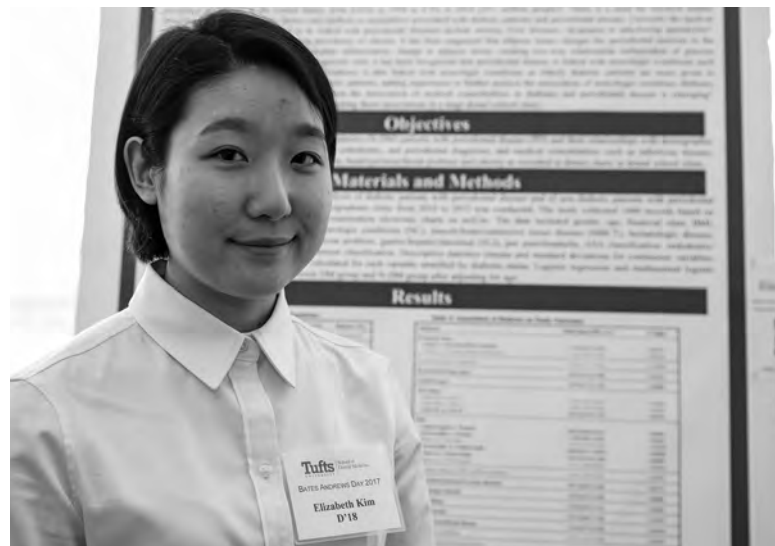
**OBJECTIVE:** The relationships between periodontal disease (PD) and diabetes, PD with infectious disease, neurologic conditions, gastric/hepatic/intestinal disorders, skin, retinal problems, and obesity have been documented. However, there has not been much done to establish the relationships and effect in diabetes. This study assesses diabetics (DM) and non-diabetics (N-DM) with PD, utilizing the health history and dental examination information in a dental school clinic.

**METHODS:** In a 5-year retrospective chart review, 302 records of 40+-year-old DM with PD and 1,231 records of 40+-year-old N with PD were collected. The demographic profiles and the self-reported health history (alcohol/drug usage, infectious disease (ID), neurologic conditions (NC), muscle/bone/connective tissue disease (MBCT), hematologic disease, eating disorder, skin, head/eye/nose/throat problem, gastric/hepatic/intestinal (SLI), jaw pain/headache) and ASA classifications were collected. The intraoral findings (endodontics/prosthodontics diagnosis, treatment classification) were collected. BMI was calculated. Data were compared between DM and N-DM by logistic regression and multinomial logistic regression, adjusting for age.

**RESULTS:** DM with PD had significant associations with ID (OR: 4.39, 95% CI: 2.03–9.49), NC (OR: 2.32, 95% CI: 1.45–3.70), and SLI (OR: 1.84, 95% CI: 1.12–3.02). Significant associations were found comparing DM to N-DM and class III vs. I treatment (OR: 2.5, 95% CI 1.56–4.02), class III vs. II treatment (OR: 1.834, 95% CI: 1.12–3.00), obese vs. normal-weight (OR: 3.51, 95% CI: 2.34–5.24), overweight vs. obese (OR: 2.72, 95% CI: 1.90–3.89), ASAI vs. I (OR: 2.78, 95% CI: 1.95–3.95), necrosis vs. normal endodontics (OR: 2.34, 95% CI: 1.36–4.02), prosthodontics full edentulous vs. none (OR: 2.56, 95% CI: 1.24–5.26).

**CONCLUSIONS:** These findings support the association of PD with diabetes requiring advanced dental care and having ID, NC, and SLI. No significant association was found with eating disorder, jaw pain/headache, MBCT, or hematologic diseases. Further investigation to understand diabetes and periodontal disease with different comorbidities is needed.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #0966.*



## Predocctoral Student Presentations

### Increased Viscosity of Fluoride Varnishes Stored at High Temperatures

Grace Kim,\* Sarah Pagni, Connie Kugel, John Morgan, and Gerard Kugel

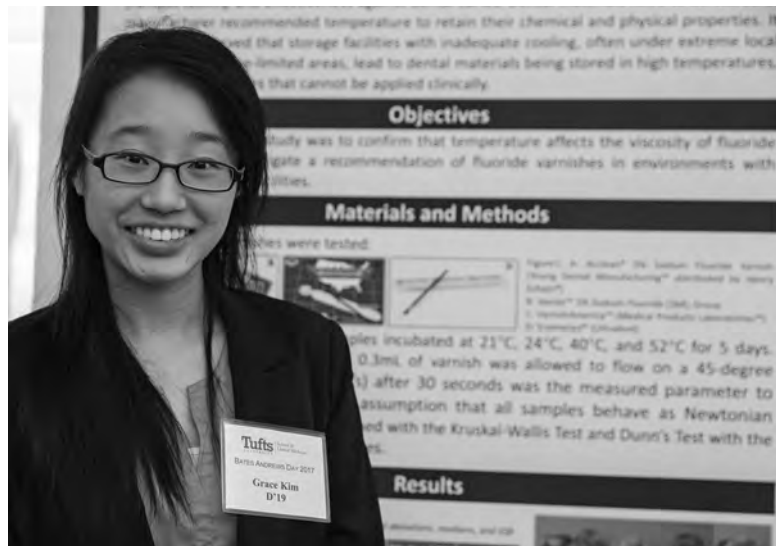
**OBJECTIVE:** The aim of this pilot study was to confirm that temperature affects the viscosity of fluoride varnish and to investigate a recommendation of fluoride varnishes in environments with inadequate cool storage facilities.

**METHOD:** Four brands of varnishes were tested: Acclean® 5% Sodium Fluoride Varnish (Young Dental Manufacturing™ distributed by Henry Schein®) (group A); Vanish™ 5% Sodium Fluoride (3M) (group B); VarnishAmerica™ (Medical Products Laboratories™) (group C); and Enamelast® (Ultradent) (group D). Each brand had a group of 5 samples incubated at 21°C, 24°C, 40°C, and 52°C for 5 days, respectively. Immediately following incubation, 3mL of varnish was allowed to flow on a 45-degree inclined plane. The distance traveled was recorded after 30 seconds. Since fluid flow is a factor of both Newtonian and non-Newtonian fluids, velocity was the measured parameter to correlate to the viscosity of samples. Statistical analysis was performed with the Kruskal-Wallis test and Dunn's test with the Bonferroni correction to adjust p-values.

**RESULT:** There were statistical significances in increased viscosity from the storage temperatures 24°C to 52°C in groups A, B, and C (p-values of 0.0002, 0.0395, and 0.0002 respectively). While there was flow for groups A, B, and C, group D was different. It had increased flow and decreased viscosity, up to 40°C, but at 52°C, the varnish became too viscous to be removed from the packaging and was deemed clinically unsuitable. Also, all varnishes except for group B experienced packaging leakage at 52°C.

**CONCLUSION:** Across all brands, it was observed that varnishes stored at 52°C resulted in increased viscosity. Thus, there was a failure to reject the null hypothesis that as temperature increases, the viscosity increases. Since group B had no packaging failures and had flow among the samples that were tested, group B demonstrated more favorable characteristics for the temperatures tested.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #1855.*



## Modulation of Fibroblast Growth and Metabolism by Sonic-Hedgehog Inhibitor Vismodegib

Sunnie Kuna,\* Arietta Rigopoulos, Tatiana Mendez, Johnson Fong, James Baleja, and Addy Alt-Holland

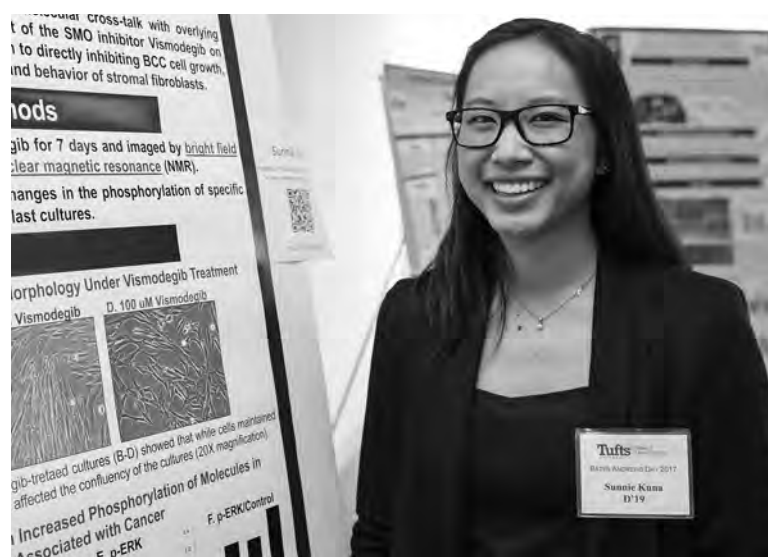
**OBJECTIVE:** The main manifestations of basal cell carcinoma nevoid syndrome include the development of multiple keratocystic odontogenic tumors (KCOTs) and dozens to hundreds of basal cell carcinomas (BCCs). Changes in the sonic hedgehog (SHh) pathway in neoplastic basal cells are major contributors of BCC development, and current SHh-targeted BCC therapies, such as Vismodegib, aim to inhibit SHh in these epithelial cells and abrogate tumor growth. However, the persistence of drug-resistant tumors and cancer recurrence suggests the contribution of additional mechanisms to BCC development. Since BCC cells develop in the context of supportive stromal cells within the tumor microenvironment, we investigated the response of dermal fibroblasts to Vismodegib.

**METHODS:** Cultures of human primary fibroblasts were treated with 10 nM, 10  $\mu$ M or 100  $\mu$ M Vismodegib or DMSO or for 7 days and imaged daily to analyze cell growth. Phosphorylation of specific signaling molecules was determined by PathScan array, and cultures conditioned media were analyzed by nuclear magnetic resonance (NMR).

**RESULTS:** Vismodegib-treated fibroblasts retained their characteristic spindle morphology. Relative to controls, Vismodegib-treated cultures showed increased phosphorylation of molecules such as ERK, P70-S6 kinase, and P-38, which are associated with signaling pathways that control cell proliferation, differentiation and motility, cell-cycle progression, and response to genotoxicity. NMR analysis revealed that fibroblasts treated with 10 nM and 10  $\mu$ M Vismodegib or DMSO secreted significant amounts of acetate, lactate, and glutamate and consumed mainly glutamine and pyruvate as energy sources. These secretion and consumption patterns were more modest in 100  $\mu$ M Vismodegib-treated cultures.

**CONCLUSION:** Although Vismodegib treatment aims to inhibit the SHh pathway in BCC cells, our study demonstrated a potential effect on the behavior and growth of the supportive dermal fibroblasts. This effect in the tumor microenvironment can in turn alter the growth of BCC cells and contribute to the pathogenesis of BCC and potentially of KCOTs.

Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #0421.



## Predocctoral Student Presentations

### Shear Bond Strength of Bonding Agents Aged Using 10,000 Cycles

Aaron Lalonde,\* Michael Miskelly,\* Jeffrey Daddona, Steven Eisen, and Gerard Kugel

**OBJECTIVES:** To determine the shear bond strength (SBS) of 4 different bonding agents at 1 day and after 10,000 thermo-mechanical cycles according to ISO 29022:2013.

**METHODS:** A sample of 96 extracted human teeth were obtained. Each tooth was embedded in acrylic and the dentinal surface was exposed. Eight groups were formed (n=12). Groups 1 through 4 were non-aged samples, and groups 5 through 8 were aged samples. Groups 1 and 5: DenTASTIC™ UNO™ (Pulpdent Corporation); groups 2 and 6: Clearfil™ SE Bond (Kuraray Dental); groups 3 and 7: Scotchbond™ Universal (3M ESPE); groups 4 and 8: ExciTE® F (Ivoclar Vivadent). Specimens were stored in distilled water at room temperature and used for the bonding procedure within 4 hours. Bonding agent was applied following manufacturer's instructions. Filtek™ Supreme Ultra (3M ESPE) composite was applied with dimensions of 2 × 2.38 mm using a bonding jig (Ultradent) and light cured (DEMI™, Kerr). Non-aged samples were tested for SBS after 24 hours of storage in distilled water. Samples were subjected to thermo-mechanical cycling for 10,000 cycles with a dwell time of 15 seconds between 5°C and 55°C to simulate aging. SBS was measured using a universal testing machine (Instron® 5566A, Norwood, Massachusetts) with a crosshead speed of 1 mm/minute. Statistical significance was assessed via two-way ANOVA; Bonferroni correction was used for post hoc tests.

**RESULTS:** Statistical analysis showed higher SBS for group 7 versus group 8 within aged groups (p=0.016). No other groups showed statistically significant differences.

**CONCLUSIONS:** The only statistically significant difference shown was between groups 7 and 8, with group 8 obtaining a higher SBS. Further research should be conducted to determine effects of increased aging beyond 10,000 thermo-mechanical cycles.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3852.*



## Three Dimensional Evaluation of the Cervical Vertebrae Maturation Index

Andrew Lemchen,\* Catalina Breton, Matthew Finkelman, Georgios Kanavakis, and Carroll Ann Trotman

**INTRODUCTION:** The cervical vertebrae maturation index (CVMI) is used to predict a patient's skeletal maturity and future jaw growth. The index is used by clinicians to rate on a 2-dimensional (2D) lateral cephalometric radiograph (LCR) the inferior border morphology of the C2-C4 vertebrae. A LCR, however, is a 2D representation of the 3-dimensional (3D) facial skeleton, and with the advent of cone beam computer tomography (CBCT), the true 3D morphology can be captured.

**OBJECTIVE:** To investigate the sensitivity of the CVMI by comparing the current approach using 2D LCRs of the C2-C4 morphology with that using 3D CBCT images. We hypothesized that there would be differences in vertebral morphology between the 2 approaches.

**METHOD:** The sample consisted of CBCT images of 18 patients (9 male and 9 female; age range, 8 to 17 yrs.). LCRs were generated from each patient's craniofacial CBCT, and the C2 to C4 images in the LCR were compared with sagittal slices from the CBCT. For each vertebra, the inferior border angle (measured from the border edges to the midline) and the maximum height of the concavity were compared between the LCR 2D and corresponding middle sagittal slice from the 3D CBCT. A mixed model analysis and paired *t*-test and Wilcoxon signed rank test were used to test for differences between the 2 images, respectively.



**RESULTS:** Averaged over all the patients' vertebrae, the angles for C2 and C3 measured from the CBCT were significantly smaller than the respective LCR angles ( $p < 0.001$ ). When individual patients' vertebrae were compared, the CBCT images had significantly smaller angles ( $p < 0.05$ ) and heights (range of significance,  $p < 0.01$  to  $p < 0.05$ ) than the LCR images. The results for the C4 vertebrae were not reported due to a low sample size.

**CONCLUSION:** The vertebral morphological differences between the CBCT and LCR images suggest that the CVMI assessment from 2D LCRs may not be a valid representation of skeletal maturity, and this may limit the sensitivity of the CVMI. Alternatively, the CVMI accuracy may be improved with CBCT images.

## Chronic Wound iPSC-Derived Fibroblasts Produce Altered Collagen and Fibronectin Levels

Olga Kashpur, James Leung,\* Avi Smith, Behzad Gerami-Naini, and Jonathan Garlick

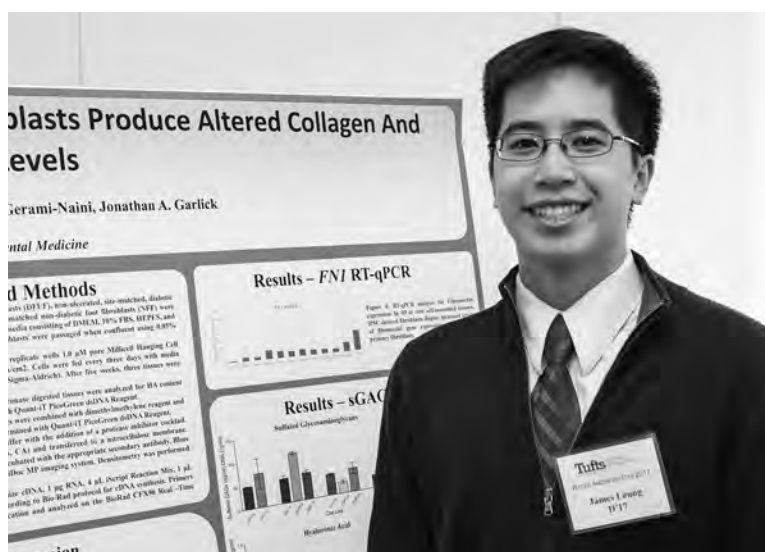
**OBJECTIVES:** Diabetic foot ulcers (DFUs) are a devastating complication of diabetes mellitus (DM) and are associated with altered extracellular matrix (ECM) production, inflammatory infiltration, and angiogenesis impairment. We have previously shown the aberrant production of ECM in primary DFU fibroblasts, when compared to normal (NFF) and diabetic (DFF) fibroblasts. We have reprogrammed into iPSCs and have differentiated these iPSCs to fibroblasts to test if fibroblasts revert to a more normal phenotype (*Cell Reprogram.* 2016 Aug;18(4):214–23). The aim of this study was to evaluate ECM production in iPSC-derived fibroblasts compared to primary NFF, DFF, and DFU cells.

**METHODS:** Primary and iPSC-derived fibroblasts were seeded on 1.0  $\mu$ m pore millicell hanging cell culture inserts and were cultured for 5 weeks to produce 3D self-assembly (SA) tissues. Gene expression of ECM proteins, including fibronectin (FN1) and collagen (COL1A1, COL1A2) was measured using real-time PCR and protein composition of the tissues was assayed by Western blot. Sulfated glycosaminoglycan (sGAG) content was determined using dimethylmethylene blue assay and hyaluronic acid (HA) content was quantified using HA ELISA.

**RESULTS:** Using 3D SA tissues, we compared ECM produced by iPSC-derived fibroblasts and primary fibroblasts. Real-time PCR analysis showed that iPSC-derived fibroblast tissues expressed less COL1A1 and COL1A2 and more FN1 compared to primary fibroblasts. Western blot analysis confirmed this real-time PCR data by showing elevated levels of FN1 protein in SA tissues. Further characterization of the ECM produced by iPSC-derived fibroblasts showed elevated levels of sulfated GAGs compared to primary fibroblasts in all iPSC-derived fibroblast lines, except for the lines that were derived from DFF24.

**CONCLUSIONS:** Fibroblasts that are iPSCs-derived produce ECM that differs from primary NFF, DFF, and DFU cells. This demonstrates that iPSC-derived cells have different properties than the parental cells, suggesting that iPSC-derived ECM should be further investigated for its potential to improve wound healing *in vivo*.

Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #0419.



## Lateral Wall Thickness among Schneiderian Membrane Perforations: A CBCT Study

Andrew Lum,\* Yumi Ogata, Sarah Pagni, and Yong Hur

**OBJECTIVES:** Lateral sinus augmentation is a standard treatment option among patients with inadequate alveolar ridge height prior to implant placement in the posterior maxilla. Despite the reported success of this procedure, clinicians frequently encounter intraoperative complications such as Schneiderian membrane perforation, which can cause bleeding, patient discomfort, loss of graft, sinusitis, and implant failure. The purpose of this retrospective study was to identify the relationship between lateral sinus wall thickness and membrane perforation during lateral sinus augmentation.

**METHODS:** This study included 189 patients with CBCT images taken prior to receiving lateral sinus augmentation at Tufts University Dental Clinics over a 10-year period. The lateral sinus wall was measured at heights 5 mm, 10 mm, and 15 mm from the alveolar ridge. This was repeated at 3 sites: second pre-molar, first molar, and second molar. Perforation rate and complications related to surgery were assessed through the axiUm database. Wilcoxon rank-sum test was used to reveal statistical significance ( $p < 0.05$ ) between perforation and non-perforation groups. This protocol received approval from Tufts University Institutional Review Board.

**RESULTS:** The lateral sinus wall was found to be thicker on average in patients with membrane perforation ( $n=55$ ,  $1.29 \text{ mm} \pm 0.30$ ) than in those without ( $n=134$ ,  $1.22 \text{ mm} \pm 0.26$ ). Differences in lateral wall thickness were observed between each tooth site, as well as between different heights along the maxillary sinus. Upon comparing the median among maximum lateral wall thicknesses, a statistical difference ( $p=0.02$ ) was found between the perforation group (1.82 mm) versus non-perforation group (1.50 mm).

**CONCLUSIONS:** Within the limits of this study, we concluded that lateral wall thickness is variable along the maxillary sinus. There was also an association between membrane perforation and the thickest point of the lateral sinus wall. Additional randomized controlled trials are recommended to confirm these findings.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #2373.*





## Predoctoral Student Presentations

## Nasal Decongestant and Piezoelectric Drill Effects on Sinus Membrane Perforation: A Retrospective Study

Sajal Swaroop, Megan Milder,\* Archana Viswanath, and David Chang

### OBJECTIVES:

- To determine whether any previous history of nasal steroid spray use increases the risk of perforation of the Schneiderian membrane during sinus lift procedures compared to patients with no history of nasal steroid spray use.
- To evaluate any frequency of perforations when using the piezoelectric system compared to using a Hall drill.

**METHODS:** This retrospective study was conducted at the TUSDM. Following IRB approval, clinical records of all patients who underwent external sinus lifts at the Oral and Maxillofacial Surgery Resident Clinic in the past 5 years were reviewed.

**RESULTS:** A total of 76 patients underwent this procedure, and there were a total of 29 (36.8%) perforations documented. Only 11 (14.5%) of the 76 patients had documented history of steroid nasal decongestant spray. Hall drill was used in 36 patients, piezoelectric system was used in 37 patients, and both the drills were used in 3 patients. Of those 29 perforations, a Hall drill was used in 16 (44.4%) procedures and piezoelectric drill was used in 10 (27.0%). There was perforation in all 3 of the cases where both the drills were used. Of those 11 sinus procedures done on patients with history of nasal steroid use, there were 5 (45%) perforations. In patients who did not have documented steroid use, there were 24 (36.9%) perforations.

**CONCLUSIONS:** This is an ongoing study. Results from this preliminary analysis show that there is not a statistically significant correlation between steroid nasal decongestant spray and the risk of perforation of the Schneiderian membrane. Furthermore, although there is higher incidence of perforation with use of a Hall drill, the results were not significant when controlled for other risk factors.



## The Gluten-Free Operative and Prophylaxis Dental Procedure

Melissa Ing, Michael Miskelly,\* Kyle Jonna,\* Britta Magnuson, Sarah Pagni, and Shubha Nanda

**OBJECTIVE:** Celiac disease is an autoimmune disorder where exposure to gluten causes small intestine damage. Gluten is a thickening agent that is found in foods, shampoos, and cosmetics. The number of celiac disease diagnoses has increased in recent years. Even trace exposure to gluten can cause severe gastrointestinal injury and discomfort in celiac-disease-positive and gluten-intolerant patients. In 2013, the FDA imposed a 20 ppm limit for gluten content in order for a food to be labelled as gluten free, but there are currently no labeling regulations for nonfood products. Fear of exposure to gluten-containing dental materials and subsequent gastro-intestinal problems can intimidate celiac-disease-positive and gluten-intolerant patients seeking oral health care. This study evaluated gluten content in dental materials routinely used in the TUSDM Predoctoral Student Clinic operative and prophylactic procedures.

**METHOD:** The study was nonhuman subjects research. Twenty-six routinely used TUSDM operative and prophylaxis dental materials were obtained and analyzed for gluten content using an Enzyme Linked Immunosorbent Assay (ELISA) kit, which uses anti-gluten antibodies to test for the presence of gluten proteins. The products were tested in triplicate and the results analyzed in comparison to a standard curve set with materials included in the test kit in order to ascertain the amount of gluten contained in each product.

**RESULTS:** According to the ELISA literature, for a product to be considered gluten free, it must test at a level below 5 ppm. All products tested showed gluten levels below 5 ppm, which is well below the 20 ppm limit established by the FDA for a food product to be labelled gluten free.

**CONCLUSION:** For a routine operative or prophylaxis visit, a patient visiting the TUSDM clinic is not at risk of exposure to gluten from the materials tested. All materials used in other dental disciplines at TUSDM should be tested to guarantee gluten-free dental visits. In addition, all products used in the dental setting including items such as soaps and lotions should be gluten free in order to provide a completely gluten-free dental environment.



*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*

## Predoctoral Student Presentations

**Contributions of International Authors to High-Impact U.S. Dental Journals**

*Kathleen Molgaard,\* Nadeem Karimbux, and Sarah Pagni*

**OBJECTIVES:** This project is a retrospective study based on the 2015 study, “Changing Demographics of Published Authors in United States Dental Journals.” The pilot established a trend of increasing publications by non-U.S. authors. This project will investigate which specific countries contribute significantly to the established trend.

**METHODS:** IRB exemption was granted. Investigation journals were selected based on the protocol used by the pilot: U.S. journals with the highest science citation index, with an impact factor greater than 2.5, and in publication since 1994 were chosen. The journals examined were: *Journal of Dental Research*, *Journal of Endodontics*, and *Journal of Periodontology*. For each journal, 5 complete sample years (1994, 1999, 2004, 2009, 2014) were investigated. Research articles from each given journal and year were examined to establish the country from which the principal investigator was based, and this information was recorded in Excel. Descriptive statistics (means and standard deviations for continuous items, counts and percentages for categorical items) were computed. Repeated measures ANOVA was used to compare the number of journal articles originating in the non-U.S. countries over the time periods collected; the Friedman test was utilized in the case that the data was not normally distributed. The assumption of normality was assessed graphically with the Shapiro-Wilk test. The software Stata (version 13.1) was used for the statistical analysis. P-values < 0.05 were considered statistically significant.

**RESULTS:** Of the 75 non-U.S. countries published in the U.S. dental journals, a statistically significant difference exists in the number of journal articles published by Brazilian authors over the 20-year study period at the 5% level of significance. The median values show an increase in the articles published by Brazilian authors within the dental journals studied over the study period.

**CONCLUSION:** Brazilian authors contributed significantly more to U.S. dental journals than other non-U.S. countries. This finding will spark further investigation into the reasoning behind this trend.

*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*



## Electron Microscope Analysis of Ceramics with Previously Bonded Orthodontic Brackets

Gregory Monfette,\* Timothy Reichheld, Matthew Finkelman, Gerard Kugel, and Ronald Perry

**OBJECTIVES:** Since the advancement of new ceramic materials (lithium disilicate and zirconia) for dental crowns, improved methods of bonding orthodontic brackets to these surfaces must be attained. The purpose of this study is to compare surface roughness created by Assure® Plus (Reliance Orthodontic) and Bis-GMA (Assure PLUS) orthodontic bonding resins on porcelain, and zirconia materials.

**METHODS:** Two groups were formed, with 2 tested surfaces per group (n=20): group 1, treated with Assure Universal Bonding Resin (Reliance Orthodontic); and group 2, treated with Assure PLUS All Surface Bonding Resin (Reliance Orthodontic). IPS e.max® CAD rods (material 1) (Ivoclar Vivadent) (1 cm × 1 cm × 2 cm) and Zirconia rods (material 1) (1 cm × 1 cm × 4 cm) were used to represent dental crowns. Groups 1 and 2 were applied according to the manufacturer's specifications, and standard edgewise universal premolar brackets were secured using Light Bond™ paste (Reliance Orthodontic) without fluoride. After 24 hours the brackets were sheared with a universal testing machine (Instron®5566A). Sites were imaged using atomic force electron microscopy before and after polishing using appropriate polishing systems. Data was analyzed using an independent sample *t*-test. A *p*-value of less than 0.05 was considered statistically significant.

**RESULTS:** *P*-values indicate statistical significance for group 2 administered on material 1 before polishing. There was no statistical significance for zirconia with unpolished sites. *P*-values indicate statistical significance for group 1 administered to material 1 compared to material 2. The roughness values were comparable between groups 1 and 2 for material 2.

**Table 1.** Material 1

Group	N	Mean	Std. Deviation	P-Value
Group 1 unpolished	20	3.1393	0.50352	<0.001
Group 2 unpolished	20	4.0040	0.79617	
Group 1 polished	20	2.6504	0.87718	0.030
Group 2 polished	20	2.2190	0.66914	

**Table 2.** Material 2

Group	N	Mean	Std. Deviation	P-Value
Group 1 unpolished	20	3.7216	0.48969	0.792
Group 2 unpolished	20	3.7632	0.50121	
Group 1 polished	20	2.1666	0.33350	0.625
Group 2 polished	20	2.1283	0.47702	

**CONCLUSION:** Group 2 produces a greater degree of roughness on porcelain before polishing. However, after polishing, group 2 leaves considerably more surface roughness on porcelain. Clinically, group 2 leaves a superior surface roughness on both porcelain and zirconia after polishing and would therefore be the recommended choice since polishing is the orthodontic standard after shearing.

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## Early Flexural Strength of Temporary Crown and Bridge Materials

Sahar Mostafavi,\* Sarah Pagni, Gerard Kugel, and Ronald Perry

**OBJECTIVES:** This study aimed to determine the early flexural strength (FS) (i.e., <10 minutes) of different crown and bridge materials in early stages of the prosthesis fabrication process.

**METHODS:** Materials tested were Integrity™ (IN) (DENTSPLY), Luxatemp Star (LS), Luxatemp Automix Plus (LA) (both by DMG), Protemp™ 4 (P4), and an experimental material (EXP) (both 3M Oral Care). FS was determined using a three-point flexural test according to ISO 4049 (specimen size 4 mm × 6 mm × 25 mm) with a universal testing machine (Zwick Z010, crosshead speed 2 mm/min). Specimens (n=10) were prepared and allowed to cure for the time according to manufacturers' instructions (MI). All specimens were also tested after 3.5 minutes and 7 minutes self-curing time. Mean maximum FS at sample breakage was analyzed using pairwise comparisons (Tukey's HSD p<0.05).

**RESULTS:** EXP demonstrated higher FS at its MI curing time when compared to other products after MI curing time (p<0.001). EXP also demonstrated higher FS than other products when all products were self-cured for 7 minutes. There was no statistically significant difference between other materials after MI time and 3.5 minutes. Table 1 summarizes the results.

**Table 1.** Mean Flexural Strength

Material	MI Curing Time	Mean FS (MPa) MI Curing Time	Std Dev1	Mean FS (MPa) 7 minutes	Std Dev2	Mean FS (MPa) 3.5 minutes	Std Dev3
EXP	3.5 min	21.4 (A)	2.1	29.2 (A)	2.0	21.4 (A)	2.1
IN	7 min	10.9 (B)	1.8	10.9 (C, D)	1.8	8.3 (B)	1.4
LS	5 min	11.2 (B)	1.6	10.5 (D)	1.7	9.2 (B)	1.8
P4	5 min	11.0 (B)	2.1	14.2 (B)	2.3	10.9 (B)	2.6
LA	7 min	13.1 (B)	1.7	13.1 (B, C)	1.7	10.8 (B)	2.4

\* Significance groupings are denoted in alphabetic letters. Means that do not share a letter are statistically significantly different.

**CONCLUSION:** At its MI curing time of 3.5 minutes, EXP showed a higher early FS than other tested materials regardless of their curing time. This faster development of mechanical strength may prevent microcracks and reduce risk of damage with early manipulation of the temporary prosthesis during the fabrication process. These comparisons are important in assessing clinical performance, strength, and durability of temporary prostheses. Early stage FS is only one determining factor of overall mechanical strength. Future studies in mid-stage and late-stage FS can help to reinforce this data.

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Mean FS (MPa) 7 minutes	Std Dev2	Mean FS (MPa) 3.5 min	Std Dev3
29.2 (A)	2.0	21.4 (A)	2.1
10.9 (C, D)	1.8	8.3 (B)	1.4
10.5 (D)	1.7	9.2 (B)	1.8
14.2 (B)	2.3	10.9 (B)	2.6
13.1 (B, C)	1.7	10.8 (B)	2.4

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## Extrinsic Stain Removal: A Power Toothbrush vs. Manual Toothbrush Study

Sangita Murali,\* Jeffrey Daddona, Tamar Roomian, Gerard Kugel, Chad Anderson, and Ronald Perry

**OBJECTIVES:** To evaluate *in vitro* stain removal of 3 different power toothbrushes versus a standard manual toothbrush.

**METHODS:** Samples of 200 extracted human teeth were stained in 5 different solutions (n=40 per group): group 1, no stain; group 2: coffee; group 3, red wine; group 4, chlorhexidine; and group 5, green tea. After short-term (5 days) and again after long-term (21 days) staining, samples were brushed with: toothbrush A, Rotadent® ProCare (DenMat); toothbrush B, Sonicare 2 Series (Philips); toothbrush C, Oral-B Pro 3000 (Oral-B); or toothbrush D, standard manual (ADA). To standardize brushing, each toothbrush was placed into a holding apparatus and samples were brushed for 15s. Angle of incidence for brushing was perpendicular to the tooth surface at 180° with pressure force maintained at 200 g±10 g, ideal tooth brushing force. An Olympus® Crystaleye Spectrophotometer was used to quantify L\*, a\*, and b\* values. Comparisons of the toothbrushes were performed using a one-way ANOVA. Post hoc pairwise comparisons were performed using Tukey's HSD to adjust for multiple comparisons. All statistical tests were two-sided. P-values less than 0.05 were considered statistically significant.

**RESULTS:** Toothbrush A ( $\Delta L_{\text{coffee}}^* = 83.72$ ,  $\Delta L_{\text{redwine}}^* = 83.93$ ), toothbrush B ( $\Delta L_{\text{coffee}}^* = 79.37$ ,  $\Delta L_{\text{redwine}}^* = 81.01$ ), and toothbrush C ( $\Delta L_{\text{coffee}}^* = 78.42$ ,  $\Delta L_{\text{redwine}}^* = 79.53$ ) brighten teeth stained by coffee or red wine long-term more than toothbrush D ( $\Delta L_{\text{coffee}}^* = 75.84$ ,  $\Delta L_{\text{red wine}}^* = 67.61$ ). Additionally, toothbrush A ( $\Delta L_{\text{coffee}}^* = 81.61$ ,  $\Delta L_{\text{redwine}}^* = 82.75$ ,  $\Delta L_{\text{chlorhexidine}}^* = 78.98$ ) and toothbrush C ( $\Delta L_{\text{coffee}}^* = 77.04$ ,  $\Delta L_{\text{redwine}}^* = 77.45$ ,  $\Delta L_{\text{chlorhexidine}}^* = 79.47$ ) brighten teeth stained by coffee, red wine, and chlorhexidine short-term more than toothbrush D ( $\Delta L_{\text{coffee}}^* = 75.38$ ,  $\Delta L_{\text{redwine}}^* = 67.54$ ,  $\Delta L_{\text{chlorhexidine}}^* = 72.71$ ).

**CONCLUSIONS:** This study demonstrates that the 3 power toothbrushes tested are most effective on brightening teeth after long-term coffee and red wine staining and that power toothbrushes A and C are most effective on brightening teeth after short-term coffee, red wine, and chlorhexidine staining when compared to a standard manual toothbrush.



Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3876

## Predocctoral Student Presentations

### Prevalence of Temporomandibular Joint Disorder at Dental School Predocctoral Clinic

*Byung Min Nahm,\* Noshir Mehta, Tamar Roomian, and Archana Viswanath*

**OBJECTIVE:** Currently, there are no studies looking at the prevalence of temporomandibular jaw disorders (TMD) among patients who visit dental school clinics for routine dental treatment. The objective of this study is to evaluate the prevalence of TMD signs and symptoms among patients in the predocctoral clinics at TUSDM and determine if there is an association between findings from demographics, exams, medical history, and development of TMD.

**METHODS:** Following IRB approval, medical records from patients who reported presence of temporomandibular jaw (TMJ) pain and/or clicking/crepitus in the past 5 years (2010–2015) were reviewed. A specifically designed questionnaire incorporated into a comprehensive exam at predocctoral clinics at TUSDM was used to select a random sample of 230 patients who reported presence of TMJ pain (N=230). A discrepancy in the sample size was identified among variables due to incomplete responses in the questionnaires found in some patient charts. The following variables were analyzed: age, gender, location of pain, pain on palpation, pain during movement, crepitus, clicking, jaw pain, headache, fibromyalgia, TMD consult, and sleep apnea. The prevalence and 95% confidence intervals for each were calculated based on the number of corresponding responses (n).

**RESULTS:** The total number of patients who visited the dental clinic during the 5 years was 44,580. A total of 1,100 (2.5%) patients reported presence of clicking or crepitus; 555 (1.26%) reported presence of TMJ pain. The mean age was 45.6 years old.

**CONCLUSIONS:** This analysis of the record reviews of 230 patients demonstrates the overall prevalence of TMD among patients visiting predocctoral clinics. Results from this study indicate that there is a need for educating predocctoral students to identify TMD and seek appropriate referral. Further studies with a larger sample size among other dental school clinics are recommended to confirm our findings.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3949.*



## Psychological and Functional Outcome Evaluation in Patients Treated for Skeletal Disharmony of the Jaw Corrected with Orthognathic Surgery

Ankur Patel,\* Harsh Patwari, Archana Viswanath, and Matthew Finkelman

**OBJECTIVE:** The goal for orthognathic surgery is to correct a functional handicap, whether it is an inability to correctly masticate, a presence of temporomandibular disease, or an airway abolition. Literature shows that there is a high prevalence of psychological disturbances in patients seeking esthetic alteration through plastic surgery. Currently, the oral surgeon is limited in the psychological management of patients undergoing orthognathic surgery since there is a lack of a validated assessment tool. We developed a patient survey with psychiatrists at Tufts Medical Center that was further refined in a focus group with patients who have had orthognathic surgery in the past 2 years.

**METHODS:** A prospective study was conducted by calling patients who underwent orthognathic surgery in the past 3 years and inviting them to participate in the survey. We excluded patients who have had a known diagnosis of a psychological disorder and whom the investigators believe might be sensitive to survey questions.

**RESULTS:** A total of 162 patients were eligible to participate in the study, of which 38 patients agreed to participate in the study following phone calls. A total of 27 patients have completed the survey in this ongoing study. Of these, 72.22% of patients reported that the results of the surgery were exactly or close to what they expected; 68.42% of patients reported being satisfied with their appearance; and 61.14% reported that they liked their facial appearance. Only 26.32% reported being reserved and 33.34% reported worrying often. Functional outcome responses showed all patients reported being able to speak clearly, 72.22% reported not having any dietary restrictions, and 50.00% reported that they did not have any restrictions eating out.

**CONCLUSION:** Results show that majority of patients were satisfied with their facial appearance and functional outcomes. This has to be validated in future studies of survey patients prior to and after orthognathic surgery. However, these results emphasize the need of evaluating psychological factors in planning orthognathic surgery.





## Prevalence of Medical Emergencies at TUSDM

Harsh Patwari,\* Daniel Oreadi, Matthew Finkelman, Ankur Patel, and Archana Viswanath

**OBJECTIVE:** Medical emergencies occur in dental school, and it is important for dental students to be prepared for the management of such emergencies. The objective of this retrospective chart review study was to determine the prevalence of medical emergencies at TUSDM. Associations between a patient's chief complaint and their past medical history were also investigated.

**METHODS:** Following IRB approval, medical records of patients for whom a code call had been placed in a 5-year span (January 1, 2011–January 1, 2016) were reviewed. Code is defined as a “serious medical emergency” that is attended to by first responders (oral surgery team). Associations between emergencies (syncope, dizziness, chest pain, seizures) and past medical history (type 1 diabetes, type 2 diabetes, high blood pressure, hypotension, syncope) were assessed using Fisher's exact test.



**RESULTS:** From January 1, 2011 through January 1, 2016, a total of approximately 671,000 patient visits occurred at the dental clinics. During the period under review, the medical emergencies code call was activated 168 times (less than 0.1% of all visits). The most common emergencies were dizziness (31 incidences) and syncope (21 incidences). All associations were not statistically significant ( $p > 0.05$ ).

**CONCLUSION:** Results from this study are similar to previous studies looking at the prevalence of medical emergency in dental school. Dizziness and syncope were the most frequently called codes. There was no significant evidence of association between the past history variables and chief complaints examined.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #2537.*

## Phase II: Testing an Oral Health Educational Booklet on the Appeal, Readability, and Usefulness with Students and Patients in the TUSDM Predoctoral Clinic

Tuvy Phan,\* Jennifer Towers, and Natalie Hagel



**PURPOSE:** A patient education booklet, *Oral Health & Disease Prevention*, was created to specifically target the patients at the predoctoral clinic at TUSDM. The overarching goal of this booklet was to help students improve their communication skills in hopes of positively impacting the health outcome of their patients. Basing our project on general common knowledge of health communication efforts, we hope to implement a teaching aid that is specific to the needs of our patient population and student dentists at TUSDM. The purpose of this study is to test the effectiveness of the current draft of *Oral Health & Disease Prevention* and to conduct 2 focus groups (1 with patients and 1 with student dentists) in order to elicit information/feedback from individuals who would either be receiving or implementing the intervention.

**METHODS:** For the survey, 18 individuals were recruited: up to 9 for each of the 2 focus groups. In focus group 1, 9 dental students were recruited from the third and fourth year predoctoral students via email. In focus group 2, 5 patients were recruited from the UG clinic using flyers. Co-investigator Tuvy Phan used a pre-written script to lead the questioning during the focus group interviews. The pre-written scripts asked questions pertaining to the design, mode, length, medium of information, etc., of each page in the patient education booklet. Focus groups were audio recorded and each lasted approximately 60 minutes. Audio recordings were scribed and the data was analyzed using thematic analysis and translation into quantitative data. The process examined: the frequency of themes, the extensiveness/intensity of the comment, and the specificity of the responses. Responses and comments were assigned categories generated from past iterations and from the data itself.

**CONCLUSION:** The *Oral Health & Disease Prevention* booklet was greatly accepted after being reviewed by faculty, students dentists, and patients. The data suggests that both students and patients may positively benefit from this patient education booklet. Common areas of agreement between student dentists and patient groups were: the booklet's ease in readability; its pictures facilitate patient comprehension; and there is enough time to implement it during the dental visit. Student and patient groups mutually agreed that the booklet would be most useful chairside in the clinic. Features that the groups felt the booklet needed improvement on were: the amount of pictures; simplicity of the graphs; and addition of missing content. Although there were many correlating opinions between students and patients, there were also differences. Student dentists from the third and fourth year predoctoral classes put a strong emphasis on the booklet needing less text and more pictures with the argument that they would use the booklet as a supplement to their own explanations. Student dentists believed the booklet seemed overwhelming and "wordy." They suggested the use of clearly sectioned information in chapters, which would help organize the content. Contrary to the students, the patients liked the booklet's text-to-picture ratio, flow of content, and front cover. In addition to using the booklet as a chairside tool, the patients expressed interest in having their own copy at home.

**SIGNIFICANCE:** The data collected from the focus group interviews helped provide a better understanding of the acceptability of this type of intervention from both the patient and student provider perspectives. The feedback received and key themes identified will be used to guide the revision of the booklet. Proper revisions will be made to the booklet and submitted to the IRB for approval for use in Phase III of the project, "Testing the Efficacy of the Oral Health Educational Booklet as an Intervention in the TUSDM Predoctoral Clinic."

## Silk Fiber Films for the Localized Release of Antibiotics

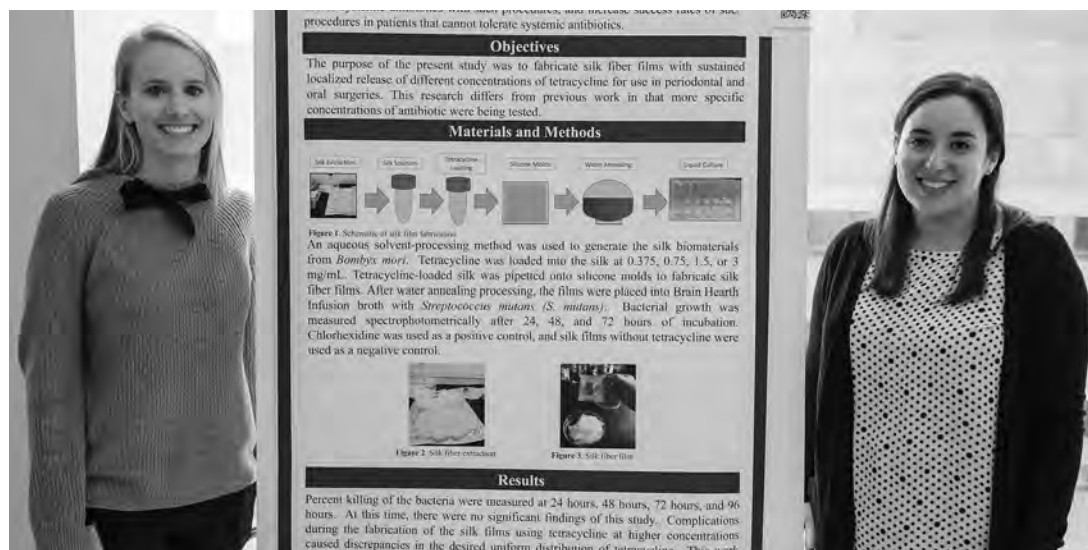
Stephanie Phillis,\* Sarah Schuback,\* Audrey Michel, David Kaplan, Chiara Ghezzi, Nina Dinjaski, Gerard Kugel, and Driss Zoukhri

**OBJECTIVES:** The purpose of the present study was to fabricate silk fiber films with sustained localized release of tetracycline with higher concentrations than previous studies for use in periodontal and oral surgeries.

**METHODS:** An aqueous solvent-processing method was used to generate the silk biomaterials from *Bombyx mori*. Tetracycline was loaded into the silk at 0.375, 0.75, 1.5, or 3 mg/mL. Tetracycline-loaded silk was pipetted onto silicone molds to fabricate silk fiber films. After water annealing processing, the films were placed into brain heart infusion broth with *Streptococcus mutans* (*S. mutans*). Bacterial growth was measured spectrophotometrically after 24, 48, and 72 hours of incubation. Chlorhexidine was used as a positive control, and silk films without tetracycline were used as a negative control.

**RESULTS:** Tetracycline-loaded silk fiber films inhibited *S. mutans* growth in a concentration and time-dependent manner. Percent killing of the bacteria was measured at 24, 48, 72, and 96 hours. At this time, there were no significant findings of this study. Complications during the fabrication of the silk films using tetracycline at higher concentrations caused discrepancies in the desired uniform distribution of tetracycline. This work will be repeated and fabrication process adjusted appropriately to obtain significant results in the future.

**CONCLUSIONS:** We concluded that tetracycline can be successfully loaded into silk fiber films at lower concentrations, specifically 0.075, 0.15, and 0.375 mg/ml; however, fabrication of silk films at concentrations above 0.375mg/ml could not be done with uniform results. At this time, there is no significant data available from this work. This work will be repeated once the silk film fabrication process is adjusted to allow for better solubility of the higher concentrations of tetracycline.



## The Effects of Disinfection and Storage Methods on Bioactive Cements

Alisha Anand, Meghan Powers,\* Gerard Kugel, Sarah Pagni, Jeffrey Daddona, and Britta Magnuson



**OBJECTIVES:** To test the effects of storage and disinfection methods on extracted teeth used for shear bond strength (SBS) tests of bioactive cements to dentin.

**METHODS:** Extracted human teeth were used for dentin samples and were divided into 3 storage solution groups (n=18 per group). The storage solution groups were distilled water, 1:10 bleach for 1 week or 30 days. The latter 2 are in accordance to the Centers for Disease Control and Prevention (CDC). After the prescribed time in the storage solutions, teeth were additionally divided into 2 groups of bioactive cements; this created a total of 6 subgroups (n=9 per group): group I, Ceramir® Crown & Bridge, and group II, ACTIVA™ BioACTIVE-CEMENT™ Pulpdent®. After the designated storage time, teeth were sectioned in the transverse plane at the occlusal third. Product was applied following manufacturer's guidelines. Samples were

then stored in deionized water for 24 hours. SBS was tested using a universal testing machine (Instron®5566A, Norwood, Massachusetts); crosshead speed moved at 5 mm/min until failure. The Kruskal-Wallis test with Dunn's test with the Bonferroni correction were used for analysis.

**RESULTS:** Means, medians, standard deviations, and IQRs for compressive stress at maximum compressive load were calculated (Table 1). The group I difference was not statistically significant (p-value=0.440). The group II difference was statistically significant (p-value=0.001), with significant differences between subgroups 2 and 4 (p-value=0.0004) and between subgroups 2 and 6 (p-value=0.0174).

**Table 1.** Shear Bond Strength

Variable	Storage Method	Compressive Stress at Maximum Compressive Load (Mpa)	
		Mean (SD)	Median (IQR)
Group I			
Subgroup 1	Deionized Water (control)	4.79 (2.37)	4.54 (2.87)
Subgroup 3	Bleach solution (1:10 sodium hypochlorite) for 1 week	6.37 (3.37)	5.74 (3.22)
Subgroup 5	Bleach solution (1:10 sodium hypochlorite) for 30 days	6.41 (3.03)	5.64 (6.21)
Group II			
Subgroup 2	Deionized Water (control)	7.76 (6.88)	7.23 (3.39)
Subgroup 4	Bleach solution (1:10 sodium hypochlorite) for 1 week	25.13 (10.16)	30.31 (15.97)
Subgroup 6	Bleach solution (1:10 sodium hypochlorite) for 30 days	18.35 (6.00)	17.88 (8.29)

**CONCLUSIONS:** Storage methods did not impact the SBS results for group I. For group II, the subgroup 2 median (deionized water) (7.23MPa) was significantly less than subgroups 4 (bleach solution-1 week) (30.31MPa) and 6 (bleach solution-30 days) (17.88MPa). This may have an impact on future studies, as storage methods did not appear to negatively affect the SBS results on group I; however, there was a significant difference in SBS results for group II samples.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3245.*

### 3D Nasolabial Morphology in Normal and Cleft Lip/Palate Subjects

Daniel Regan,<sup>1\*</sup> Carroll Ann Trotman,<sup>1</sup> and Julian Faraway<sup>2</sup>

<sup>1</sup>Tufts University School of Dental Medicine, Boston; <sup>2</sup>University of Bath, Bath, England

**OBJECTIVES:** To measure differences in nasolabial morphology (1) among control subjects within different age groups; and (2) among patients with repaired unilateral and bilateral cleft lip and palate (CL/P) and control subjects.

**METHODS:** Three-dimensional facial images of 184 control subjects (within age groups 5–7, n=36; 8–10, n=49; 11–13, n=53; 14–16, n=46 yrs.) and 42 patients with repaired CL/P (range 5–26 yrs.; mean age 11.9 yrs., SD=4.7) were captured using a 3dMDface System. Nasolabial landmarks were digitized on each subject's "at rest" image. Generalized Procrustes analysis was used to calculate the overall shape mean for the control subjects, and the distance from this mean was computed for each subject using ordinary Procrustes analysis. A "disfigurement score" based on the square root of the normalized Procrustes distance was taken as a measure of how far a subject was from the control mean. Comparisons were made of the nose, upper lip, and lower lip among the control groups and among these regions between the controls and the patients. Pivotal bootstrap methods were used to test for significant group differences ( $p < 0.001$ ).

**RESULTS:** There were no significant differences in mean disfigurement scores among the control groups. There were significant differences for the cleft patients. The bilaterals had higher scores for the nose and lower lip while the unilaterals had higher scores for the nose, upper lip, and lower lip; and the unilaterals had a greater range of scores.



**CONCLUSIONS:** The disfigurement of the entire nasolabial region was greater for the unilaterals compared with the bilaterals; the upper lip of the bilaterals was closer to normal. The unilaterals also had greater variation in disfigurement suggesting less uniformity of the surgical results following repair. This method can be used to objectively quantify the degree of nasolabial disfigurement in patients with CL/P compared to controls by means of a single score.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3991.*

## Observational Staining Properties of Silver Fluoride on Dental Materials

Timothy Reichheld,\* Jacob Donohue, M. Luo, Gerard Kugel, and Ronald Perry

**OBJECTIVES:** The purpose of this study was to observe the staining properties of silver fluoride on different dental materials.

**METHODS:** Eighteen disks per dental material ( $1.00 \pm 0.05$  mm thick) were made using 15mm diameter stainless steel molds and placed in artificial saliva (modified Fusyama solution) at  $37^{\circ}\text{C}$ . There were 3 disks per treatment group with 1 group as the control. Tested surfaces included: conventional glass ionomer cement (GIC) (Riva Self-Cure, SDI Limited, Australia); resin modified GIC (RMGIC) (Riva Light-Cure, SDI Limited, Australia); trial material cement (TMC), Composite (Com) (Aura Bulk Fill, SDI Limited, Australia); and orthodontic adhesive (Adh) (Transbond XT<sup>®</sup>, 3M Unitek). After 24 hours, the disks were dried and treated with various treatments: SDFa, Riva Star Step 1 (SDI Limited, Australia); SDFa +KI, Riva Star Part 1 + Part 2; AgF, Trial Material; AgF+KI, Trial Material + Riva Star Part 2; and SDFb, Advantage Arrest (Elevate Oral Care). All treatments added per manufacturer instructions. Samples were returned to artificial saliva for 24 hours. After incubation, disks were exposed to ambient light for 2 hours at room temperature. Surfaces were wiped to remove extrinsic staining, and color change was assessed via photographic analysis using Cannon camera (EOS 5D Mark II).

**RESULTS:** SDFa, AgF, and SDFb showed most intrinsic staining on GIC, RMGIC, and TMC samples, with reduction in staining seen when KI was incorporated into treatments (SDFa+KI, AgF+KI).

**CONCLUSION:** Intrinsic staining by silver fluoride on dental materials appeared to be reduced by addition of KI. This would prove useful to dentists hoping to use the benefits of silver fluoride on surfaces adjacent to these materials, but who are worried about aesthetics. Although the orthodontic adhesive and composite samples did not show any discoloration, clinically the use of KI could provide protection against staining of the patient's mucosa by the silver fluoride.

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## Tumor Cell Energy Metabolism in Basal Cell Carcinoma Development

Arietta Rigopoulos,\* Sunnie Kuna, Tatiana Mendez, Johnson Fong, James Baleja, and Addy Alt-Holland

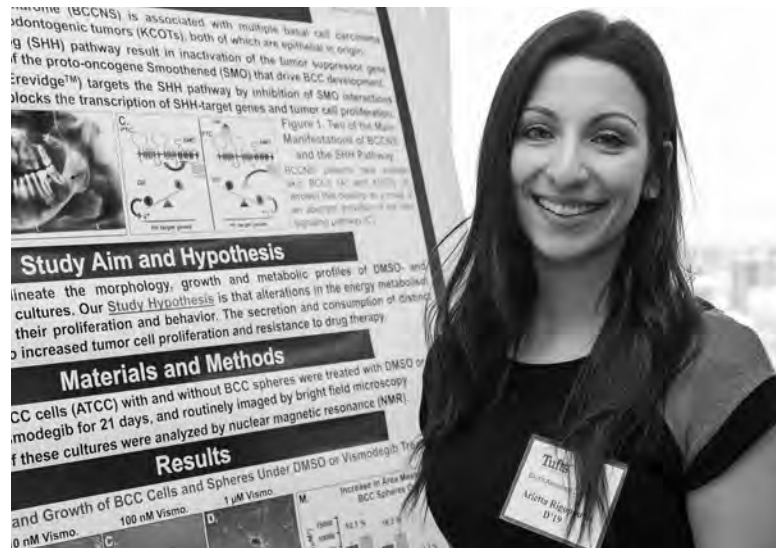
**OBJECTIVE:** Sporadic keratocystic odontogenic tumors (KCOTs) and basal cell carcinomas (BCCs) can be treated by surgical procedures. These treatments are more challenging in inherited basal cell carcinoma nevoid syndrome patients, who develop multiple KCOTs and hundreds of BCCs from young age. Alterations in the sonic hedgehog (SHh) pathway are key in BCC development. While the SHh inhibitor Vismodegib effectively reduces tumor burden in BCCNS patients, it leads to considerable morbidity and appearance of drug-resistant tumors. To delineate mechanisms beyond SHh that contribute to the growth of these tumors, we investigated the effect of Vismodegib on metabolism and growth of BCC cells and tumor spheres in cultures.

**METHODS:** Cultures of human BCC cells (ATCC TE 354.T) and tumor spheres were treated with 10nM–1 $\mu$ M Vismodegib or DMSO (control) for 21 days, and imaged daily to monitor their growth. Media conditioned by the cultures were analyzed by nuclear magnetic resonance (NMR).

**RESULTS:** Preliminary NMR analysis revealed that under DMSO and Vismodegib treatment, both culture types consumed glutamine rather than glucose and secreted significant amounts of lactate and acetate. Glutamate secretion and pyruvate consumption were markedly increased in cultures with BCC cells only, when compared to cultures with tumor spheres. In contrast to DMSO, Vismodegib treatment modestly reduced acetate levels in cultures without tumor spheres and decreased glutamine levels in cultures with those spheres. Over time and under both treatments, new tumor spheres continued to accumulate in the cultures with tumor spheres and began to develop in cultures that initially included merely BCC cells.

**CONCLUSION:** Cultures continued to grow and develop even when treated with Vismodegib, which indicates resistance to the physiologically relevant drug concentrations used. The altered metabolic profiles seen in these cultures can potentially contribute to the development of drug-resistant tumors in humans; thus, the corresponding cellular metabolic pathways may serve as future targets for therapy.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #0119.*



## Shear Bond Strength of Bioactive Dental Cements to Dentin over Time

Zamone Sawyer,\* Melissa Ing, Gerard Kugel, Matthew Finkelman, and Britta Magnuson

**INTRODUCTION:** Bioactive dental cements contain numerous oxides that produce a strong bond with tooth structure and are hypothesized to increase in shear bond strength (SBS) over time. This study compared SBS to dentin of a resin modified glass ionomer cement RelyX™ Luting Plus Automix (group 1), to 2 bioactive cements Ceramir® Crown & Bridge (group 2) and ACTIVA™ BioACTIVE-CEMENT™ (group 3) over a 30-day period.

**METHODS:** In the study, 153 extracted human teeth were used, with 17 teeth in each subgroup.

- Group 1. Subgroups: 1A: 1 day, 1B: 1 week, 1C: 30 days.
- Group 2. Subgroups: 2A: 1 day, 2B: 1 week, 2C: 30 days.
- Group 3. Subgroups: 3A: 1 day, 3B: 1 week, 3C: 30 days.

Teeth were mounted in cylindrical molds with dentin exposed. A button of dental cement was applied following manufacturer's instructions and samples were stored in deionized water for the durations noted. After storage, SBS was tested. Samples were placed in a universal testing machine, Instron®5566A (Norwood, Massachusetts), at 1 mm/minute crosshead speed. Force was applied until breakage. Samples in which the cement button fell off during storage were excluded from analysis.

**RESULTS:** The results of the study did not yield a normal distribution, thus median and interquartile ranges were reported (Table 1).

**Table 1.** Median and interquartile ranges for each subgroup.

Subgroup	Median SBS (MPa)	IQR
1A	1.59	3.49
1B	3.75	2.74
1C	5.49	6.41
2A	0.54	1.05
2B	0.71	2.02
2C	8.90	11.02
3A	7.46	8.74
3B	6.81	7.44
3C	7.39	13.85

To compare the time points within each group (Table 2) and the groups within each time point (Table 3) Kruskal-Wallis tests were conducted. Post hoc comparisons were performed using Dunn's test with Bonferroni correction.



## Predocutorial Student Presentations

**Table 2.** Kruskal-Wallis tests ( $p < 0.05$  was considered statistically significant) and Dunn's test with Bonferroni correction ( $p < 0.0167$  was considered statistically significant) comparing the time points for each group.

Group	Kruskal-Wallis p-value	Post hoc 1 day vs. 1 week p-value	Post hoc 1 day vs. 30 days p-value	Post hoc 1 week vs. 30 days p-value
1	0.004	0.014	0.002	0.418
2	<0.001	0.395	<0.001	<0.001
3	0.616	Not performed	Not performed	Not performed

**Table 3.** Kruskal-Wallis tests ( $p < 0.05$  was considered statistically significant) and Dunn's test with Bonferroni correction ( $p < 0.0167$  was considered statistically significant) comparing the groups for each time point.

Time	Kruskal-Wallis p-value	Post hoc group 1 vs. group 2 p-value	Post hoc group 2 vs. group 3 p-value	Post hoc group 1 vs. group 3 p-value
1 Day	<0.001	0.063	<0.001	0.003
1 Week	0.003	0.009	0.001	0.421
30 Days	0.398	Not performed	Not performed	Not performed

**CONCLUSION:** Group 1 had significantly higher SBS at 1 week and 30 days compared to 1 day. Group 2 had significantly higher SBS at 30 days compared to 1 day and 1 week. Although group 3 did not increase over time, it was significantly stronger than both other groups at 1 day. At 30 days, the groups were not statistically significantly different.



## Determination of Cross-Head Speed Relevance in ISO 4049 Testing Protocols

Daniel Seay,\* Aikaterini Papathanasiou, and Gerard Kugel

**OBJECTIVE:** The purpose of this investigation was to evaluate the effects of variable crosshead speed on the flexural strength of 2 materials (group I, Diamond Crown®—DRM; and group II, Orthodontic Resin®—DENTSPLY) at 3 different crosshead speeds (group A, 0.1 mm/min; group B, 1.0 mm/min; and group C, 10.0 mm/min).

**METHODS:** Test samples were made according to specifications set by ISO 4049. Resin composite (group I) and acrylic (group II) samples were prepared in a mold and adjusted using a turntable sander to 2.0 × 2.0 × 25.0 mm. Fifteen samples of each material were prepared and hydrated in room-temperature water overnight. Each sample was subjected to a 3-point flexural strength test as defined by ISO 4049, with the exception of the crosshead speed, which was variable (groups A, B, and C). Five samples of each material were tested at each crosshead speed using an Instron materials testing machine. The maximum force applied and the distance the probe traveled was recorded for each sample (Bluehill, Instron).

**RESULTS:** There were no statistically significant differences between either material at any tested crosshead speed. Data was analyzed using Student's *t*-test (two-tailed) and pairwise comparisons between groups A, B, and C for each material. A p-value of <0.05 was predetermined to indicate significant differences.

**CONCLUSIONS:** Our results indicate that crosshead speed does not affect the flexural strength measurements of the 2 materials tested within a 100-fold range from 0.1 mm/min to 10.0 mm/min. Future studies need to consider other commonly tested dental materials to appreciate the relevance of crosshead speed when utilizing the ISO 4049 protocol.



## Retrospective Analysis of Tooth Loss following Periodontal Regeneration: 196 Patients

Yusuf Sheikh,\* Yong Hur, and Yumi Ogata

**OBJECTIVES:** Regenerative periodontal therapy (RPT) has been proven effective for the treatment of intrabony defects and furcation defects in patients with periodontitis. Previous studies reported that multiple factors may affect the predictability of RPT. The aims of this study were to determine the long-term survival rate of teeth after RPT and evaluate patient-related and site-related factors that could affect the outcome of periodontal regeneration.

**METHODS:** Data for this project was gathered from the electronic health records (EHRs) of patients who received RPT from July 2006 to June 2011 at TUSDM. Treatment modalities of RPT included in the study were bone replacement grafts (BRG), guided tissue regeneration (GTR), and biologics such as enamel matrix derivative (EMD), when used alone or in combination. The following patient-related and site-related data were extracted from the EHRs: sex, age, the tooth site, smoking history, the defect configuration, the type of furcation defects, the presence of root canal treatment (RCT), and the type of materials used for RPT. EHRs were reviewed and the data were extracted by 2 independent examiners. Patients who were lost to follow-up less than 5 years were excluded from the study.

**RESULTS:** After searching the EHRs, 241 patients were identified. After exclusion of 45 patients, a total of 196 patients were included in the study. The average age of patients was 52.60 years old consisting of 82 males and 114 females. The tooth survival rate (>5 years) following RPT was 93.4%. Defect morphology ( $p<0.001$ ) and the type of furcation defects ( $p=0.001$ ) were significantly associated with tooth loss.

**CONCLUSIONS:** Long-term tooth retention following RPT is possible with various methods of RPT. There are patient-related and site-related factors related with the long-term outcome of RPT.

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## Evidence-Based Clinical Questions Presented during the Spiral Seminar Series

Gayathri Shenoy,\* Nadeem Karimbux, Sarah Pagni, Jennipher Murphy, and Irina Dragan

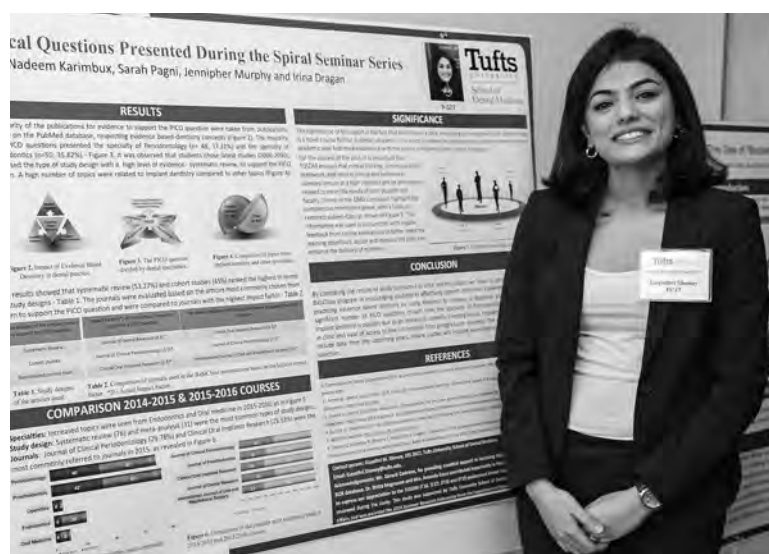
**OBJECTIVE:** The Basic Science/Clinical Science Seminar (BaSiCSsss) series teaches and assesses skills in communication, teamwork, leadership, critical thinking, self-assessment, and clinical and behavioral sciences. The course is taken by all dental students during the 4 years of their dental education (each student from each year presents a component of a clinical case). The primary aim of this study was to identify the type of PICO (population, intervention, comparison, and outcome) questions that the third-year students presented to support the treatment plan option for the selected case.

**METHODS:** The University Institutional Review Board approved the study. Presentations compiled by 130 teams, available on the school's online file storage, were reviewed, and the relevant information was tabulated to facilitate data extraction. The following data was collected: the PICO question and data from 322 publications that were used as reference to support the clinical question (choice of journal, year of publication and the type of study design).

**RESULTS:** Most topics were from the subjects of periodontics (38.23%), prosthodontics (33.23%), and oral surgery (14.70%). The clinical cases were supported most commonly by the following study designs: systematic review (54.30%), meta-analysis (9.31%), and randomized controlled trial (9.31%). The most common publications referred to were the *Journal of Clinical Periodontology* (12.42%), *Clinical Oral Implants Research* (12.42%), and the *Journal of Prosthodontics* (10.55%) published between the period of 2006 to 2010.

**CONCLUSION:** The BaSiCSsss course ensures that critical thinking and use of evidence-based dentistry remain at a high standard at TUSDM, according to the ADA and ADEA recommendations. Dental students present a high interest in implant dentistry. All the topics that were presented were supported by recently published studies with the highest level of evidence.

*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*



## The Use of Student-Response Systems in the Dental School Curriculum

Sahar Mostafavi, Benjamin Smith,\* Jennipher Murphy, Sarah Pagni, Irina Dragan, and Nadeem Karimbux

**PURPOSE:** The use of technology in dental education has paved the way for innovative teaching methods and increased student engagement. Student-response systems aim to increase active learning inside the dental classroom by encouraging participation. At TUSDM, the use of the student-response system Learning Catalytics (LC) was implemented in 2013. Despite LC's growing popularity among educators, this information has not yet been studied. Characterizing LC's broad usage in the current curriculum and tracking trends in technology is an important first step in analyzing the outcomes and effectiveness of this tool. The purpose of this study is to examine the extent and methods of use of LC system across the TUSDM curriculum since its implementation.

**METHODS:** A retrospective study design was approved by TUSDM Institutional Review Board. Data from the 115 existing clinical, preclinical, and didactic/basic science courses at TUSDM was collected and analyzed to identify the following outcomes: number and types of courses using LC, number and types of questions delivered to students using LC, and correct/incorrect responses per question. Counts, descriptive statistics, and percentages were computed to compare data points across the 3 years to observe changes and progression throughout LC's use.

**FINDINGS:** In 2013, a total of 2 courses at TUSDM used LC student-response technology in their curriculum. In 2014 and 2015, this increased to 6 and 19, respectively. All courses using LC were clinical courses in 2013 and 2014. In 2015, 21% didactic and 11% preclinical courses began implementing LC. Since 2013, there has been a cumulative 1625% increase in number of LC questions delivered to students, with student participation remaining consistent at an average of 61%, 65%, and 60% in 2013, 2014, and 2015, respectively.

**CONCLUSIONS:** The rapid growth of emerging technological teaching tools such as LC can pose an overwhelming task for educators who wish to adopt these tools into dental school curricula. Follow-up survey studies on student and faculty perceptions of LC will provide valuable data on how to optimize its use.

*Presented at the 2017 ADEA Annual Session & Exhibition in Long Beach, California.*



## Microleakage Evaluation of Elevated Temperatures in Combined Adhesives and Restoratives

Michelle Ta,\* Matthew Finkelman, John Morgan, and Gerard Kugel

**OBJECTIVE:** To compare marginal microleakage after heating restoratives and adhesives before placement across 3 different restoratives: dental composite, bioactive restorative, and glass ionomer. The delivery and storage of materials exposed to prolonged high temperatures prior to application may compromise their restorative properties.

**METHODS:** Ninety standard Class II slot preparations were performed on non-cariou human posterior teeth with approximately 3-mm depth at gingival floor and 4-mm width bucco-lingually. Samples were randomly assigned into 9 groups (n=10). Three dental restoratives were tested: Filtek™ Supreme Ultra composite 3M ESPE (FS); ACTIVA™ BioACTIVE-Restorative™ Pulpdent (AB); and Photac™ Fil Quick Aplicap™ 3M ESPE (PT). Excite® F Ivoclar Vivadent was used as the adhesive. All materials were placed in incubator (Thermo Scientific™, ELED265) and heated 120 hours at 24°C, 40°C, or 52°C. Materials were applied according to manufacturer's instructions. Completed restorations were thermocycled for 6,000 cycles between 5°C and 55°C. Samples were immersed in 2% methylene blue dye for 8 hours. Samples were embedded in acrylic resin, sectioned mesio-distally, and evaluated under stereomicroscope (Olympus, SZX16). A dye-penetration-to-axial-wall (DP) score was used on gingival floor: 0=0% DP; 1=1–25% DP; 2=26–50% DP; 3=51–75% DP; and 4=76–100% DP. Counts and percentages were calculated, and statistical significance was assessed via generalized estimating equations (GEE) for separate comparisons of materials and temperatures.

**RESULTS:** Table 1 displays counts and percentages of microleakage scores. Table 2 displays GEE analysis with post hoc tests using Bonferroni correction to adjust for multiple comparisons ( $p < 0.0167$ ).

**Table 1.** Microleakage Counts and Percentages

Material	Temp (°C)	DP Microleakage					Total
		0	1	2	3	4	
FS	24	5 (50%)	3 (30%)	2 (20%)	0 (0%)	0 (0%)	10 (100%)
FS	40	1 (10%)	7 (70%)	1 (10%)	1 (10%)	0 (0%)	10 (100%)
FS	52	1 (10%)	2 (20%)	5 (50%)	2 (20%)	0 (0%)	10 (100%)
AB	24	5 (50%)	2 (20%)	3 (30%)	0 (0%)	0 (0%)	10 (100%)
AB	40	4 (40%)	3 (30%)	3 (30%)	0 (0%)	0 (0%)	10 (100%)
AB	52	1 (10%)	5 (50%)	2 (20%)	1 (10%)	1 (10%)	10 (100%)
PT	24	1 (10%)	8 (80%)	1 (10%)	0 (0%)	0 (0%)	10 (100%)
PT	40	1 (10%)	0 (0%)	5 (50%)	2 (20%)	2 (20%)	10 (100%)
PT	52	1 (10%)	3 (30%)	6 (60%)	0 (0%)	0 (0%)	10 (100%)

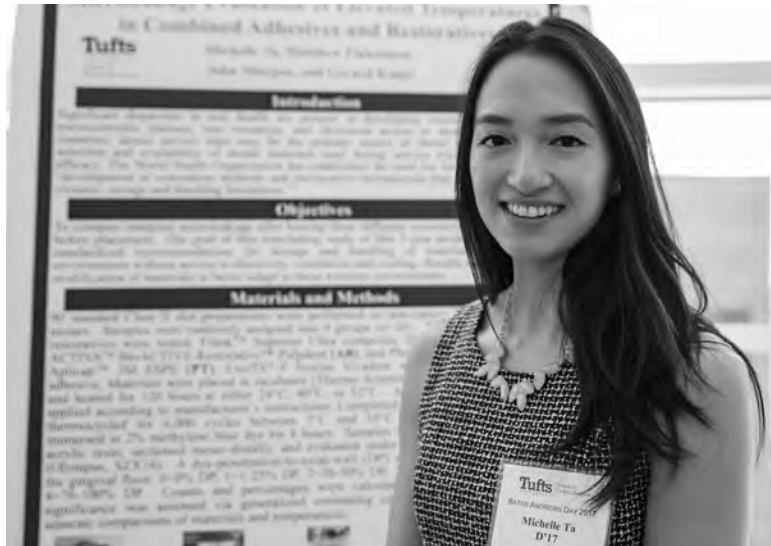
Predocctoral Student Presentations

**Table 2.** Results of GEE Analysis with Post Hoc Tests

Comparison of Materials	p=0.035
FS vs. AB	p=0.458
FS vs. PT	p=0.056
AB vs. PT	p=0.019
Comparison of Temperatures	p=0.001
24 vs. 40	p=0.007
24 vs. 52	p<0.001
40 vs. 52	p=0.542

**CONCLUSION:** Significant microleakage differences were seen in comparisons between materials and temperatures. Materials heated at 24°C showed least microleakage, as compared to 40°C and 52°C, which had higher DP scores. Compared to previous years’ study, the effect of heating the adhesive with the restorative did not affect microleakage outcome.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3273.*



## Effect of Material and Storage Temperature on Sealant Microleakage

Kanupriya Tewari,\* Matthew Finkelman, John Morgan, and Gerard Kugel

**OBJECTIVES:** To investigate how material type and storage temperature affect the marginal microleakage of different sealant materials. This study is part of a larger analysis that aims to establish recommendations for management of materials in settings where cooling systems may not be accessible (i.e., extreme climate conditions in resource-limited countries).

**METHODS:** Ninety extracted human teeth were obtained. Samples were randomly assigned into 9 groups (n=10). Three sealants were tested: GC Fugii® Triage GC America (GC); Embrace™ WetBond™ Pulpdent (EW); and Voco Grandio Seal Voco (VG). Materials were placed in an incubator and heated for 72 hours at either 24°C, 40°C, or 52°C. All materials were applied according to manufacturer’s instructions. Completed restorations were thermocycled for 500 cycles with a dwell time of 30 seconds between 5°C and 55°C. Samples were immersed in 2% methylene blue dye for 8 hours, embedded in acrylic resin, sectioned bucco-lingually to expose 4 surfaces, and evaluated under stereomicroscope (Olympus, SZX16). A dye-penetration-to-sealant (DS) score was used (0: 0% DS; 1: 1–50% DS; 2: 51–100% DS; 3: >100% DS (fissure penetration). Counts and percentages were calculated. Statistical significance was assessed via Kruskal-Wallis tests (p<0.05) for separate comparisons of materials and temperatures; Dunn’s test with Bonferroni correction (p<0.017) was used for post hoc comparisons.

**RESULTS:** Table 1 displays counts and percentages of microleakage scores. Table 2 displays p-values of comparisons between materials for each temperature. Table 3 displays p-values of comparisons between temperatures for each material.

**Table 1.** Microleakage Counts and Percentages by Material and Temperature

Material	Temp (°C)	DS Microleakage			
		0	1	2	3
EW	24	5 (50%)	5 (50%)	0 (0%)	0 (0%)
EW	40	0 (0%)	3 (30%)	5 (50%)	2 (20%)
EW	52	0 (0%)	0 (0%)	2 (20%)	8 (80%)
VG	24	1 (10%)	8 (80%)	1 (10%)	0 (0%)
VG	40	2 (20%)	7 (70%)	1 (10%)	0 (0%)
VG	52	0 (0%)	0 (0%)	3 (30%)	7 (70%)
GC	24	0 (0%)	0 (0%)	3 (30%)	7 (70%)
GC	40	1 (10%)	0 (0%)	2 (20%)	7 (70%)
GC	52	2 (20%)	7 (70%)	1 (10%)	0 (0%)

**Table 2.** P-values of Comparisons between Materials for each Temperature

Temperature	Kruskal-Wallis test	Post hoc comparisons		
		EW vs VG	EW vs GC	VG vs GC
24	<0.001	0.212	<0.001	0.001
40	0.001	0.026	0.152	<0.001
52	<0.001	0.773	<0.001	<0.001



Predocctoral Student Presentations

**Table 3.** P-values of Comparisons between Temperatures for each Material

Material	Kruskal-Wallis test	Post hoc comparisons		
		24 vs 40	24 vs 52	40 vs 52
EW	<0.001	0.007	<0.001	0.053
VG	<0.001	0.805	<0.001	<0.001
GC	<0.001	0.755	<0.001	0.001

**CONCLUSIONS:** At 24°C, material GC exhibited significantly greater microleakage than EW and VG. At 40°C, material VG exhibited significantly less microleakage than GC. At 52°C, material GC exhibited significantly less microleakage than EW and VG.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3279.*



## Bioactive Materials, Demineralization, and Shear Strength of Orthodontic Brackets

Lauren Trager,\* Jacob Donohue, Sarah Pagni, Ronald Perry, and Gerard Kugel

**OBJECTIVES:** This study compared the shear bond strength and demineralization of 2 conventional bracket adhesives to a new bioactive material.

**METHODS:** Three groups of bonded orthodontic brackets were analyzed for demineralization (DIAGNOdent™, KaVo (DAG) score) and shear bond strength (SBS) (MPa). A total of 30 teeth (n=10) were assigned to the following groups: composite resin (Transbond™ XT Light Cure Adhesive, 3M Unitek) (XT); resin modified glass ionomer (GC Fuji ORTHO™ LC Automix, GC America) (FJ); and a bioactive restorative (ACTIVA™ BioACTIVE™ Restorative, Pulpdent) (AB). Teeth were initially screened to determine no demineralization was present. Brackets were applied to the buccal surface of each tooth using the respective material (XT, FJ, or AB) and light cured (Translux® Wave, Heraeus Kulzer) per manufacturer instructions. Samples were placed in 0.05 M acetate buffer pH 5.0 for 30 days and upon removal were tested for demineralization using a DAG and SBS (MPa) using an Instron®5566A (Norwood, Massachusetts). Differences in demineralization and shear strength between the 3 materials were compared using Kruskal-Wallis test with Dunn's test for post hoc pairwise comparisons (State version 13.1).

**RESULTS:** Lower mean demineralization was noted with AB ( $4.90 \pm 2.18$ ) compared to both XT and FJ groups ( $p=0.021$  and  $p=0.032$ , respectively). AB showed similar mean SBS ( $28.52 \pm 6.98$ ) compared to XT ( $25.83 \pm 12.46$ ) and a higher SBS compared to FJ ( $16.85 \pm 4.51$ ) ( $p=0.012$ ).

**CONCLUSIONS:** Demineralization was significantly less with AB compared to both XT and FJ ( $p < 0.05$ ). Statistical significance was noted between SBS of AB and FJ ( $p < 0.05$ ), however, not between AB and XT ( $p > 0.05$ ). The results of this study indicate that AB has similar SBS to orthodontic composite resins and may exhibit less demineralization of tooth structure. Clinically this material may offer better strength of orthodontic brackets while reducing the presence of white spot lesions.

*Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #3289.*



## Predoctoral Student Presentations

**Craniofacial Characteristics of Patients with Non-Syndromic Tooth Aplasia***George Tsougranis,\* Tamar Roomian, and Georgios Kanavakis*

**OBJECTIVES:** To identify potential differences in craniofacial morphology between subjects with tooth aplasia and control subjects with normal tooth eruption.

**METHODS:** Cephalometric radiographs of 106 matched subjects (53 with tooth aplasia and 53 controls) were reviewed. Of these, 20 cephalometric landmarks were measured on each subject using ViewBox Software. After landmark identification, the following variables were calculated: upper lip to subnasale vertical; lower lip to subnasale vertical; ANB; cranial base angle; gonial angle; interincisal angle; mandibular plane angle; palatal plane to mandibular plane; SNA; SNB; and U1 to SN. Normality of data was assessed graphically. Differences between groups were explored with paired *t*-tests. Bonferroni adjustment was used to account for multiple testing, and thus  $p$ -values  $< 0.0045$  were considered statistically significant.

**RESULTS:** Subjects with tooth aplasia presented a smaller gonial angle ( $149.76 \pm 3.65$  degrees) than controls ( $152.40 \pm 3.49$  degrees), a statistically significant mean difference of 2.45 degrees ( $p = 0.0008$ ). Differences for all other outcomes were not statistically significant ( $p > 0.0045$ ).

**CONCLUSION:** Subjects with tooth aplasia appear to have a smaller gonial angle than subjects with a complete permanent dentition. This observation might be indicative of a different development of the mandible in patients with tooth aplasia.



## Isolation and Propagation of Myoepithelial Cells from Exocrine Glands

Kathryn Weber,\* Dillon Hawley, and Driss Zoukhri

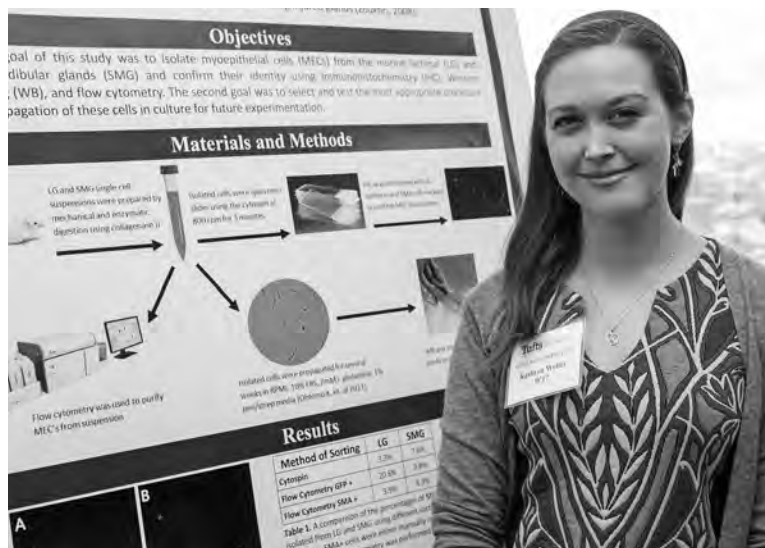
**OBJECTIVE:** The goal of this study was to isolate myoepithelial cells (MECs) from the murine lacrimal (LG) and submandibular glands (SMG) and confirm the isolation using immunohistochemistry (IHC), Western blotting, and RT-PCR analyses. The second purpose was to propagate the isolated MECs in cell culture.

**METHODS:** Single cell suspensions were prepared from the LG and SMG using mechanical and enzymatic digestion with Collagenase II. Isolated cells were spun onto slides using a Shandon Cytospin 2 at 800 rpm for 3 minutes. IHC staining was performed using epithelial (e-cadherin) and myoepithelial ( $\alpha$ -smooth muscle actin, SMA) cell markers to validate proper isolation of MECs. Isolated cells were then propagated in culture media (RPMI, 10% FBS, 2mM L-glutamine, 1% pen/strep). Following several weeks in culture, propagated cells were used for Cytospin/IHC (as above) and protein and RNA was extracted for PCR and Western blotting analyses using MECs and epithelial cell markers.

**RESULTS:** IHC analysis of isolated LG and SMG cells using e-cadherin and SMA indicated that myoepithelial cells were present and fully dissociated from all other cells. We identified 7.6% MEC and 50.7% epithelial cells in isolated cells using Cytospin/IHC from the SMG. Cultured cells from the LG showed the expected morphology of myoepithelial cells after several weeks in culture. Western blotting and RT-PCR analyses confirmed the presence of the MEC marker SMA and absence of both epithelial cell markers e-cadherin and aquaporin 5.

**CONCLUSION:** In conclusion, this study has developed a viable protocol for isolation and propagation of MECs from the LG. Ongoing experiments will attempt to propagate MECs isolated from the SMG. Future experiments will test the reported stem cell capabilities of MECs and if they can be used to fabricate a tissue-engineered secreting device capable of treating patients afflicted with dry eye and dry mouth syndromes.

Presented at the 2017 IADR/AADR/CADR General Session & Exhibition in San Francisco, California. Abstract #1066.



## Predoctoral Student Presentations

**Could 75 Be the New 65 in Geriatric Dental Care?***Jessaca York\* and Bhavik Desai*

**OBJECTIVES:** Geriatric dental patients, defined as adults over 65 years, report on average 2 or more chronic medical comorbidities that may demand modifications in their outpatient dental care. The American Society of Anesthesiologists (ASA) classification of physical health status is used in dentistry to assess risks secondary to the patient's health. The aim of this study was to evaluate the ASA status of geriatric patients at TUSDM across advancing age ranges: young-old (65–74.9); old (75–84.9); and oldest-old (>85).

**METHODS:** Patient records of geriatric adults were reviewed from TUSDM's axiUm electronic health record database for the calendar years 2013, 2014, and 2015. Patients were subdivided into young-old, old, and oldest-old. In each age category, ASA status of geriatric patients from I through VI was recorded. Statistical significance of ASA status against age groups was determined using Kruskal-Wallis test comparing the 3 groups, and post hoc comparisons using Dunn's test with the Bonferroni correction.

**RESULTS:** In calendar years 2013, 2014, and 2015, 18.92%, 19.37%, and 19.85% respectively of all patients seen at TUSDM were adults over 65. In each of these years, over half of geriatric patients between 65 and 74.9 years were ASA I, whereas a majority of patients over 75 were ASA II or higher ( $p < 0.001$ ).

**CONCLUSIONS:** Dental schools may treat a disproportionately higher number of geriatric patients than their surrounding communities. Infrastructural and educational modifications may be undertaken to accommodate needs of geriatric patients. Our study determined that a decline in physical health according to ASA status may not be evident in most patients until 75 years of age. This study underscores the importance of geriatric dental education in curricula and suggests 75 years as the age when most dental patients need some form of alterations in outpatient care.

*Presented at the 2017 IADR/AADR/CADR  
General Session & Exhibition in San  
Francisco, California. Abstract #2678.*

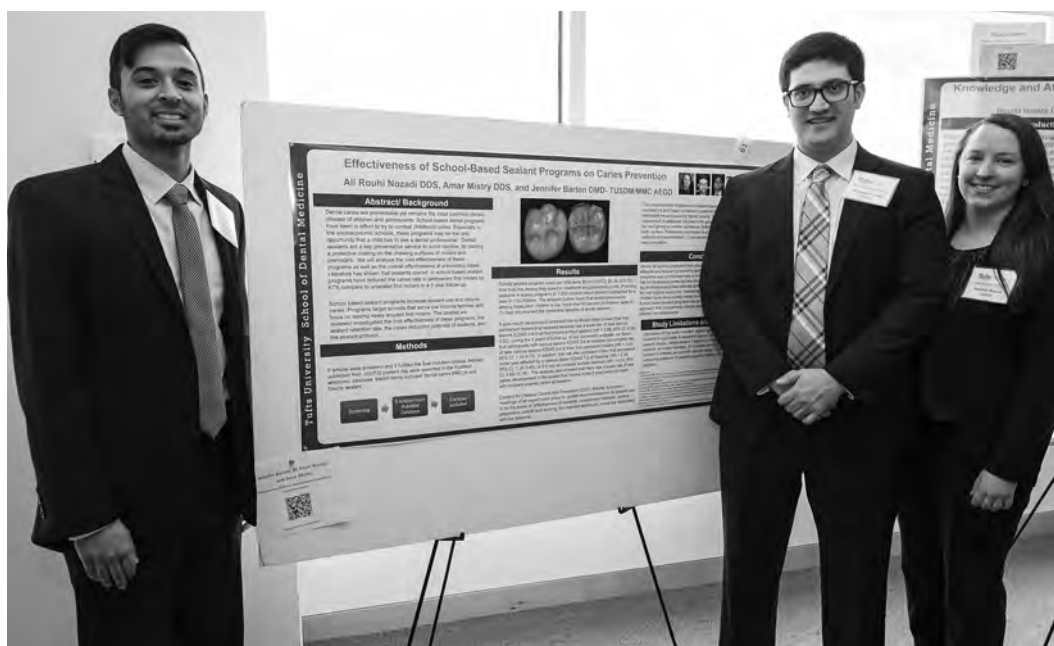


## POSTDOCTORAL STUDENT PRESENTATIONS

### Effectiveness of School-Based Sealant Programs on Caries Prevention

Jennifer Barton, Ali Rouhi Nozadi, and Amar Mistry

Dental caries is preventable yet remains the most common chronic disease of children and adolescents. School-based dental programs have been in effect to try to combat childhood caries. Especially in low socioeconomic schools, these programs may be the only opportunity that a child has to see a dental professional. Dental sealants are a key preventative service to avoid cavities by placing a protective coating on the chewing surfaces of molars and premolars. We will analyze the cost effectiveness of these programs as well as the overall effectiveness at preventing caries. Literature has shown that sealants placed in school-based programs have reduced the caries rate in permanent first molars by 67% compared to unsealed first molars in a 3-year follow-up study.



## Postdoctoral Student Presentations

## Viability of Stainless Steel Crowns as a Long-Term Restorative Option for Permanent Teeth in Patients with Intellectual and Developmental Disabilities: A Review of the Literature

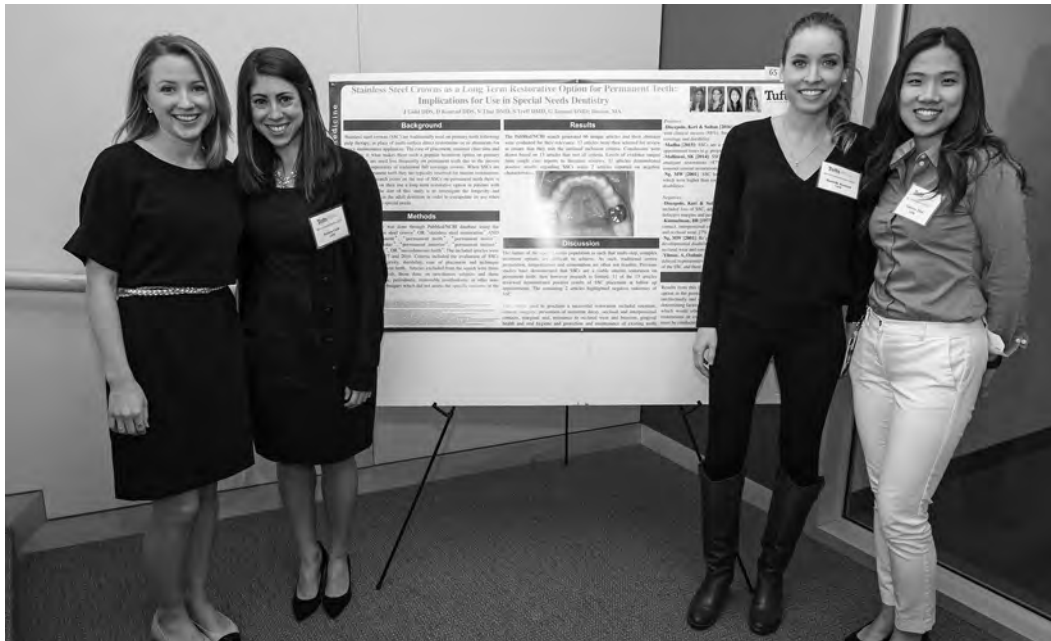
*Jessica Gold, Danielle Konrad, Vanessa Thai, and Sarah Treff*

**OBJECTIVE:** To provide an organized resource for clinicians to determine if stainless steel crowns (SSCs) are an appropriate long-term restorative option for permanent teeth in patients with intellectual and developmental disabilities (IDD). Limited research exists investigating the use of SSCs on permanent teeth in patients with IDD. The aim of this study is to investigate the longevity and viability of SSCs in the adult dentition of the general population in order to extrapolate its use when treating special needs adults in the operating room under general anesthesia.

**METHODS:** Literature published from May 1968 to current was searched using PubMed/Medline. After searching for articles related to keywords “permanent dentition” and “stainless steel crowns,” 58 papers were found. Exclusion criteria included stainless steel crowns placed on primary dentition. Articles were then grouped together according to their methods and results. Common variables observed in the studies were longevity, indications, affordability, and techniques.

**RESULTS:** Pending.

**CONCLUSIONS:** Pending analysis.



## Combination of Mandibular Advancement Device and Positional Therapy in the Management of Severe OSA: A Case Report

Nader Karimi,\* Leopoldo Correa, and Noshir Mehta

**OBJECTIVE:** To present the results of positional therapy (PT) as adjunct option for management of residual obstructive sleep apnea (OSA) in a patient utilizing a mandibular advancement device (MAD).

**METHODS:** A 78-year-old male was referred by a sleep physician to the Dental Sleep Clinic at Tufts Dental School for the use of MAD due to BIPAP therapy intolerance. Diagnostic sleep study (Type I) revealed severe obstructive sleep apnea (AHI=59.72, nadir O<sub>2</sub>=84%), REM sleep 23.3%, BIPAP titration (18/7 cm) with persistent obstructive events and emergence of central apneas. Examination of masticatory muscles and TMJ within normal findings with a baseline discomfort visual analog scale (VAS) of 0/10. A MAD was fabricated and fitted with 80% maximum jaw protrusion, reaching 90% at the last visit with discomfort VAS scale 0/10 at the end of therapy.

**RESULTS:** Type III sleep test (WP-200) read and interpreted by sleep physician showed a reduction of OSA severity (AHI=21.2) and increased nadir O<sub>2</sub>=89%, REM sleep 23% with MAD. Combination of MAD and positional therapy revealed additional reduction to normal values (AHI=3.9, nadir O<sub>2</sub>=92%, REM sleep=23%). Patient was scheduled to follow up with his sleep physician and at the dental sleep clinic for long-term follow-ups as standard clinical guidelines.

**CONCLUSION:** This case report showed the benefit of body position as an adjunct therapy for residual OSA in patients with mandibular advancement devices. Evidence of positional therapy efficacy is emerging and in combination with MAD could be an important armamentarium in the management of OSA patients in dental practice.

*Presented at the 26th Annual Meeting of the American Academy of Dental Sleep Medicine in Boston, Massachusetts. Poster #14.*



## Effectiveness of Interprofessional Oral Health Education for Pediatric Nurse Practitioner Students

Azita Khanbodaghi, \* Martha Forero, Zuhair Natto, and Cheen Loo

**OBJECTIVES:** 1) To assess and compare the effectiveness of an educational and interprofessional program for pediatric nurse practitioner students (PNPs) at Northeastern University in oral hygiene education and fluoride varnish application; and 2) to test a new scale to measure student attitudes and behavior toward interprofessional collaboration.

**METHODS:** A seminar and a practical session on oral health were used to determine how beneficial such training would be in improving the PNPs dental knowledge. Pre- and post-session surveys with a 1-month follow-up was used to evaluate the effectiveness of the seminar and practical session given to PNPs. Differences in the opinions and practices questions were evaluated using the Friedman nonparametric repeated-measures test to compare the 4 time points (pre-test, post-test, post-post-test, and 1 month later).

**RESULTS:** Thirty knowledge-based and attitude-based questions were used. The total sample size was 16 students. Knowledge, awareness, attitude, and behavior scores were determined based on the number of correct responses. Internal consistency (reliability) for each group of questions was explored using Cronbach's alpha, and it was above 0.60. These scores were differed by time of test ( $p < 0.01$ ). It was the highest after post-post-test and the lowest in pre-test.

**CONCLUSION:** Interprofessional education programs provide a unique opportunity to reinforce the importance of oral health and broaden the reach of healthcare. This study revealed evidence that there is a significant benefit to an interprofessional oral health education for PNPs.



## Management of Complex Sleep Apnea with Mandibular Advancement Device: Case Report

Sergei Li,\* Leopoldo Correa, and Noshir Mehta

A 59-year-old male with severe complex sleep apnea was referred by sleep physician to the Dental Sleep Clinic at Tufts Dental School to explore the option of a mandibular advancement device (MAD) due to intolerance to positive air pressure (PAP) therapy. Therapy with a custom adjustable MAD demonstrated control of obstructive sleep apnea events with significant reduction of central apnea component.

**INTRODUCTION:** Complex sleep apnea may be defined as the presence of both obstructive and repetitive central sleep apnea occurring in the same individual during the same night. During REM sleep, the behavioral system is dominant, with impaired ventilator response to hypercapnia, especially during phasic REM sleep. During non-REM sleep, in contrast, the metabolic control of breathing is dominant, with minimal to absent behavioral control. For this reason, in adults, significant central apnea is more frequently and sometimes exclusively seen during non-REM sleep, whereas obstructive apnea is more frequently seen in REM sleep. Some authors state that the number of central apnea events may increase with initiation of positive airway pressure (PAP) therapy due to increased alveolar ventilation with a decrease of CO<sub>2</sub> lower than the apneic threshold. However, there is a lack of data on the influence of oral appliance therapy (OAT) on central component of complex sleep apnea. The purpose of this case report is to show result of management of complex sleep apnea with OAT.

**METHODS:** A 59-year-old male with long-term symptoms of sleep disturbance was referred by his sleep physician to explore the option MAD due to intolerance to PAP therapy. The patient underwent home sleep study with type 3 CleveMed SleepView device. He was diagnosed with complex sleep apnea (AHI=31.4 per hour) with large amount of central apnea (CA) events (CA index=20.2 per hour). The overall respiratory events index (REI) was 38.2 per hour with the majority of the events happening in supine position. Baseline oxygen saturation was 97.4% with lowest O<sub>2</sub> saturation of 84.2%. A custom adjustable MAD was fabricated and fitted with 80% jaw protrusion; titration of MAD was reached at 90% during follow-up appointment. Morning jaw repositioning device (MRD) was provided to minimize potential development of occlusal side effects. After achieving subjective success the patient was referred back to the sleep physician to objectively assess the efficacy of MAD.



**RESULTS:** Follow-up PSG demonstrated reduction of obstructive and central sleep apnea with the use of MAD with residual apnea in the supine position (AHI=8.8, CA=6) mean O<sub>2</sub> saturation=94%, with lowest O<sub>2</sub> saturation=90%. Subjective improvement included feeling more refreshed at the morning and improved quality of sleep. Epworth Sleepiness Scale (ESS) score was reduced from 13/24 to 4/24. He was told by his wife that he did not snore and she had not witnessed apneas events while he was wearing the MAD. Patient was satisfied

## Postdoctoral Student Presentations

with MAD and reported minor bite symptoms at the morning after removal of MAD, which were eliminated by using a MRD for 15–20 minutes. Visual analog scale (VAS) reporting discomfort on a scale of 0–10 was scored on 0/10 on all appointments. Long-term follow-ups were scheduled at 6 months and 1 year accordingly to standard clinical care protocols to continue the assessment of effectiveness and management of possible side effects.

**CONCLUSION:** This case report demonstrated improvement of obstructive and central apnea components with MAD. A possible mechanism of reduction of central apnea events could be associated with stabilization of the ventilator control system and improving the sleep architecture.

*Presented at the 26th Annual Meeting of the American Academy of Dental Sleep Medicine in Boston, Massachusetts. Poster #3.*

## Combination Therapy for Severe OSA and Relief of TMD Umbrella Symptoms: A Case Report

Noor Mansouri,\* Leopoldo Correa, and Noshir Mehta

**OBJECTIVE:** The purpose of this case report is to present the effects of a mandibular advancement device (MAD) on a patient with severe obstructive sleep apnea (OSA) and chronic history of TMJ pain, headaches, and neck pain and the effects of a combination therapy of continuous positive airway pressure (CPAP) and MAD on OSA patients.

**METHODS:** A 45-year-old male referred by a sleep physician to the Dental Sleep Clinic at Tufts Dental School for the use of MAD due to PAP therapy intolerance. Diagnostic split night sleep study (Type I) revealed severe obstructive sleep apnea (AHI=71.6, central apneas=3, lowest SpO<sub>2</sub>s: 89%, REM=0%) in the first half of the night and moderate obstructive sleep apnea and emergent central apneas when using the CPAP in the second half (AHI=25.4, central apneas=15, lowest SpO<sub>2</sub>=86%, REM=1.1%). Epworth Sleepiness Scale (ESS) 6/24. PAP therapy was prescribed, but he experienced air leakage and developed neck pain when using it. He also reported frequent trans-meridian travels for work and having difficulty carrying the PAP machine. Clinical history intake and examination revealed chronic symptoms of TMJ pain, headaches, ear pain, and neck pain with a visual analogue scale (VAS) score of 6/10. A MAD was fabricated and fitted with 80% maximum jaw protrusion.

**RESULTS:** Patient reported improvement in the overall quality of sleep and a significant reduction in TMJ pain (VAS 0/10), ear pain (0/10), headaches (2/10), and neck pain (VAS 2/10) with ESS reduction 2/24. Follow-up split night sleep study (Type 1) interpreted by a board certified sleep physician with the MAD in place for the first half of the night showed a >60% reduction of OSA severity (AHI=28.46, central apneas=2, lowest SpO<sub>2</sub>=89%, REM=13.4%) while the second half of the night showed (AHI=11.57, central apneas=5, lowest SpO<sub>2</sub>=82%, REM=92%) while using the MAD and PAP therapy. Combination therapy of MAD and PAP was recommended, long-term follow-ups were scheduled at 6 months and 1 year as standard clinical guidelines.



**CONCLUSION:** This case report showed a reduction of OSA from severe to mild with resolution of TMD symptoms and chronic headaches. Studies support the direct effect of anterior jaw repositioning and increase of VDO over neck, masticatory muscles, and unloading of TMJ area. The use of MAD for OSA may be beneficial on patients with pre-existing TMD symptoms, and in severe OSA cases combination therapy may help to improve PAP compliance by assisting on reducing air pressure. Patient selection is a key factor when using MAD for severe OSA, as anatomical features and BMI are potential clinical predictors for oral appliance success.

*Presented at the 26th Annual Meeting of the American Academy of Dental Sleep Medicine in Boston, Massachusetts. Poster #16.*

Postdoctoral Student Presentations

**Porcelain Fracture Resistance Outcomes of Screw-Retained vs. Cement-Retained Implant Restorations**

Shreena Mistry, Riley Stearns,\* and Melissa Torres

**OBJECTIVE:** The purpose of the literature review was to analyze the porcelain fracture resistance rates and complications of screw-retained vs. cement-retained implant restorations.

**METHODS:** The authors performed an electronic search on ScienceDirect.com for articles from 2004 to 2015. Literature review was performed on clinical studies about the clinical porcelain fracture rates and complications of screw-retained vs. cement-retained implant reconstructions.

**RESULTS:** The initial search produced 6 articles. Of these, 3 articles were available for evaluation. In these 3 articles, it was found that screw-retained single crowns showed fracture resistance values of 95.01 Kgf and 108.61 Kgf when the screw access hole was 1 mm offset from the occlusal table. These values were significantly lower than cement-retained crowns, which measured 390.94 Kgf and 380.04 Kgf when the occlusal table was narrowed. It was found that both screw-retained and cement-retained implant crowns had signs of cohesive fractures in the porcelain; however screw-retained crowns also presented with microcracks at the level of the occlusal access to the screw.

**CONCLUSIONS:** From the data reviewed, it was concluded that both cement- and screw-retained single crowns reached fracture resistance values higher than loads produced in oral cavity. Cement-retained connection showed values of fracture resistance higher than screw-retained. Screw access holes of ceramic veneered, screw-retained implant restorations form a weak point of the ceramic layer. Unfilled screw access holes result in more chipping fractures during dynamic loading than cement-retained FPDs.



## Comparison of Autogenous Graft and Soft Tissue Alternatives: Case Report

*Pooyan Refahi,\* Federico Ausenda, and Irina Dragan*

**OBJECTIVE:** To compare soft tissue alternatives with autogenous gingival graft in correcting mucogingival deformities around teeth by measuring the width of attached gingiva, patient discomfort, and satisfaction.

**METHODS:** A 64-year-old patient was referred to the department of periodontology at TUSDM to correct mucogingival deformities around teeth. Patient was diagnosed with developmental and acquired deformities around teeth, soft tissue recession, and lack of keratinized tissue on teeth in the areas #19–21, #23–25, and #28–30. Patient consented to correct the deformities with autogenous gingival graft.

**RESULTS:** Following the initial procedure in the area of #23–25, patient had a significant postoperative discomfort in the donor area. Furthermore, an alternative soft tissue grafting procedure was discussed. The area of #19–21 was corrected with the use of bilayer collagen matrix and the area of #28–30 with decellularized dermis allograft. All treatment outcomes revealed an increase in the amount of attached gingiva. Patient was satisfied with the esthetics of all 3 areas.

**CONCLUSION:** The use of autogenous gingival graft, bilayer collagen matrix, and decellularized dermis allograft provided the patient with an increase attached gingiva around teeth. However, the patient reported discomfort in the donor area of the autogenous gingival graft. Upon observation, the esthetic outcome for the soft tissue alternatives was enhanced compared to the site that was corrected with the autogenous gingival graft.



## FACULTY ABSTRACTS

*Note: Names marked with an asterisk denote presenter of paper.*

### **BEHAVIORAL, EPIDEMIOLOGIC, AND HEALTH SERVICES RESEARCH**

#### **Examination of Relationship between Sitting Posture and Masticatory Function**

*Keisuke Chino,\* Kiwamu Sakaguchi, Noshir Mehta, Tomoaki Maruyama, Leopoldo Correa, Emad Abdallah, and Atsuro Yokoyama*

**OBJECTIVES:** The purpose of this study was to evaluate the effect of changes in sitting posture on the stability of sitting posture and masticatory function.

**METHODS:** Fifteen asymptomatic subjects (10 males and 5 females, ages 23–30 years, average age 25.9 years) were included in this study. The CONFORMat (Nitta Corp., Osaka, Japan) system was used to measure the result of changes in sitting posture (center of seat pressure: COSP) and the amount of glucose extraction from chewing gummy jelly was measured to evaluate masticatory performance while subjects maintained the following 2 postural positions: 1) sitting posture with feet flat on the ground (SP-FFG), and 2) sitting posture with feet off the ground (SP-FOG). The Wilcoxon signed rank test was used for statistical analysis. This study was approved by the Ethics Committee of Hokkaido University Graduate School of Dental Medicine.

**RESULTS:** The total trajectory length of COSP in SP-FFG was longer than in SP-FOG ( $p < 0.05$ ). The COSP area in SP-FFG was smaller than in SP-FOG ( $p < 0.05$ ). The root mean square value of COSP in SP-FFG was smaller than in SP-FOG ( $p < 0.05$ ). There were no significant differences in the mean displacement of COSP in left-right direction between SP-FFG and SP-FOG. The mean displacement of COSP in anterior-posterior direction in SP-FFG was smaller than in SP-FOG ( $p < 0.05$ ). The amount of glucose extraction in SP-FFG was larger than in SP-FOG ( $p < 0.05$ ).

**CONCLUSIONS:** Based on these findings, it was found that body sway was more convergent and masticatory performance was superior when subjects maintained the sitting posture with feet flat on the ground than when they maintained the sitting posture with feet off the ground. In conclusion, changes in sitting posture affected the stability of sitting posture and masticatory function.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 3546.*

## CARIOLOGY RESEARCH

### Factors Associated with Carious Lesions in a Medicated Population

*Mabi Singh,\* Athena Papas, Sarah Pagni, and Matthew Finkelman*

**OBJECTIVES:** Dental caries is a multifactorial disease. The objective of this study was to investigate the factors associated with progression of carious lesions in a population that was on prescription medications.

**METHODS:** Six hundred forty-six subjects were recalled in 9–12 months and reexamined for incipient and frank carious lesions on the coronal and root surfaces. Inclusion criteria for the study were the use of xerogenic medication, salivary flow below 0.2 ml/min, being 40–80 years old, and having at least 10 teeth. Medication(s) were self-reported. Oral hygiene care, frequency of dental visits, income, and smoking status were recorded. Statistical analysis was conducted via Spearman's rho and the Mann-Whitney *U* test.

**RESULTS:** The mean age was 65.0 (SD=9.91) years and 58% were females. The mean number of teeth was 23.2 (2.4), and mean number of medications taken 3.5 (2.4). Variables exhibiting significant Spearman correlation with total incipient and cavitated carious lesions were the number of teeth present (Spearman rho= -0.087, p=0.027), flossing (Spearman rho= -0.114, p=0.005), age (Spearman rho= -0.114, p=0.004), and income (Spearman rho= -0.100, p=0.013). Sex (p=0.007) and psychiatric medication (p<0.001) were also significantly associated with total carious lesions (Mann-Whitney *U* test), with males and subjects on psychiatric medication(s) exhibiting more total carious lesions. Number of medications, blood pressure medications, frequency of brushing, medication to control pain, smoking status, and frequency of dental visits did not show statistically significant association with total carious lesions

**CONCLUSIONS:** Although development of carious lesions involves multiple factors, income, oral hygiene behavior (especially flossing), and xerogenic medications may be associated with incipient and frank carious lesions. Larger studies need to be conducted with more stratification of the medication groups to determine the causal effect.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2671.*



## CLINICAL AND TRANSLATIONAL SCIENCE

### Current and Emerging Treatments for Postsurgical Cleft Lip Scarring: Effectiveness and Mechanisms

*Evangelos Papathanasiou,<sup>1,2</sup> Carroll Ann Trotman,<sup>2</sup> Andrew Scott,<sup>3</sup> and Thomas Van Dyke<sup>1</sup>*

<sup>1</sup>The Forsyth Institute; <sup>2</sup>Tufts University School of Dental Medicine; <sup>3</sup>Tufts University School of Medicine

**ABSTRACT:** Cleft lip with or without cleft palate is the most common congenital malformation of the head and the third-most common birth defect. Surgical repair of the lip is the only treatment and is usually performed during the first year of life. Hypertrophic scar (HTS) formation is a frequent postoperative complication that impairs soft tissue form, function, or movement. Multiple lip revision operations are often required throughout childhood, attempting to optimize aesthetics and function. The mechanisms guiding HTS formation are multifactorial and complex. HTS is the result of dysregulated wound healing, where excessive collagen and extracellular matrix proteins are deposited within the wound area, resulting in persistent inflammation and resultant fibrosis. Many studies support the contribution of dysregulated, exaggerated inflammation in scar formation. Fibrosis and scarring result from chronic inflammation that interrupts tissue remodeling in normal wound healing. Failure of active resolution of inflammation pathways has been implicated. The management of HTS has been challenging for clinicians, since current therapies are minimally effective. Emerging evidence that specialized proresolving mediators of inflammation accelerate wound healing by preventing chronic inflammation and allowing natural uninterrupted tissue remodeling suggests new therapeutic opportunities in the prevention and management of HTS.

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## CRANIOFACIAL BIOLOGY

### A Zebrafish Model of Human Fibrodysplasia Ossificans Progressiva

Melissa LaBonty, Nicholas Pray, and Pamela Yelick

Fibrodysplasia ossificans progressiva (FOP) is a rare, autosomal dominant genetic disorder in humans characterized by explosive inflammatory response to injury leading to gradual ossification within fibrous tissues, including skeletal muscle, tendons, and ligaments. A variety of animal models are needed to study and understand the etiology of human FOP. To address this need, here we present characterizations of the first adult zebrafish model for FOP. In humans, activating mutations in the Type I BMP/TGF $\beta$  family member receptor, *ACVR1*, are associated with FOP. Zebrafish *acvr1l*, previously known as *alk8*, is the functional ortholog of human *ACVR1*, and has been studied extensively in the developing zebrafish embryo, where it plays a role in early dorsoventral patterning. Constitutively active and dominant negative mutations in zebrafish *acvr1l* cause early lethal defects. Therefore, to study roles for activating *acvr1l* mutations in adult zebrafish, we created transgenic animals expressing mCherry-tagged, heat-shock-inducible constitutively active *Acvr1l*, *Acvr1l*<sup>Q204D</sup>, to investigate phenotypes in juvenile and adult zebrafish. Our studies showed that adult zebrafish expressing heat-shock-induced *Acvr1l*<sup>Q204D</sup> develop a number of human FOP-like phenotypes, including heterotopic ossification lesions, spinal lordosis, vertebral fusions, and malformed pelvic fins. Together, these results suggest that transgenic zebrafish expressing heat-shock-inducible *Acvr1l*<sup>Q204D</sup> can serve as a model for human FOP.

Published in *Zebrafish*. 2017 Aug;14(4):293-304. doi: 10.1089/zeb.2016.1398. Epub 2017 Apr 10. PMID:28394244.

## DENTAL MATERIALS

### Biocompatibility Study of Lithium Disilicate and Zirconium Oxide Ceramics for Esthetic Dental Abutments

Céline Brunot-Gohin,<sup>1,2</sup> Jean-Luc Duval,<sup>2</sup> Sandra Verbeke,<sup>1</sup> Kayla Belanger,<sup>2</sup> Isabelle Pezron,<sup>2</sup> Gerard Kugel,<sup>3</sup> Dominique Laurent-Maquin,<sup>1</sup> Sophie Gangloff,<sup>1</sup> and Christophe Egles<sup>2,3</sup>

<sup>1</sup>University of Reims Champagne-Ardenne, France; <sup>2</sup>Sorbonne Universities, France; <sup>3</sup>Tufts University School of Dental Medicine

**PURPOSE:** The increasing demand for esthetically pleasing results has contributed to the use of ceramics for dental implant abutments. The aim of this study was to compare the biological response of epithelial tissue cultivated on lithium disilicate (LS<sub>2</sub>) and zirconium oxide (ZrO<sub>2</sub>) ceramics. Understanding the relevant physicochemical and mechanical properties of these ceramics will help identify the optimal material for facilitating gingival wound closure.

**METHODS:** Both biomaterials were prepared with 2 different surface treatments: raw and polished. Their physicochemical characteristics were analyzed by contact angle measurements, scanning white-light interferometry, and scanning electron microscopy. An organotypic culture was then performed using a chicken epithelium model to simulate peri-implant soft tissue. We measured the contact angle, hydrophobicity, and roughness of the materials as well as the tissue behavior at their surfaces (cell migration and cell adhesion).

**RESULTS:** The best cell migration was observed on ZrO<sub>2</sub> ceramic. Cell adhesion was also drastically lower on the polished ZrO<sub>2</sub> ceramic than on both the raw and polished LS<sub>2</sub>. Evaluating various surface topographies of LS<sub>2</sub> showed that increasing surface roughness improved cell adhesion, leading to an increase of up to 13%.

**CONCLUSIONS:** Our results demonstrate that a biomaterial, here LS<sub>2</sub>, can be modified using simple surface changes in order to finely modulate soft tissue adhesion. Strong adhesion at the abutment associated with weak migration assists in gingival wound healing. On the same material, polishing can reduce cell adhesion without drastically modifying cell migration. A comparison of LS<sub>2</sub> and ZrO<sub>2</sub> ceramic showed that LS<sub>2</sub> was more conducive to creating varying tissue reactions. Our results can help dental surgeons to choose, especially for esthetic implant abutments, the most appropriate biomaterial as well as the most appropriate surface treatment to use in accordance with specific clinical dental applications.

*Published in J Periodontal Implant Sci. 2016 Dec;46(6):362-371. doi: 10.5051/jpis.2016.46.6.362. Epub 2016 Dec 27. PMID:28050314.*

### Effect of Thermocycling on Compressive Strength of Four Cements

Jeffrey Daddona,\* Tamar Roomian, and Gerard Kugel

**OBJECTIVES:** To compare 10,000 thermocycles' effect on the compressive strength of four cements; Group 1: ACTIVA™ BioACTIVE-Cement™ (Pulpdent Corporation); Group 2: RelyX™ Unicem 2 Automix (3M); Group 3: FujiCEM™2 (GC America); and Group 4: Ceramir® Crown & Bridge (Doxa).

**METHODS:** Eighty cylindrical samples (N=10), measuring 4 mm × 8 mm were prepared as follows: A glass plate was placed on the bottom of the mold followed by a Mylar® strip. Cement was extruded into the mold. A second Mylar film followed, which was covered by a second glass plate placed on top of the filled mold. Steady

pressure was applied to the glass to displace any excess material. The cements were cured (DEMI™, Kerr) in accordance with manufacturers' instructions and removed from the holder. Samples were wet-ground using 400-grit sandpaper (EcoMet™250, Buehler) to standardize dimensions and then stored in 37°C distilled water for 24 hours. Baseline samples were tested for compressive strength after 24 hours of storage. Samples were thermocycled for 10,000 cycles with a dwell time of 15 seconds between 5°C and 55°C to simulate aging. All compressive strength testing was measured using a universal testing machine (Instron®5566A) with 1K load cell and 1mm/min cross-head speed.

**RESULTS:** Descriptive statistics were calculated for all groups' compressive strengths. Kruskal-Wallis tests were used to compare the materials at baseline and after aging. Mann-Whitney *U* tests were used for post hoc pairwise comparisons. P-values were corrected for multiple comparisons using the Bonferroni adjustment. There was statistical significance when comparing materials at baseline and after aging. For both baseline and aged samples, group 1 was statistically significant from groups 3 and 4. When comparing baseline to aged, statistically significant differences were between groups 2 and 4.

**CONCLUSIONS:** Thermocycling had a significant negative effect on all groups except groups 1 and 3.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1963.*

## Effect of Grinding and Polishing on Roughness and Strength of Zirconia

*Waad Khayat, Najla Chebib, Matthew Finkelman, Samer Khayat, and Ala Ali*

**STATEMENT OF PROBLEM:** The clinical applications of high-translucency monolithic zirconia restorations have increased. Chairside and laboratory adjustments of these restorations are inevitable, which may lead to increased roughness and reduced strength. The influence of grinding and polishing on high-translucency zirconia has not been investigated.

**PURPOSE:** The purpose of this *in vitro* study was to compare the roughness averages (Ra) of ground and polished zirconia and investigate whether roughness influenced strength after aging.

**MATERIAL AND METHODS:** High-translucency zirconia disks were milled, sintered, and glazed according to the manufacturer's recommendations. Specimens were randomized to 4 equal groups. Group G received only grinding; groups GPB and GPK received grinding and polishing with different polishing systems; and group C was the (unground) control group. All specimens were subjected to hydrothermal aging in an autoclave at 134°C at 200 kPa for 3 hours. Roughness average was measured using a 3-dimensional (3D) optical interferometer at baseline (Ra1), after grinding and polishing (Ra2), and after aging (Ra3). A biaxial flexural strength test was performed at a rate of 0.5 mm/min. Statistical analyses were performed using commercial software ( $\alpha=0.05$ ).

**RESULTS:** Group G showed a significantly higher mean value of Ra3 ( $1.96\pm 0.32\ \mu\text{m}$ ) than polished and glazed groups ( $p<0.001$ ), which showed no statistically significant difference among them (GPB,  $1.12\pm 0.31\ \mu\text{m}$ ; GPK,  $0.88\pm 0.31\ \mu\text{m}$ ; C,  $0.87\pm 0.25\ \mu\text{m}$ ) ( $p>0.05$ ). Compared with baseline, the roughness of groups G and GPB increased significantly after surface treatments and after aging, whereas aging did not significantly influence the roughness of groups GPK or C. Group G showed the lowest mean value of biaxial flexural strength ( $879.01\pm 157.99\ \text{MPa}$ ), and the highest value was achieved by group C ( $962.40\pm 113.84\ \text{MPa}$ ); no statistically significant differences were found among groups ( $p>0.05$ ). Additionally, no significant correlation was detected between the Ra and flexural strength of zirconia.

**CONCLUSIONS:** Grinding increased the roughness of zirconia restorations, whereas proper polishing resulted

in smoothness comparable with glazed surfaces. The results provide no evidence that grinding and polishing affect the flexural strength of zirconia after aging.

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### **Clinical Significance of Bis-GMA and HEMA Orthodontic Resins Bonding to Enamel and Ceramic Materials**

*Timothy Reichheld,<sup>1</sup> Gregory Monfette,<sup>1</sup> Ronald Perry,<sup>1</sup> Matthew Finkelman,<sup>1</sup> Eric Gheewalla,<sup>2</sup> and Gerard Kugel<sup>1</sup>*

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The advancement of new ceramic materials for dental crowns has prompted the need for improved methods of bonding orthodontic brackets to these surfaces. Currently, lithium-disilicate is the primary material being used for anterior crowns, while zirconia is the primary material being used in the posterior. The purpose of this study was to compare the shear bond strength of HEMA (Assure<sup>®</sup> Universal Bonding Resin) and bis-GMA (Assure<sup>®</sup> PLUS All Surface Bonding Resin) orthodontic bonding resins on enamel, lithium-disilicate, and zirconia materials. Two groups were formed, with three tested surfaces per group (n=20). The categories included premolars, zirconia rods, and lithium-disilicate rods. Group 1 was treated with Assure, and group 2 was treated with Assure PLUS. Zirconia rods (1 cm × 1 cm × 4 cm) were used to represent zirconia crowns, and IPS e.max CAD rods (1 cm × 1 cm × 2 cm) were used to represent lithium-disilicate crowns. Assure and Assure PLUS bonding agents were applied according to the manufacturer's specifications, and standard edgewise universal premolar brackets were secured using Light Bond<sup>™</sup> paste without fluoride. After 24 hours the brackets were sheared with a universal testing machine (Instron<sup>®</sup>5566A) and the results were recorded. Data were analyzed using a combination of ANOVA and Tukey tests. A p-value of less than 0.05 was considered statistically significant. Although group 1 and group 2 gave statistically equivalent results, the authors found that the ease of use when applying the group 2 bonding agent made it a safer, superior product within the confines of this study. It did not require a 4-minute hydrofluoric acid-etch and needed half the curing time of the group 1 agent when bonding to ceramic materials.

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### **Microleakage of Lithium Disilicate Ceramic Crowns vs. Nano Ceramic Crowns**

*Vasiliki Tsakalelli,\* Ahmad Alzayer, Marcelo Suzuki, Matthew Finkelman, and Ala Ali*

**OBJECTIVES:** To evaluate and compare the microleakage of lithium disilicate ceramics (IPS e.max, Ivoclar Vivadent AG, Liechtenstein) and CAD/CAM crowns made of nano ceramics (CERASMART, GC, Tokyo, Japan) on extracted teeth after thermocycling testing. It was hypothesized that lithium disilicate crowns would have lower microleakage values compared to nano ceramic ones.

**METHODS:** Thirty extracted human third molar teeth were prepared in a consistent way to receive full-coverage CAD/CAM crowns. The specimens were scanned and designed using the CEREC system. The crowns were fabricated from IPS e.max CAD blocks and CERASMART CAD/CAM blocks using a CEREC

milling machine. The specimens were randomly distributed into two groups. The crowns of both groups were attached using Rely X Ultimate resin cement. All crowns were subjected to 10,000 thermocycles and then immersed in silver nitrate followed by using a photo-developer. Specimens were segmented buccolingually and the microleakage was measured at 1.0 magnification using a stereomicroscope. Descriptive statistics were computed. For the percentage microleakage scale, the Mann-Whitney *U* test was used since the data were not normally distributed. For the ordinal microleakage scale, statistical significance between groups was judged by generalized estimating equations (GEE). SPSS version 22 and SAS 9.4 were used in the analysis and p-values of less than 0.05 were considered statistically significant.

**RESULTS:** The CERASMART group showed lower median microleakage at 5.9% (IQR=20.7) than the e.max group, which showed a median microleakage of 7.4% (IQR=13.9). No statistically significant difference between the groups was found ( $p=0.806$ ). For the ordinal data, there was no statistically significant difference between the groups ( $p=0.605$ ).

**CONCLUSIONS:** Within the limitations of this study, no proven evidence showed a statistically significant difference when comparing the microleakage of lithium disilicate crowns and nano ceramic crowns.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2542.*

## EDUCATION

### Creation and Initial Outcomes of a Selective Four-Year Research Program for Predoctoral Dental Students

*Eileen Doherty, Nadeem Karimbux, and Gerard Kugel*

**ABSTRACT:** Educators agree that dental students' involvement in research plays an important role in their development and contributes to the future of dental education. However, dental schools are challenged to provide the time and support necessary to nurture their students in undertaking research activities. The aim of this study was to examine student participation in a predoctoral student research program at one U.S. dental school and to track participants' outcomes both before and after introduction of an additional, highly selective research scholarship program. Research participation was recorded for all predoctoral dental students in the graduating classes of 2005–15. The number of years of participation was also tracked for each student who participated in research. The results showed that, since the inception of the research honors scholarship in 2005, there has been a more than threefold increase in the number of dental students participating in research each year. The number of students who do multiple years of research has tripled, and the number of students' poster presentations at national academic meetings has risen tenfold in those ten years. The introduction of a competitive award that recognizes exceptional research by students has added to the research profile of the school and has shown success in encouraging students to become involved in research throughout their four years in dental school.

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### Is the Advanced Dental Admission Test the Metric Needed to Assist with Postgraduate Admissions? Two Viewpoints

*Alec Eidelman and Thomas Whitmer*

Viewpoint 1: The Advanced Dental Admission Test (ADAT) provides a viable solution to help postgraduate programs differentiate applicants; and Viewpoint 2: The ADAT has questionable utility and value for postgraduate admissions.

**ABSTRACT:** In 2012, when the National Board Dental Examination (NBDE) was changed from a numerical scoring system to pass/fail, advanced dental education programs lost a metric widely used for differentiating applicants to those programs. The American Dental Association (ADA) developed the ADAT to address this issue. Implementation of the ADAT began in 2016 with a pilot program, which has not yet been widely accepted in the overall admissions process. This point/counterpoint explores the benefits and challenges of using the ADAT for postgraduate admissions. Viewpoint 1 supports use of the ADAT, arguing that the test provides a viable, long-term solution to this immediate need. In contrast, Viewpoint 2 questions the need for and appropriateness of this additional academic measure for postgraduate admissions.

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## The Benefit of a Switch: Answer Changing on Multiple-Choice Exams by First-Year Dental Students

*Sarah Pagni, Anna Bak, Steven Eisen, Jennipher Murphy, Matthew Finkelman, and Gerard Kugel*

**ABSTRACT:** The aim of this study was to determine if dental students would benefit from changing their initial responses to what they deemed to be more suitable answers during high-stakes multiple-choice examinations. Students are often advised to stay with their first answers despite evidence from other fields, suggesting this is not the best course for obtaining optimal final exam scores. Data were collected for 160 first-year DMD students in fall 2013 for 3 operative dentistry and 4 biochemistry exams at TUSDM. As students take all of their exams through ExamSoft, a test-taking software application that tracks and records all changes students make during the exam period, the subjective nature of previous studies on answer changing was eliminated. The results showed that all students changed their answers on a minimum of nine questions over the seven exams, with an average of 26.55 (SD=8.8) questions changed per student. Answers changed from an incorrect to a correct response comprised nearly 65% of total answer changes, while changes from a correct to an incorrect answer encompassed slightly above 10% of answer changes. Nearly all students (99.4%) benefitted from answer changing with a net gain of at least two correct questions, with only one student not increasing the final score. Overall, the students greatly benefitted from changing their answer choice, suggesting that dental students could be advised to change their answers from their first choice if they identify a better option when taking multiple-choice exams.

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## Change Is Here: ADEA CCI 2.0—A Learning Community for the Advancement of Dental Education

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**ABSTRACT:** On May 12, 2005, the inaugural meeting of the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI) was convened. Comprised of thought leaders representative of dental education and practice, the ADEA CCI published groundbreaking white papers that effectively helped bring dental education across the threshold of the twenty-first century. Twelve years later, a new ADEA CCI has been convened: ADEA CCI 2.0. The ADEA CCI 2.0 is a broad-ranging, strategically interconnected, flexible, and multifarious community of stakeholders situated within and across all facets of oral health education and practice. Whereas the first iteration of the ADEA CCI made the case for change regarding revisions of the dental curriculum and learning environment, the ADEA CCI 2.0 will focus on external domains that are having a global impact on the content and delivery of healthcare and health professions education and, ultimately, how healthcare benefits people. The principal work of the ADEA CCI 2.0 will be to create educational and implementation resources and opportunities for dental educators to



## Education

contemplate, investigate, and ultimately define the future needs of their academic dental institutions in this constantly changing world.

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### Interactive Learning in Oral and Maxillofacial Radiology

*Aruna Ramesh and Rumpa Ganguly*

**PURPOSE:** The use of electronic tools in teaching is growing rapidly in all fields, and there are many options to choose from. We present one such platform, Learning Catalytics™ (LC) (Pearson, New York, New York), which we utilized in our oral and maxillofacial radiology course for second-year dental students.

**MATERIALS AND METHODS:** The aim of our study was to assess the correlation between students' performance on course exams and self-assessment LC quizzes. The performance of 354 predoctoral dental students from 2 consecutive classes on the course exams and LC quizzes was assessed to identify correlations using the Spearman rank correlation test. The first class was given in-class LC quizzes that were graded for accuracy. The second class was given out-of-class quizzes that were treated as online self-assessment exercises. The grading in the self-assessment exercises was for participation only and not accuracy. All quizzes were scheduled 1–2 weeks before the course examinations.

**RESULTS:** A positive but weak correlation was found between the overall quiz scores and exam scores when the two classes were combined ( $p < 0.0001$ ). A positive but weak correlation was likewise found between students' performance on exams and on in-class LC quizzes (class of 2016) ( $p < 0.0001$ ) as well as on exams and online LC quizzes (class of 2017) ( $p < 0.0001$ ).

**CONCLUSION:** It is not just the introduction of technological tools that impacts learning, but also their use in enabling an interactive learning environment. The LC platform provides an excellent technological tool for enhancing learning by improving bidirectional communication in a learning environment.

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### Interprofessional Education for the Dentist in Managing Acute and Chronic Pain

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Dental education is at the intersection of affordable healthcare, opioid-abuse crisis, and collaborative practice benefits. Students must engage in interprofessional education (IPE) for pain management. Graduates must recognize appropriate management of acute dental pain and understand the dentist's role in interprofessional treatment of chronic disease, including management of temporomandibular disorders and orofacial neuropathic pain, chronic pain in general, and the consideration of opioids. This article reviews accreditation standards, compares these standards with recommendations from the International Association for the Study of Pain and regulatory boards, and presents examples of enhanced pain education.

*Published in Dent Clin North Am. 2016 Oct;60(4):825-42. doi: 10.1016/j.cden.2016.05.003.*

## Do Standard Bibliometric Measures Correlate with Academic Rank of Full-Time Pediatric Dentistry Faculty Members?

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**ABSTRACT:** The aim of this cross-sectional study was to assess the relationship between quantitative measures of research productivity and academic rank for full-time pediatric dentistry faculty members in accredited U.S. and Canadian residency programs. For each pediatric dentist in the study group, academic rank and bibliometric factors derived from publicly available databases were recorded. Academic ranks were lecturer/instructor, assistant professor, associate professor, and professor. Bibliometric factors were mean total number of publications, mean total number of citations, maximum number of citations for a single work, and h-index (a measure of the impact of publications, determined by total number of publications  $h$  that had at least  $h$  citations each). The study sample was comprised of 267 pediatric dentists: 4% were lecturers/instructors, 44% were assistant professors, 30% were associate professors, and 22% were professors. The mean number of publications for the sample was  $15.4 \pm 27.8$ . The mean number of citations was  $218.4 \pm 482.0$ . The mean h-index was  $4.9 \pm 6.6$ . The h-index was strongly correlated with academic rank ( $r=0.60$ ,  $p=0.001$ ). For this sample, an h-index of  $\geq 3$  was identified as a threshold for promotion to associate professor, and an h-index of  $\geq 6$  was identified as a threshold for promotion to professor. The h-index was strongly correlated with the academic rank of these pediatric dental faculty members, suggesting that this index may be considered a measure for promotion, along with a faculty member's quality and quantity of research, teaching, service, and clinical activities.

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## ENDODONTICS

### Incidental Findings in Small Field of View Cone-Beam Computed Tomography Scans

*David Oser, Brett Henson, Elaine Shiang, Matthew Finkelman, and Robert Amato*

**INTRODUCTION:** The use of cone-beam computed tomography (CBCT) in endodontics has increased in recent years. In clinical application of small field of view (FOV) CBCTs, these scans are not reviewed routinely by a radiologist. Studies of large FOV CBCT scans show the prevalence of incidental findings to be greater than 90%. The purpose of this study was to evaluate the prevalence of missed findings by endodontic residents as compared with a radiologist on small FOV CBCT scans.

**METHODS:** Two hundred and three small FOV CBCTs obtained for endodontic purposes were analyzed by an endodontic resident and a medical radiologist. The reported findings of each practitioner were compared to evaluate for missed incidental findings by the endodontic resident.

**RESULTS:** The radiologist reported abnormalities in 176 of the 203 subjects (87%), with a total of 310 abnormalities reported. The endodontic resident reported abnormalities in 102 of the 203 subjects (50%), with a total of 126 abnormalities reported. The percentage of scans with any abnormality reported by the radiologist was significantly greater than the endodontic resident ( $p < 0.001$ ). There was no significant difference between jaw locations in percentage of missed findings for the 3 most common types of finding-rarefying osteitis, sinusitis/mucosal lining thickening, and excess restorative material in the periapical area. Rarefying osteitis was missed significantly less than the other 2 types of findings ( $p < 0.001$ ).

**CONCLUSIONS:** A radiologist is significantly more likely to identify incidental findings in small FOV CBCT scans than an endodontic resident. Scan location had no significant association with the rate of missed findings.

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## IMPLANTOLOGY

### Digital vs. Conventional Full-Arch Implant Impressions: A Comparative Study

*Sarah Amin, Hans-Peter Weber, Matthew Finkelman, Khaled El Rafie, Yukio Kudara, and Panos Papaspyridakos*

**PURPOSE:** To test whether or not digital full-arch implant impressions with 2 different intra-oral scanners (CEREC Omnicam and True Definition) have the same accuracy as conventional ones. The hypothesis was that the splinted open-tray impressions would be more accurate than digital full-arch impressions.

**MATERIAL AND METHODS:** A stone master cast representing an edentulous mandible using 5 internal connection implant analogs (Straumann Bone Level RC, Basel, Switzerland) was fabricated. The 3 median implants were parallel to each other; the far left implant had 10°; and the far right had 15° distal angulation. A splinted open-tray technique was used for the conventional polyether impressions (n=10) for group 1. Digital impressions (n=10) were taken with 2 intra-oral optical scanners (CEREC Omnicam and 3M True Definition) after connecting polymer scan bodies to the master cast for groups 2 and 3. Master cast and conventional impression test casts were digitized with a high-resolution reference scanner (Activity 880 scanner; Smart Optics, Bochum, Germany) to obtain digital files. Standard tessellation language (STL) datasets from the 3 test groups of digital and conventional impressions were superimposed with the STL dataset from the master cast to assess the 3D deviations. Deviations were recorded as root-mean-square error. To compare the master cast with conventional and digital impressions at the implant level, Welch's F-test was used together with Games-Howell post hoc test.

**RESULTS:** Group 1 had a mean value of 167.93  $\mu\text{m}$  (SD 50.37); group 2 (Omnicam) had a mean value of 46.41  $\mu\text{m}$  (SD 7.34); group 3 (True Definition) had a mean value of 19.32  $\mu\text{m}$  (SD 2.77). Welch's F-test was used together with the Games-Howell test for post hoc comparisons. Welch's F-test showed a significant difference between the groups ( $p < 0.001$ ). The Games-Howell test showed statistically significant 3D deviations for all 3 groups ( $p < 0.001$ ).

**CONCLUSION:** Full-arch digital implant impressions using True Definition scanner and Omnicam were significantly more accurate than the conventional impressions with the splinted open-tray technique. Additionally, the digital impressions with the True Definition scanner had significantly less 3D deviations when compared with the Omnicam.

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### Management of a Malpositioned Implant in the Anterior Maxilla

*Catherine DeFuria, Hans-Peter Weber, Yukio Kudara, and Panos Papaspyridakos*

The surgical and prosthodontic management of patients with multiple missing teeth in the anterior maxilla can be challenging. The purpose of this clinical report is to illustrate the 2-year outcome after immediate implant placement in unintentional close proximity with the adjacent root. Following uneventful healing, the definitive implant rehabilitation was done with a modified monolithic zirconia framework and porcelain veneers bonded to the framework. The patient's satisfaction with the functional and esthetic outcomes remained high throughout the observation time, with no symptoms or biologic and technical complications.

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## Full-Arch Implant Fixed Prosthesis: A Comparative Study on the Effect of Connection Type and Impression Technique on Accuracy of Fit

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Vasilios Chronopoulos,<sup>2,4</sup> and Hans-Peter Weber<sup>1</sup>

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**PURPOSE:** The aim of this study was to assess the effect of connection type and impression technique on the accuracy of fit of implant-supported fixed complete-arch dental prostheses (IFCDPs).

**MATERIALS AND METHODS:** An edentulous mandibular cast with five implants was fabricated to serve as master cast (control) for both implant- and abutment-level baselines. A titanium one-piece framework for an IFCDP was milled at abutment level and used for accuracy of fit measurements. Polyether impressions were made using a splinted and non-splinted technique at the implant and abutment level leading to 4 test groups, n=10 each. Hence, 4 groups of test casts were generated. The impression accuracy was evaluated indirectly by assessing the fit of the IFCDP framework on the generated casts of the test groups, clinically and radiographically. Additionally, the control and all test casts were digitized with a high-resolution reference scanner (IScan D103i, Imetric, Courgenay, Switzerland) and standard tessellation language datasets were generated and superimposed. Potential correlations between the clinical accuracy of fit data and the data from the digital scanning were investigated. To compare the accuracy of casts of the test groups versus the control at the implant and abutment level, Fisher's exact test was used.

**RESULTS:** Of the 10 casts of test group I (implant-level splint), all 10 presented with accurate clinical fit when the framework was seated on its respective cast, while only 5 of 10 casts of test group II (implant-level non-splint) showed adequate fit. All casts of group III (abutment-level splint) presented with accurate fit, whereas 9 of 10 of the casts of test group IV (abutment-level non-splint) were accurate. Significant 3D deviations ( $p<0.05$ ) were found between group II and the control. No statistically significant differences were found between groups I, III, and IV compared with the control. Implant connection type (implant level versus abutment level) and impression technique did affect the 3D accuracy of implant impressions only with the non-splint technique ( $p<0.05$ ).

**CONCLUSION:** For 1-piece IFCDPs, the implant-level splinted impression technique showed to be more accurate than the non-splinted approach, whereas at the abutment-level, no difference in the accuracy was found.

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## Digital Workflow for Fixed Implant Rehabilitation of an Extremely Atrophic Edentulous Mandible in Three Appointments

*Panos Papaspyridakos, Neha Rajput, Yukio Kudara, and Hans-Peter Weber*

**OBJECTIVE:** To present a rationale to reduce treatment complexity, number of surgeries, and overall treatment time for patients with extreme mandibular ridge deficiency.

**CLINICAL CONSIDERATIONS:** A 67-year-old fully edentulous male presented with a chief complaint of poor retention and stability of the mandibular complete denture with consequent discomfort and inability to chew. A novel 3-appointment protocol from guided implant placement to definitive prosthesis delivery was implemented. At the first appointment, a guided surgery protocol with the All-on-4 concept was used in the mandible. Implant placement was followed by immediate loading with a fixed provisional prosthesis providing the patient with immediate function. Final impression, cast verification and articulation, determination of VDO, and interocclusal records were obtained in the same appointment. In the second appointment, the framework try-in was performed and a pick-up impression was taken after a new CR record. The third appointment included the delivery of the final screw-retained, one-piece, full-arch prosthesis opposed by a maxillary complete denture.

**CONCLUSION:** This expedited protocol allows for implant placement with a surgical template generated from preoperative virtual planning of the implants and the CAD/CAM prosthodontic rehabilitation using a digital workflow. The patient was satisfied with the esthetic and functional outcome and was enrolled into a 6-month recall program.

**CLINICAL SIGNIFICANCE:** This article describes an expedited protocol illustrating a digital workflow for full arch implant rehabilitation of the extremely atrophic mandible. Flapless implant placement with a surgical template generated from virtual planning was followed by immediate loading with a fixed prosthesis. Digital impression/digitization of the working cast and CAD/CAM technology were used to mill the definitive prosthesis. From guided surgery to the definitive rehabilitation, only three appointments were necessary. This digital workflow can enhance patient acceptance and comfort and serve as an alternative treatment in the indicated clinical scenario.

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### The Key Points of Maintenance Therapy for Dental Implants: A Literature Review

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Dental implants require lifelong maintenance and care. Success is defined by biologic factors (presence of inflamed soft tissues surrounding dental implants and radiographic changes in the crestal bone levels) and mechanical factors (stability of the implant fixture and implant supported restoration, etc.). Most implant failures are initiated by incipient stages of inflammatory processes, which lead to peri-mucositis and peri-implantitis. The evidence regarding the value of maintenance protocol regarding implants is sparse compared with the one for teeth. This article addresses the existing literature on processes for oral hygiene for implant care.

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## Preoperative Use of Mouthwashes and Bacterial Contamination during Implant Placement

Wael Yaghmour,\* Montserrat Ruiz-Torruella, Yumi Ogata, Matthew Finkelman, Toshi Kawai, and Yong Hur

**OBJECTIVES:** To evaluate and compare the efficacy of preoperative rinse with chlorhexidine, essential oil-based, and cetylpyridinium chloride mouthwashes on bacterial contamination at the time of implant placement.

**METHODS:** Patients who were qualified for dental implants placement and met the inclusion criteria were included in the study. They were randomly divided into 4 groups according to the mouthwash used: chlorhexidine, essential oil-based, cetylpyridinium chloride, and saline. On the day of the implant placement, 3 saliva samples were collected: before the procedure and before the rinse with any of the mouthwashes (pre), immediately after the use of the mouthwash but before the procedure (post), and at the end of the procedure and after suturing the flap (end). Real-time PCR (qPCR) was used to analyze the samples and quantify the targeted periodontal pathogens with the utilization of propidium monoazide (PMA™) dye.

**RESULTS:** Forty patients were included in the study. The analysis showed that all mouthwashes resulted in a significant reduction in the number of the pathogens in the saliva samples collected after the use of the mouthwashes compared to the saline group. There was a statistically significant difference between the groups for pre-post and pre-end samples ( $p < 0.001$ ,  $p < 0.001$ , respectively) but not for post-end ( $p = 0.203$ ). There was a statistically significant difference between the chlorhexidine and the saline, essential oil and saline, and CPC and saline groups ( $p < 0.001$ ,  $p < 0.001$ ,  $p < 0.001$ , respectively). The use of PMA™ dye showed a significant difference in the bacterial counts compared to samples without the dye.

**CONCLUSIONS:** Pre-operative use of examined mouthwashes could be advantageous in terms of reducing the bacterial load at the time of implant placement, which may reduce the possibility of implant-related complications. PMA™ dye should be used with the qPCR to overcome the limitation of inability to distinguish dead and live bacteria.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2036.*

## MICROBIOLOGY/IMMUNOLOGY

### Role of Lymphocytes in Obesity-Associated Periodontitis

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**OBJECTIVES:** Destructive immune responses underlie type 2 diabetes (T2D)-associated periodontitis (PD). B cells are top candidates for driving synergistic pathology between these two diseases. Work herein directly tests the hypothesis that B cells from a T2D milieu directly promote PD.

**METHODS:** Lean (6-wk-old) or obese (high fat diet for 10 wks; N=8/group) WT C57BL/6J and B-cell-null mice were orally infected with *P. gingivalis* strain A7436 or vehicle 3 times at 2-day intervals. Alternatively, B cells from obese WT mice were transplanted into lean lymphocyte-null (RAG<sup>-/-</sup>) mice immediately prior to oral infection. Body weights and glucose tolerance test assessed obesity and metabolic health over time. Alveolar bone loss was determined by morphometric analysis 6 weeks post-infection. TRAP staining and immunohistochemistry (anti-B220) were performed on jaws. Gingival tissue gene expression was assessed by qRT-PCR.

**RESULTS:** Bone loss following *P. gingivalis* challenge was similar in lean WT and B-cell-null mice compared with vehicle-treated genotype controls. In sharp contrast, results from obese mice showed oral infection with *P. gingivalis* induced significant bone loss in WT mice (one-way ANOVA, p<0.05), but not in obese B-cell-null mice when compared to vehicle controls. B cells from obese mouse also support oral osteoclastogenesis and gingival inflammation *in vivo* as evidenced by more TRAP-positive osteoclasts (*t*-test, p<0.05) and gingival expression of TNF-alpha (one-way ANOVA, p<0.05) in WT compared to B cell-null samples. These changes occurred despite similar weight gain and glucose intolerance in all mice. However, B cells from obese mice alone did not induce *P. gingivalis*-induced periodontal bone loss in lymphocyte-null mice.

**CONCLUSIONS:** B cells promote pathogen-induced PD in hosts that are “primed” by obesity, but not in lean hosts. However, B cells from obese mice are not able to induce pathogen-induced PD in the absence of host T cells.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2110.*



## MINERALIZED TISSUE

### Bone Tissue Regeneration: Application of Mesenchymal Stem Cells and Cellular and Molecular Mechanisms

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**BACKGROUND AND OBJECTIVE:** The regeneration of damaged bone tissues to a predisease state has been a major goal for both clinicians and researchers worldwide. However, critical-sized bone defects that are unable to heal completely are a major clinical concern because effective, evidence-based regenerative therapy is still missing. Bone tissue engineering, aiming at providing novel and effective materials to promote bone regeneration, has been considered as a promising alternative to the traditional use of autografts, allografts, and xenografts based on the fact that engineered bone tissue has limitless supply and has no disease transmission. Mesenchymal stem cells (MSCs) can be derived from various adult tissues such as adipose tissues, dental follicles of wisdom teeth, bone marrow, dental pulp, gingiva, etc., which do not raise any ethical concerns. Furthermore, the application of MSCs in bone tissue engineering has moved to the preclinical stage, and an *ex vivo* cell manufacturing procedure for obtaining high-quality bioactive MSCs from human bone marrow has been approved by the U.S. Food and Drug Administration (FDA).

**SUMMARY:** In this review, we summarized the cell sources and biological characteristics of MSCs, discussed the *in vivo* functions of MSCs during bone regeneration, and briefly introduced the strategies for the application of MSCs in bone tissue engineering. Further research efforts are still needed to facilitate the application of MSCs in enhancing bone regeneration.

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### Exercise-Induced Irisin in Bone and Systemic Irisin Administration Reveal New Regulatory Mechanisms of Bone Metabolism

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Irisin is a polypeptide hormone derived from the proteolytic cleavage of fibronectin-type III domain-containing 5 (FNDC5) protein. Once released to circulation upon exercise or cold exposure, irisin stimulates browning of white adipose tissue (WAT) and uncoupling protein 1 (UCP1) expression, leading to an increase in total body energy expenditure by augmented UCP1-mediated thermogenesis. It is currently unknown whether irisin is secreted by bone upon exercise or whether it regulates bone metabolism *in vivo*. In this study, we found that 2 weeks of voluntary wheel-running exercise induced high levels of FNDC5 messenger RNA as well as FNDC5/irisin protein expression in murine bone tissues. Increased immunoreactivity due to exercise-induced FNDC5/irisin expression was detected in different regions of exercised femoral bones, including growth plate, trabecular bone, cortical bone, articular cartilage, and bone-tendon interface. Exercise also increased expression of osteogenic markers in bone and that of UCP1 in WAT, and led to bodyweight loss. Irisin intraperitoneal

(IP) administration resulted in increased trabecular and cortical bone thickness and osteoblasts numbers, and concurrently induced UCP1 expression in subcutaneous WAT. Lentiviral FNDC5 IP administration increased cortical bone thickness. *In vitro* studies in bone cells revealed irisin increases osteoblastogenesis and mineralization and inhibits receptor activator of nuclear factor- $\kappa$ B ligand (RANKL)-induced osteoclastogenesis. Taken together, our findings show that voluntary exercise increases irisin production in bone, and that an increase in circulating irisin levels enhances osteogenesis in mice.

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## Runx2/DICER/miRNA Pathway in Regulating Osteogenesis

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**ABSTRACT:** DICER is the central enzyme that cleaves precursor microRNAs (miRNAs) into 21-25 nucleotide duplex in cell lineage differentiation, identity, and survival. In the current study, we characterized the specific bone metabolism genes and corresponding miRNAs and found that DICER and Runt-related transcription factor 2 (Runx2) expressions increased simultaneously during osteogenic differentiation. Luciferase assay showed that Runx2 significantly increased the expression levels of DICER luciferase promoter reporter. Our analysis also revealed weaker DICER expression in embryos of Runx2 knock out mice (Runx2<sup>-/-</sup>) compared with that of Runx2<sup>+/-</sup> and Runx2<sup>+/+</sup> mice. We further established the calvarial bone critical-size defect (CSD) mouse model. The bone marrow stromal cells (BMSCs) transfected with siRNA targeting DICER were combined with silk scaffolds and transplanted into calvarial bone CSDs. Five weeks post-surgery, micro-CT analysis revealed impaired bone formation and repairing in calvarial defects with the siRNA targeting DICER group. In conclusion, our results suggest that DICER is specifically regulated by osteogenic master gene Runx2 that binds to the DICER promoter. Consequently, DICER cleaves precursors of miR-335-5p and miR-17-92 cluster to form mature miRNAs, which target and decrease the Dickkopf-related protein 1 (DKK1), and proapoptotic factor BIM levels, respectively, leading to an enhanced Wnt/ $\beta$ -catenin signaling pathway. These intriguing results reveal a central mechanism underlying lineage-specific regulation by a Runx2/DICER/miRNAs cascade during osteogenic differentiation and bone development. Our study also suggests a potential application of modulating DICER expression for bone tissue repair and regeneration.

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## Irisin Regulated Bone Metabolism in Gain-of- and Loss-of-Function Mouse Models

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**OBJECTIVES:** To explore the effects of myokine irisin in bone formation and further establish irisin knockout mouse line to determine the mechanisms of irisin regulating bone metabolism.

**METHODS:** (1) MC3T3-E1 and RAW264.7 cells were cultured with induction, and treated in the presence of

## Mineralized Tissue

irisin for 7, 10, and 14 days. (2) Irisin protein (3.24 ng/mouse) or saline (N=6) were injected Intraperitoneal (IP) daily for 14 days. (3) We created C57BL/6 mice carrying irisin gene bordered with two loxP sequences (irisin<sup>fl/fl</sup>). Irisin conditional knockout (cKO) mice were generated by crossing irisin<sup>fl/fl</sup> mice with Sp7-Cre mice, the transgenic mice expressing Cre recombinase gene specifically in osteoblastic lineage. Micro-CT scanning was performed on cKO and wild-type (WT) group (N=4) on 6 and 10 weeks.

**RESULTS:** (1) Irisin increased osteoblast differentiation and nuclear levels of  $\beta$ -catenin in MC3T3-E1 preosteoblastic cells and reduced osteoclastogenesis by inhibiting NFATc1 expression in RANKL-treated RAW264.7 cells. (2) IP injections of recombinant irisin increased the presence of osteoblasts at the edge of the growth plate and enhanced irisin levels in serum. Micro-CT analyses of femur revealed significant increases in bone volume and thickness. (3) Mineralization of skull, hyoid, ribs, xiphoid, and coccyx in cKO group were significantly slower than in WT group at 6 and 10 weeks. (4) Co.BMD and Tb.BV/TV in femurs in cKO group were significantly lower than in WT group, while the Co.BS/BV were increased ( $p < 0.05$ ).

**CONCLUSIONS:** Our studies for the first time demonstrated that irisin increased osteoblastogenesis through the Wnt/ $\beta$ -catenin pathway and inhibited osteoclastogenesis by suppressing the RANKL/NFATc1 pathway. Irisin systemic administration increased trabecular bone volume, cortical bone thickness, and osteoblast numbers. Our newly established irisin cKO mice showed delayed bone formation and mineralization. Irisin, as a new myokine, may play an important role in bone metabolism, representing a potential molecule for prevention and treatment of bone diseases.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1782.*

## NEUROSCIENCE/TMJ/PAIN

### How Accurate Is Information about Diagnosis and Management of Temporomandibular Disorders on Dentist Websites?

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**OBJECTIVE:** The purpose of this study was to determine the accuracy of information provided on websites of dental practices about the diagnosis and management of temporomandibular disorders (TMDs) because patients often use the internet to get information about their condition and to seek a practitioner for treatment.

**STUDY DESIGN:** A web search was done to identify the types of dental providers who advertise themselves on the internet as “specialists” in the management of TMDs. Issues that were analyzed included their classification of these disorders, the presumed etiology of such problems, and the types of treatment offered.

**RESULTS:** Over two-thirds of the 255 dental providers identified who advertised management of TMDs on their websites were general dentists. TMDs were attributed to occlusal problems or malocclusion on 66.7% of the websites and were labeled as a single disorder rather than a group of disorders on 38.8% of the websites. Recommendations to treat occlusal problems or malocclusion to alleviate TMDs were made by 54.5% of the providers.

**CONCLUSIONS:** Since these findings are not in line with current concepts about TMDs, significant inaccuracies exist with regard to the diagnosis and management of TMDs on dental practice websites. Therefore, patients need to be concerned about the dentists they may select to get their treatment, and practitioners need to be prepared to deal with the issues raised by misinformed patients.

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### Utilizing the Concept of Geste Antagoniste for Conservative Management of Oro-Mandibular Tardive Dyskinesia: A Case Report and Mini-Review

*Arwa Farag, Robert Mier, and Leopoldo Correa*

**OBJECTIVE:** This case report highlights the implication of the concept of “geste antagoniste” in conservatively managing oromotor dysfunction and its complications.

**CLINICAL PRESENTATION:** A 66-year-old female with a 1-year history of tardive dyskinesia (TD) was referred to the Craniofacial Pain Department (CPC) at TUSDM for management of sore labial/lingual mucosa secondary to excessive daytime involuntary activity of the tongue, lips, and mandible. A detailed head/neck examination revealed excessive involuntary movements of the tongue, lips, and mandible with generalized tenderness of her masticatory muscles. No TMJ or bone pathology was evident in a panoramic radiograph.

**INTERVENTION:** A lower daytime appliance with bilateral posterior contacts was fabricated to protect her oral mucosa. On reevaluation, excessive movement of the jaw/tongue was significantly reduced with the presence of the appliance in her mouth. Face/neck muscle tenderness was also greatly reduced.

**CONCLUSION:** The use of oral appliance therapy in TD patients plays an important role in protecting the

teeth/oral mucosa. The subsequent inhibition of excessive motor activity is proposed and should be further investigated.

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## **Cross-Validation of Short Forms of the Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R)**

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**BACKGROUND:** The Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R) is a 24-item assessment designed to assist in the prediction of aberrant drug-related behavior (ADB) among patients with chronic pain. Recent work has created shorter versions of the SOAPP-R, including a static 12-item short form and two computer-based methods (curtailment and stochastic curtailment) that monitor assessments in progress. The purpose of this study was to cross-validate these shorter versions in two new populations.

**METHODS:** This retrospective study used data from patients recruited from a hospital-based pain center (N=84) and pain patients followed and treated at primary care centers (N=110). Subjects had been administered the SOAPP-R and assessed for ADB. In real-data simulation, the sensitivity, specificity, and area under the curve (AUC) of each form were calculated, as was the mean test length using curtailment and stochastic curtailment.

**RESULTS:** Curtailment reduced the number of items administered by 30% to 34% while maintaining sensitivity and specificity identical to those of the full-length SOAPP-R. Stochastic curtailment reduced the number of items administered by 45% to 63% while maintaining sensitivity and specificity within 0.03 of those of the full-length SOAPP-R. The AUC of the 12-item form was equal to that of the 24-item form in both populations.

**CONCLUSIONS:** Curtailment, stochastic curtailment, and the 12-item short form have potential to enhance the efficiency of the SOAPP-R.

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## **An Investigation of Completion Times on the Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R)**

*Matthew Finkelman,<sup>1</sup> Ronald Kulich,<sup>1</sup> Stephen Butler,<sup>2</sup> William Jackson,<sup>3</sup> Franklin Friedman,<sup>4</sup> Niels Smits,<sup>5</sup> and Scott Weiner<sup>6</sup>*

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**BACKGROUND:** Respondents' scores to the Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R) have been shown to be predictive of aberrant drug-related behavior (ADB). However, research is lacking on whether an individual's completion time (the amount of time taken to finish the screener) has utility in predicting ADB, despite the fact that response speed has been useful in predicting behavior in other fields.

The purpose of this study was to evaluate the degree to which SOAPP-R completion time is predictive of ADB.

**MATERIALS AND METHODS:** This retrospective study analyzed completion-time data from 82 adult emergency department patients who completed the SOAPP-R on a tablet computer. The utility of SOAPP-R completion times in predicting ADB was assessed via logistic regression and the area under the curve (AUC) statistic. An external measure of ADB using prescription drug monitoring program data defined ADB to have occurred in individuals with at least 4 opioid prescriptions and at least 4 prescribers in 12 months.

**RESULTS:** Although there was a slight trend for individuals with greater completion times to have greater odds of ADB (odds ratio 1.004 in simple logistic regression), the association between SOAPP-R completion time and ADB was not statistically significant in either simple logistic regression ( $p=0.307$ ) or multiple logistic regression adjusting for SOAPP-R score ( $p=0.419$ ). AUC values for the prediction of ADB using completion time alone, SOAPP-R score alone, and both completion time and SOAPP-R score were 0.63, 0.64, and 0.65, respectively.

**CONCLUSION:** There was no significant evidence that SOAPP-R completion times were predictive of ADB among emergency department patients. However, the AUC value for completion times was only slightly less than that for SOAPP-R total scores.

*Published in J Pain Res. 2016 Dec 5;9:1163-1171. eCollection 2016.PMID:27980436.*

## Development of Short-Form Versions of the Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R): A Proof-of-Principle Study

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**BACKGROUND:** The Screener and Opioid Assessment for Patients with Pain—Revised (SOAPP-R) is a 24-item questionnaire designed to assess risk of aberrant medication-related behaviors in chronic pain patients. The introduction of short forms of the SOAPP-R may save time and increase utilization by practitioners.

**OBJECTIVE:** To develop and evaluate candidate SOAPP-R short forms.

**DESIGN:** Retrospective study.

**SETTING:** Pain centers.

**SUBJECTS:** Four hundred and twenty-eight patients with chronic noncancer pain.

**METHODS:** Subjects had previously been administered the full-length version of the SOAPP-R and been categorized as positive or negative for aberrant medication-related behaviors via the Aberrant Drug Behavior Index (ADBI). Short forms of the SOAPP-R were developed using lasso logistic regression. Sensitivity, specificity, and area under the curve (AUC) of all forms were calculated with respect to the ADBI using the complete data set, training-test analysis, and 10-fold cross-validation. The coefficient alpha of each form was also calculated. An external set of 12 pain practitioners reviewed the forms for content.

**RESULTS:** In the complete data set analysis, a form of 12 items exhibited sensitivity, specificity, and AUC greater than or equal to those of the full-length SOAPP-R (which were 0.74, 0.67, and 0.76, respectively). The short form had a coefficient alpha of 0.76. In the training-test analysis and 10-fold cross-validation, it exhibited

an AUC value within 0.01 of that of the full-length SOAPP-R. The majority of external practitioners reported a preference for this short form.

**CONCLUSIONS:** The 12-item version of the SOAPP-R has potential as a short risk screener and should be tested prospectively.

*Published in Pain Med. 2016 Sep 7. pii: pnw210. [Epub ahead of print]PMID:27605589.*

### **Efficacy and Tolerability of Buccal Buprenorphine in Opioid-Experienced Patients with Moderate to Severe Chronic Low Back Pain: Results of a Phase 3, Enriched Enrollment, Randomized Withdrawal Study**

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<sup>5</sup>BioDelivery Sciences International Inc., Raleigh, North Carolina

A buccal film of buprenorphine (BBUP) was evaluated for safety and efficacy in a multicenter, double-blind, placebo-controlled, enriched-enrollment, randomized-withdrawal study in opioid-experienced patients (30 to  $\leq$ 160 mg/d morphine sulfate equivalent) with moderate to severe chronic low back pain taking around-the-clock opioid analgesics. Patients' opioid doses were tapered to  $\leq$ 30 mg morphine sulfate equivalent before open-label titration with BBUP (range, 150–900  $\mu$ g every 12 hours). Patients who responded (received adequate analgesia that was generally well tolerated for 14 days) were randomized to receive BBUP (n=254) or placebo (n=257) buccal film. The primary efficacy variable was the change from baseline to week 12 of double-blind treatment in mean average daily pain-intensity scores using a rating scale of 0 (no pain) to 10 (worst pain imaginable). In the intent-to-treat population, mean pain scores were 6.7 after opioid taper and declined to 2.8 after the BBUP titration period. After randomization, mean pain scores were lower in the BBUP group than in the placebo group; the difference between groups in the mean change from baseline to week 12 was  $-0.98$  (95% CI,  $-1.32$  to  $-0.64$ ;  $p < 0.001$ ). A significantly larger percentage of patients receiving BBUP rather than placebo had pain reductions  $\geq 30\%$  and  $\geq 50\%$  ( $p < 0.001$  for both). In the double-blind portion of the study, the only adverse event reported more frequently with BBUP rather than placebo and in  $\geq 5\%$  of patients was vomiting (5.5% vs 2.3%). These findings demonstrate the efficacy and tolerability of BBUP in opioid-experienced patients taking around-the-clock opioid treatment for chronic low back pain.

*Published in Pain. 2016 Nov; 157(11): 2517–2526.*

### **A Model for Opioid Risk Stratification: Assessing the Psychosocial Components of Orofacial Pain**

*Ronald Kulich,<sup>1,2</sup> Jordan Backstrom,<sup>3</sup> Jennifer Brownstein,<sup>1,2</sup> Matthew Finkelman,<sup>1</sup> Shuchi Dhadwal,<sup>1</sup> and David DiBenedetto<sup>1</sup>*

<sup>1</sup>Tufts University School of Dental Medicine, Boston; <sup>2</sup>Harvard Medical School, Boston; <sup>3</sup>Boston PainCare Center, Waltham, Massachusetts

This article describes a model of opiate risk stratification with a special focus on dentistry and oral surgery. A brief overview covers the scope of the U.S. opioid abuse and misuse epidemic, and the role of the dentist in

mitigating the problems of diversion and misuse of controlled substances. The expanding role of dentistry is summarized. An assessment outlines gathering critical risk information, screening questionnaires, access to state prescription monitoring programs, and communication with cotreating providers. Special populations are discussed. Barriers and possible solutions for effective implementation of these strategies are summarized.

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## **Cannabis for the Treatment of Chronic Pain in the Era of an Opioid Epidemic: A Symposium-Based Review of Sociomedical Science**

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<sup>3</sup>McLean Hospital, Boston; <sup>4</sup>Boston University School of Medicine, Boston; <sup>5</sup>Boston PainCare Center, Waltham; <sup>6</sup>Moriarty, Shay and Associates, Wakefield, Massachusetts

**OBJECTIVE:** This manuscript reviews medical literature published pertaining to the management of chronic pain with medical marijuana therapy (MMJ), with an emphasis on the social, medical, and legal aspects of therapy.

**DESIGN:** Narrative review of peer-reviewed literature.

**METHODS:** The Third Symposium on Controlled Substances and Their Alternatives for the Treatment of Pain was held in Boston on February 27, 2016, with a focus on MMJ for the treatment of chronic pain. Invited speakers had diverse backgrounds, including pain management, addiction psychiatry, neurology, and legal authorities. The purpose of this conference and this subsequent narrative review is to provide a medical, legal, and logistical framework for physicians and other healthcare providers to refer to when considering the initiation of medical marijuana therapy.

**RESULTS:** The invited speakers each covered a unique aspect of MMJ therapy for the treatment of chronic pain. These presentations highlighted the current data for and against the use of MMJ as a pain therapy. Optimal patient selection and screening, in addition to policy developments, were discussed.

**CONCLUSIONS:** Increasing interest in MMJ for chronic pain underscores a need for primary care and pain physicians to better understand the indications and evidence for its use free from cultural bias. Given a lack of full conclusive clinical utility, continued research is needed to better understand how to best utilize MMJ therapy for the treatment of chronic pain. Policy initiatives, such as enumerated indications, should follow medical science in order to prevent another abused substance epidemic.

*Published in Pain Med. 2017 Jul 13. doi: 10.1093/pm/pnx143. [Epub ahead of print].*

## **Combination Therapy for Severe OSA and Relief of TMD Umbrella Symptoms: A Case Report**

*Noor Mansouri, Leopoldo Correa, and Noshir Mehta*

**INTRODUCTION:** The purpose of this case report is to present the effects of a mandibular advancement device (MAD) on a patient with severe obstructive sleep apnea (OSA) and chronic history of TMJ pain, headaches, and neck pain and the effects of a combination therapy of continuous positive airway pressure (CPAP) and MAD on OSA patients.



**METHODS:** A 45 year-old male referred by a sleep physician to the Dental Sleep Clinic at Tufts Dental School for the use of MAD due to PAP therapy intolerance. Diagnostic split night sleep study (Type I) revealed severe obstructive sleep apnea (AHI=71.6, central apneas=3, lowest SpO<sub>2</sub>=89%, REM=0%) in the first half of the night and moderate obstructive sleep apnea and emergent central apneas when using the CPAP in the second half (AHI=25.4, central apneas=15, lowest SpO<sub>2</sub>=86%, REM=1.1%). Epworth Sleepiness Scale (ESS) 6/24, PAP therapy was prescribed, but he experienced air leakage and developed neck pain when using it. He also reported frequent transmeridian travels for work and having difficulty carrying the PAP machine. Clinical history intake and examination revealed chronic symptoms of TMJ pain, headaches, ear pain, and neck pain with a visual analog scale (VAS) score of 6/10. A MAD was fabricated and fitted with 80% maximum jaw protrusion.

**RESULTS:** Patient reported improvement in the overall quality of sleep and a significant reduction in TMJ pain (VAS 0/10), ear pain (0/10), headaches (2/10), and neck pain (VAS 2/10) with ESS reduction 2/24. Follow-up split night sleep study (Type I) interpreted by a board-certified sleep physician with the MAD in place for the first half of the night showed a >60% reduction of OSA severity (AHI=28.46, central apneas=2, lowest SpO<sub>2</sub>=89%, REM=13.4%) while the second half of the night showed (AHI=11.57, central apneas=5, lowest SpO<sub>2</sub>=92%, REM=8.4%) while using the MAD and PAP therapy. Combination therapy of MAD and PAP was recommended; long-term follow-ups were scheduled at 6 months and 1 year as standard clinical guidelines.

**CONCLUSIONS:** This case report showed a reduction of OSA from severe to mild, an improvement in REM sleep cycle, and resolution of TMD symptoms and chronic headaches. Studies support the direct effect of anterior jaw repositioning and increase of VDO over neck, masticatory muscles, and unloading of TMJ area. The use of MAD for OSA may be beneficial on patients with pre-existing TMD symptoms and PAP emergent central apneas. In severe OSA cases, combination therapy may help to improve PAP compliance by assisting to reduce air pressure. Patient selection is a key factor when using MAD for severe OSA, as anatomical features and BMI are potential clinical predictors for oral appliance success.

*Presented at the 26th Annual Meeting of the American Academy of Dental Sleep Medicine in Boston, June 2017. Poster #16.*

## **A Multicenter, Open-Label, Long-Term Safety and Tolerability Study of DFN-02, an Intranasal Spray of Sumatriptan 10 Mg Plus Permeation Enhancer DDM, for the Acute Treatment of Episodic Migraine**

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**BACKGROUND:** DFN-02 is a novel intranasal spray formulation composed of sumatriptan 10 mg and a permeation-enhancing excipient comprised of 0.2% 1-O-n-Dodecyl-β-D-Maltopyranoside (DDM). This composition of DFN-02 allows sumatriptan to be rapidly absorbed into the systemic circulation and exhibit pharmacokinetics comparable to subcutaneously administered sumatriptan. Rapid rate of absorption is suggested to be important for optimal efficacy. The objective of this study was to evaluate the safety and tolerability of DFN-02 (10 mg) in the acute treatment of episodic migraine with and without aura over a 6-month period based on the incidence of treatment-emergent adverse events and the evaluation of results of clinical laboratory tests, vital signs, physical examination, and electrocardiograms.

**METHODS:** This was a multi-center, open-label, repeat-dose safety study in adults with episodic migraine with and without aura. Subjects diagnosed with migraine with or without aura according to the criteria set forth in the International Classification of Headache Disorders, 2nd edition, who experienced 2 to 6 attacks per month with fewer than 15 headache days per month and at least 48 headache-free hours between attacks, used DFN-02 to treat their migraine attacks acutely over the course of 6 months.

**RESULTS:** A total of 173 subjects was enrolled, 167 (96.5%) subjects used at least 1 dose of study medication and were evaluable for safety, and 134 (77.5%) subjects completed the 6-month study. A total of 2,211 migraine attacks was reported, and 3,292 doses of DFN-02 were administered; mean per subject monthly use of DFN-02 was 3.6 doses. Adverse events were those expected for triptans, as well as for nasally administered compounds. No new safety signals emerged. Dysgeusia and application site pain were the most commonly reported treatment-emergent adverse events over 6 months (21% and 30.5%, respectively). Most of the treatment-emergent adverse events were mild. There were 5 serious adverse events, all considered unrelated to the study medication; the early discontinuation rate was 22.5% over the 6-month treatment period.

**CONCLUSION:** DFN-02 was shown to be well tolerated when used over 6 months to treat episodic migraine acutely.

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## Comparison of Excursive Occlusal Force Parameters in Postorthodontic and Nonorthodontic Subjects Using T-Scan® III

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**OBJECTIVE:** Published studies indicate that orthodontically treated patients demonstrate increased posterior occlusal friction contributing to temporomandibular disorder (TMD) symptoms. This study investigated measured excursive movement occlusal contact parameters and their association with TMD symptoms between non- and postorthodontic subjects.

**METHODS:** Twenty-five postorthodontic and 25 nonorthodontic subjects underwent T-Scan® computerized occlusal analysis to determine their disclusion time (DT), the excursive frictional contacts, and occlusal scheme. Each subject answered a TMD questionnaire to determine the presence or absence of TMD symptoms. Statistical analysis compared the within group and between group differences ( $p < 0.05$ ).

**RESULTS:** Statistically significant differences were observed in the disclusion time: DT=2.69 s in the postorthodontic and 1.36 s in the nonorthodontic group. In the nonorthodontic group, 72.7% working and 27.3% nonworking side contacts were seen, while in the postorthodontic group, (near equal) 54.7% working and 45.3% non-working side contacts were seen. Presence of canine guidance was seen in 60% of the nonorthodontic group and 24% in the postorthodontic group. Seventy-two percent of the postorthodontic subjects presented with one or more TMD symptoms.

**CONCLUSION:** Significantly longer disclusion time, higher posterior frictional contacts, and more TMD symptoms were observed in the postorthodontic group, suggesting that orthodontic treatment increases posterior tooth friction. Computerized occlusal analysis is an objective diagnostic tool determining the quality of excursive movements following orthodontic treatment.

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## Lubiprostone for Opioid-Induced Constipation Does Not Interfere with Opioid Analgesia in Patients with Chronic Noncancer Pain

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**OBJECTIVE:** To determine whether lubiprostone 24 µg twice daily (BID), administered to relieve opioid-induced constipation (OIC), affects opioid analgesia in patients with chronic noncancer pain.

**METHODS:** Data were pooled from 3 randomized, double-blind, placebo-controlled trials of lubiprostone in adults with chronic noncancer pain receiving stable opioid analgesia and who had documented OIC. In each study, lubiprostone 24 µg BID or placebo was administered for 12 weeks for relief of OIC using a common protocol. The Brief Pain Inventory short form (BPI-SF) was administered, and opioid use (expressed as morphine-equivalent daily dose [MEDD]) was recorded at baseline and months 1, 2, and 3. The BPI-SF provided patient scores for pain severity, the worst pain experienced in the past 24 hours, and pain interference with daily life.

**RESULTS:** The pooled patient population (N=1,300) was predominately female (62.5%) and white (82.1%), with a mean age of 50.5 years. The MEDD was 97.5 mg (range, 5 to 3656 mg) in patients receiving placebo and 112.5 mg (range, 4 to 7605 mg) in patients treated with lubiprostone. Lubiprostone 24 µg BID treatment did not appear to affect opioid use or pain scores; changes from baseline were not significantly different with placebo versus lubiprostone 24 µg BID at months 1, 2, and 3 for MEDD ( $p \geq 0.435$ ) and for BPI-SF scores for pain interference, pain severity, and worst pain ( $p \geq 0.402$ ).

**DISCUSSION:** Lubiprostone 24 µg BID administered for relief of OIC in patients with chronic noncancer pain does not interfere with opioid analgesia.

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## Efficacy and Safety of Lubiprostone in Patients with Opioid-Induced Constipation: Phase 3 Study Results and Pooled Analysis of the Effect of Concomitant Methadone Use on Clinical Outcomes

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**OBJECTIVE:** The efficacy and safety of oral lubiprostone for relieving symptoms of opioid-induced constipation (OIC) in patients with chronic noncancer pain were evaluated in a randomized, double-blind, placebo-controlled study. These data were also pooled with those from 2 similar phase 3 studies to explore the effects of methadone on treatment response.

**METHODS:** In the primary study, adults with OIC (fewer than three spontaneous bowel movements [SBMs]

per week) were randomized to receive lubiprostone 24 mcg or placebo twice daily for 12 weeks. The primary end point was a change from baseline in the frequency of SBMs at week 8 in patients without a prior dose reduction. For the pooled analysis, the efficacy of lubiprostone was compared with placebo in patients receiving methadone or nonmethadone opioids. Responders were defined as patients with nine or more weeks of nonmissing SBM data who had one or more additional SBMs per week from baseline for each week that data were available and three or more SBMs per week for nine or more weeks.

**RESULTS:** In the primary study, the change from baseline at week 8 in SBM frequency was similar in the lubiprostone and placebo groups ( $p=0.842$ ). In the pooled analysis, the response rate was significantly higher with lubiprostone treatment versus placebo for patients receiving nonmethadone opioids ( $p=0.002$ ) but was similar between lubiprostone treatment and placebo in patients receiving methadone ( $p=0.692$ ). The safety profile of lubiprostone was unaffected by methadone use.

**CONCLUSIONS:** The phase 3 study did not meet its primary efficacy end point. However, analysis of pooled data from all phase 3 studies in the OIC clinical development program, stratified by methadone opioid usage, confirmed that lubiprostone is effective for treatment of OIC in patients taking nonmethadone opioids; no safety concerns were identified based on the type of opioid used.

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## Opioid Treatment of Migraine: Risk Factors and Behavioral Issues

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**ABSTRACT:** Migraine can impact every aspect of a person's functioning. Psychological comorbidities, cognitive constructs, and behavioral responses to pain greatly impact the perception of migraine pain, treatment efficacy and outcome, and overall quality of life and functioning. Current considerations for migraine treatment emphasize the utility of the biopsychosocial model in understanding and treating migraine, noting both the importance of addressing psychological factors such as cognitive beliefs as well as psychiatric comorbidities. The guidelines for migraine treatment implicate opioid therapy as a second- or third-tier treatment. Guidelines and recommendations for the safe use of opioid medications among patients with chronic pain emphasize the importance of screening prior to prescribing opioid medications. Chronic opioid therapy has been shown to further levels of disability, decrease quality of life, and correlate to psychiatric comorbidities, concerns that are already present in migraine patients. While opioid treatment provides an alternative for persons with contraindications for alternative migraine treatments, it is critical that opioids be used sparingly and exclusively in conjunction with comprehensive assessment and integration of psychological treatment.

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## Disclusion Time Reduction Therapy in Treating Occluso-Muscular Pains

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**ABSTRACT:** Disclusion time reduction (DTR) is an objective treatment protocol using T-Scan III (digital analysis of occlusion) and electromyography for treating occlusally activated orofacial pains. Chronic

occlusomuscle disorder is a myogenous subset of temporomandibular disorder symptoms. These muscular symptoms are induced within hyperactive masticatory muscles due to prolonged disclusion time, occlusal interferences, and occlusal surface friction that occur during mandibular excursive movements. This case report describes a patient treated by DTR therapy, whereby measured pretreatment prolonged disclusion time was reduced to short disclusion time using the immediate complete anterior guidance development enameloplasty, guided by T-Scan occlusal contact time and force analysis synchronized with electromyographic recordings of 4 masticatory muscles.

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## Oxytocin and Migraine Headache

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**ABSTRACT:** This article reviews material presented at the 2016 Scottsdale Headache Symposium. This presentation provided scientific results and rationale for the use of intranasal oxytocin for the treatment of migraine headache. Results from preclinical experiments are reviewed, including *in vitro* experiments demonstrating that trigeminal ganglia neurons possess oxytocin receptors and are inhibited by oxytocin. Furthermore, most of these same neurons contain CGRP, the release of which is inhibited by oxytocin. Results are also presented that demonstrate that nasal oxytocin inhibits responses of trigeminal nucleus caudalis neurons to noxious stimulation using either noxious facial shock or nitroglycerin infusion. These studies led to testing the analgesic effect of intranasal oxytocin in episodic migraineurs studies that did not meet their primary endpoint of pain relief at 2 h, but which were highly informative and led to additional rat studies wherein inflammation was found to dramatically upregulate the number of oxytocin receptors available on trigeminal neurons. This importance of inflammation was supported by a series of *in vivo* rat behavioral studies, which demonstrated a clear craniofacial analgesic effect when a pre-existing inflammatory injury was present. The significance of inflammation was further solidified by a small single-dose clinical study, which showed analgesic efficacy that was substantially stronger in chronic migraine patients that had not taken an anti-inflammatory drug within 24 h of oxytocin dosing. A follow-on open label study examining effects of 1 month of intranasal oxytocin dosing did show a reduction in pain, but a more impressive decrease in the frequency of headaches in both chronic and high frequency episodic migraineurs. This study led to a multicountry double blind, placebo-controlled study studying whether, over 2 months of dosing, “as needed” dosing of intranasal oxytocin by chronic and high frequency migraineurs would reduce the frequency of their headaches compared to a 1-month baseline period. This study failed to meet its primary endpoint, due to an extraordinarily high placebo rate in the country of most of the patients (Chile), but was also highly informative, showing strong results in other countries and strong post hoc indications of efficacy. The results provide a strong argument for further development of intranasal oxytocin for migraine prophylaxis.

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## Randomized Clinical Trial of Duloxetine for TMJD Pain

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**OBJECTIVES:** Temporomandibular Joint Disorder (TMJD) is a major cause of chronic craniofacial pain. Several studies have shown a link between TMJD and fibromyalgia, and the association of widespread pain and generalized alterations in pain processing suggests that these disorders may share a common pathophysiology. Duloxetine, an antidepressant that increases 5-HT and NE-mediated neurotransmission has been FDA-approved for treatment of chronic pain. The purpose of this study was to evaluate the effect of duloxetine on TMJD pain.

**METHODS:** This study was a double blind, placebo-controlled, parallel groups prospective study to evaluate the analgesic effect of 60 mg duloxetine taken daily in comparison to matching placebo for a 6-week period using the primary outcome measure of change in spontaneous facial pain. Case classification was established using the modified RDC-TMD. Adverse effects, comorbid conditions, and a variety of other assessments were recorded.

**RESULTS:** A total of 90 subjects were evaluated. The median age for all study participants was 39 years. Pain ratings were reported as moderate in both groups at baseline; these ratings decreased to mild in the drug group but remained at moderate in the placebo group at the end of the study. Similarly, current pain, as measured by BPI, decreased over time in the drug group but not in the placebo group. These changes followed the same pattern observed with the VAS, but the difference did not achieve statistical significance ( $p=0.08$ ). Headache was the most frequently reported co-existing pain condition by all the subjects (58.9%), followed by osteoarthritis (5.7%), and fibromyalgia (1.1%). The most commonly reported adverse effects were headache, nausea, vomiting, loss of appetite, and sleep disturbance. Adverse events occurred more frequently in the drug group at the beginning of treatment.

**CONCLUSIONS:** In comparison to a matching placebo, daily duloxetine treatment over 6 weeks was well-tolerated and reduced spontaneous facial pain. Our findings suggest that duloxetine may offer a safe and effective therapy for patients with painful TMJD conditions.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 3950.*

## ORAL HEALTH RESEARCH

### One-Month Randomized Controlled Trial Comparing Brush Effects on Sensitivity Response

*Chad Anderson,\* Gerard Kugel, Marco Ferrari, and Robert Gerlach*

**OBJECTIVES:** A randomized controlled trial was conducted to compare power and manual brushing effects on a professional plus at-home sensitivity regimen.

**METHODS:** In this practice-based research, institutional review was obtained, adults with a history of dentinal hypersensitivity were screened, and test sites with air sensitivity were selected. After baseline measurements, a professional treatment with oxalate acid potassium salt solution (Super Seal® Dental Desensitizing Liner, Phoenix Dental) was administered. Balancing for baseline, subjects were then randomly assigned to a rotation-oscillation power brush (Oral-B® Professional Care 4000, Procter & Gamble) or manual crisscross brush control. Test products were dispensed in blinded test kits with a 0.454% stannous fluoride dentifrice for at-home use. Sensitivity was measured after stimulation with a 1-sec application of cool air from a dental air syringe. Two measurements were collected: clinical sensitivity was measured using a standard 4-point scale (Schiff), while self-assessment used a 100 point pain-ranking scale (VAS) collected via a tablet.

**RESULTS:** A total of 24 adults were enrolled (12 per group), ages ranged from 21 to 67 years, most (92%) subjects were female, and 23 completed the 1-month recall. Baseline sensitivity means (SD) were 2.4 (0.72) for Schiff Air, and 57.9 (17.0) for VAS. Both groups exhibited significant ( $p < 0.05$ ) durable reductions in sensitivity (Schiff and/or VAS) with treatment. Overall, the power brush group exhibited greater sensitivity reductions, and groups differed ( $p = 0.006$ ) for VAS sensitivity. Each treatment was well-tolerated, and there were no “for cause” dropouts.

**CONCLUSIONS:** In practice-based research, use of a rotation-oscillation power brush improved dentinal hypersensitivity responses to professional plus at-home care over a 30-day period.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1538.*

### Practice-Based Research on Topical Oxalates to Treat Dentinal Hypersensitivity

*Nicolette Kafasis,\* Gerard Kugel, Elizabeth Tzavaras, Jill Underwood, Melanie Miner, and Robert Gerlach*

**OBJECTIVES:** Practice-based research was conducted to assess decision-making, oral tolerability, and effectiveness of topical oxalate use and home care to treat dentinal hypersensitivity.

**METHODS:** After institutional review, a multicenter practice-based study was conducted among adults with evidence of dentinal hypersensitivity. After training, practitioners at 4 U.S. sites recruited and enrolled individuals with dentinal hypersensitivity in the clinical study, and selected one of two specific professional plus at-home treatments. Subjects received either 1) professional paint-on application of 3% oxalate acid potassium salt solution (Super Seal® Dental Desensitizing Liner, Phoenix Dental) plus 0.454% stannous fluoride (Crest® Sensi Repair & Prevent, Procter & Gamble) for at-home use or 2) professional 10-minute application of a 1.5% oxalate gel strip (Crest Sensi-Stop™ Strips, Procter & Gamble) plus 5 additional oxalate strips for subsequent at-home use. After professional treatment, an oral examination was conducted to assess tolerability. Each subject

received the selected follow-up product (paste or strip) for at-home use, and a post-treatment examination and/or interview was scheduled 2–8 weeks after treatment.

**RESULTS:** A total of 105 subjects were enrolled, 104 received treatment, and 100 were evaluated after at-home use. Mean age was 43.6 years, ranging from 19 to 74, and 73% were female. Strips were more commonly selected for in-office use (55% versus 45%), with coverage, ease-of-use, and patient preference as factors in treatment selection. Favorable experiential responses were reported by 84% and 68% of the strip and paint-on users, respectively. Weeks 2 through 8 post-treatment responses were generally similar, with significant ( $p < 0.05$ ) reductions in sensitivity for both groups. There was one adverse event (sloughing) reported by one subject in the paint-on plus paste group.

**CONCLUSIONS:** In practice-based research, strip or paint-on oxalates plus at-home care resulted in significant immediate and durable reductions in reported dentinal hypersensitivity for periods of up to 8 weeks.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1539.*

### **Short Review on Scleroderma and a Case Report: Scleroderma and External Resorption of a Tooth Root, Treatment, and Pathology**

*David Leader, Jonathan Garlick, and Jason DeFuria*

Scleroderma (SSC) affects about 80,000 Americans. Systemic and oral healthcare providers do not always recognize the importance of oral health effects of SSC, which include xerostomia (medication induced and/or due to secondary Sjögren's syndrome), microstomia, external resorption of the angle of the mandible, ankyloglossia, and widening of the periodontal ligament. A less common and poorly understood finding is internal and external tooth resorption. This kind of resorption is unusual; however, the lead author has seen many instances of this condition in SSC patients. This is the case of a 56-year-old man with a 3-year history of SSC. His oral radiographic exam was significant for resorption of part of the root of the upper right canine. The lead author accessed the lesion by opening a gingival flap and removed soft tissue from within the lesion, leaving a smooth surface of dentin. Final restoration of the tooth was with a bonded composite and primary closure of the flap with OOO gut suture. Microscopic examination by the other authors demonstrated fused phagocytic macrophages, giant cells that resorb tooth surfaces and bone. The authors do not have a recommendation for prevention of this complication of SSC. The poster will include images of radiographs, clinical photographs, and photographs of the biopsy slides.

*Presented at the 2017 Synergy Conference in New York, New York.*



## ORAL AND MAXILLOFACIAL SURGERY

### Primary and Secondary Flap Coverage in Extraction Sites: Pilot Study

Majdi Aladmawy,\* Michael Kreitzer, Yumi Ogata, Matthew Finkelman, Bjorn Steffensen, and Yong Hur

**OBJECTIVES:** To evaluate bone dimensional changes following extraction and ridge preservation with primary coverage (closed flap technique: CFT) in comparison to healing by secondary intention (open flap technique: OFT), and to evaluate patients' self-report of post-operative pain comparing both techniques.

**METHODS:** 10 subjects in need of bilateral extraction and ridge preservation in the same arch were recruited in a randomized split-mouth clinical trial. A total of 20 extraction sockets (10 sites with CFT, 10 sites with OFT) received ridge preservation with nonresorbable barrier membrane (d-PTFE) and FDBA. Clinical measurements were made utilizing a stent and a probe (UNC-15) to evaluate dimensional changes of the alveolar ridge at 4 sites for each tooth: center height (CH), buccal height (BH), coronal width (CW) at 3 mm apical to the buccal crest, and apical width (AW) at 5 mm apical to the buccal crest. Subjects were asked the level of post-operative pain using a VAS scale 24 hours after extraction and ridge preservation.

**RESULTS:** The mean gain of CH was  $8.1 \pm 1.9$  mm in the CFT and  $7.5 \pm 1.8$  mm in the OFT when comparing baseline and 6 months. The differences were statistically significant in both groups ( $p=0.005$ ). Only CFT yielded a statistical significance in BH at 6 months ( $0.8 \pm 1$  mm) compared to the baseline. CH, BH, CW, AW did not differ significantly between two groups. The mean pain score was  $1.1 \pm 0.5$  in the OFT versus  $3.0 \pm 0.8$  in the CFT and the difference between the groups was statistically significant ( $p=0.006$ ).

**CONCLUSIONS:** The bone dimensional changes following extraction and ridge preservation with a nonresorbable membrane were similar between two techniques. The postoperative pain was significantly lower with the OFT than the CFT.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2844.*

### Prevalence of Substance Abuse among Oral and Maxillofacial Residents from 2006 to 2015

Pasquale Eckert, Matthew Finkelman, and Morton Rosenberg

**PURPOSE:** Substance abuse in oral and maxillofacial surgery (OMS) training programs is an important and under-represented topic in the literature. This study's purpose was to assess the prevalence of substance abuse in OMS training programs in the United States during a 10-year period and to determine the substances most abused by OMS residents.

**MATERIALS AND METHODS:** A cross-sectional survey study was conducted by sending an online questionnaire to program directors and chairpersons of all OMS graduate training programs accredited by the Commission on Dental Accreditation. The content- and validity-tested survey asked respondents to report on substance abuse cases at their program from 2006 to 2015. Auxiliary questions asked opinions on substance abuse. To analyze the data, percentages were calculated, including the estimated prevalence of abuse; results were presented as bar charts.

**RESULTS:** Forty-six of the 101 OMS training programs (45.5%) responded. Sixteen of the responding 46

programs (34.8%) reported at least 1 suspected or encountered incident of substance abuse. The 2 most abused substances were alcohol and narcotics. During the decade studied, the prevalence of resident substance abuse was estimated to be 1.2%.

**CONCLUSION:** The estimated prevalence of resident substance abuse has gone unchanged since Rosenberg's initial study in 1986 (*J Oral Maxillofac Surg* 44:458, 1986). With the introduction of new drugs and despite more stringent protocols, substance abuse continues to be a germane issue for OMS requiring ongoing attention clinically and in the literature.

*Published in J Oral Maxillofac Surg Dec 2016; 74(12):2351-2358.*

### **Most American Association of Oral and Maxillofacial Surgeons Members Have Not Adopted the American Society of Anesthesiologists Recommended Nil Per Os Guidelines**

*Robert Johnson III, Pasquale Eckert, William Gilmore, Archana Viswanath, Matthew Finkelman, and Morton Rosenberg*

**PURPOSE:** The purpose of this study was to determine if American Association of Oral and Maxillofacial Surgeons members have integrated the current American Society of Anesthesiologists (ASA) nil per os (NPO) guidelines into their preoperative instructions.

**MATERIALS AND METHODS:** We designed and implemented a cross-sectional study and enrolled a random sample of private-practice American Association of Oral and Maxillofacial Surgeons members who practice in the United States. The predictor variables were year of graduation from residency, dual degree (MD and DDS or DMD) or single degree, and region. The primary outcome variable was adoption of the ASA NPO guidelines, defined as recommending fasting times of 2 hours for clear liquids and 6 hours for solid foods. To collect data, a systematic online search was implemented. Appropriate univariate and bivariate statistics were computed, and the level of significance was set at 0.05; in addition, 95% confidence intervals were calculated.

**RESULTS:** The study sample was composed of 431 oral and maxillofacial surgeons (OMSs). Almost all of the study sample (99.1%) did not adopt the ASA guidelines. The fasting recommendations were different from 2 hours for clear liquids and 6 hours for solid foods. However, recommendations of 2 hours or greater for clear liquids were made by 99.8% of OMSs, and recommendations of 6 hours or greater for solid foods were made by 99.3%. Only 4.4% of OMSs made different recommendations for clear liquids and solid foods. No substantial association was found between whether OMSs adopted the most current ASA guidelines and the year they graduated from residency or the obtainment of dual degrees.

**CONCLUSIONS:** OMSs in private practice are overwhelmingly recommending longer fasting times for clear liquids and solid foods on their websites when compared with the current ASA guidelines before ambulatory anesthesia. The ASA guidelines are based on meta-analysis; therefore, deviations in practice, although not incorrect, may call for discussion.

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## Surgical Safety Checklists Are Underutilized in Ambulatory Oral and Maxillofacial Surgery

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**PURPOSE:** The objective of this study was to determine attitudes toward and the prevalence of using a surgical safety checklist in ambulatory oral and maxillofacial surgery (OMS) practice.

**MATERIALS AND METHODS:** The authors designed and implemented a cross-sectional study and enrolled a random sample of oral and maxillofacial surgeons. The predictor variable was years removed from residency. The primary outcome was the prevalence of surgical safety checklist usage in ambulatory OMS practice. The secondary outcome was to determine whether surgeons who do not currently use a checklist would be willing to do so if provided with one. Other demographic variables included age, gender, location of practice, type of practice, and number of ambulatory procedures performed per week. Appropriate uni- and bivariate statistics were computed, and the level of significance set at 0.05; 95% confidence intervals also were calculated.

**RESULTS:** The study sample was composed of 120 clinicians. Forty-two percent of respondents reported that they were not using a surgical safety checklist for ambulatory surgery. Ninety-three percent of those respondents not currently using a checklist reported they would consider implementing a surgical safety checklist in their practice if provided with one. In addition, 45.3% of surgeons performing more than 30 procedures a week reported not using a surgical safety checklist. Most respondents (67.9%) who had completed OMS training more than 20 years previously reported not using a checklist in their practice.

**CONCLUSION:** According to this survey, most practicing oral and maxillofacial surgeons do not currently use surgical safety checklists. Although the response rate was only 12%, the survey does reflect a clear lack of use of checklists among practicing oral and maxillofacial surgeons despite its widespread acceptance in the medical community.

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## ORAL MEDICINE AND PATHOLOGY

### TFOS DEWS II Pathophysiology Report

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The TFOS DEWS II Pathophysiology Subcommittee reviewed the mechanisms involved in the initiation and perpetuation of dry eye disease. Its central mechanism is evaporative water loss leading to hyperosmolar tissue damage. Research in human disease and in animal models has shown that this, either directly or by inducing inflammation, causes a loss of both epithelial and goblet cells. The consequent decrease in surface wettability leads to early tear film breakup and amplifies hyperosmolarity via a vicious circle. Pain in dry eye is caused by tear hyperosmolarity, loss of lubrication, inflammatory mediators, and neurosensory factors, while visual symptoms arise from tear and ocular surface irregularity. Increased friction targets damage to the lids and ocular surface, resulting in characteristic punctate epithelial keratitis, superior limbic keratoconjunctivitis, filamentary keratitis, lid parallel conjunctival folds, and lid wiper epitheliopathy. Hybrid dry eye disease, with features of both aqueous deficiency and increased evaporation, is common, and efforts should be made to determine the relative contribution of each form to the total picture. To this end, practical methods are needed to measure tear evaporation in the clinic, and similarly, methods are needed to measure osmolarity at the tissue level across the ocular surface, to better determine the severity of dry eye. Areas for future research include the role of genetic mechanisms in non-Sjögren's syndrome dry eye, the targeting of the terminal duct in meibomian gland disease and the influence of gaze dynamics and the closed eye state on tear stability and ocular surface inflammation.

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### Relationship between OSDI and ESSDAI

Noe Duenas,\* Mabi Singh, Joseph Cimmino, Elizabeth Tzavaras, and Athena Papas

**OBJECTIVES:** The objective of this analysis is to investigate the correlation between OSDI and different domains in ESSDAI.

**METHODS:** Xerostomic patients (N=132) who attended Oral Medicine Clinic of TUSDM were assessed for EULAR Sjögren's Syndrome Disease Activity Index (ESSDAI) and Ocular Surface Disease Index (OSDI) as part of the clinical exam. The 12 ESSDAI domains assessed were: cutaneous, respiratory, renal, articular, muscular, peripheral nervous system, central nervous system, hematological, glandular, constitutional, lymphadenopathic, and biological. Values to determine dry eye severity calculated using the OSDI: (sum of scores) × 25 ÷ (# of

questions answered), where the sum score is the scores of all questions answered. Student *t*-test and Spearman correlation coefficients between OSDI and ESSDAI were obtained.

**RESULTS:** In the sicca group (N=91), 91% were female; mean age=65 (range 29–87). In the Sjögren's syndrome group (N=41), 92% were female; mean age=62 (range 33–80). The mean scores for OSDI in sicca 28.46 (21.05) was significantly less than the Sjögren's syndrome group 38.92 (24.96),  $p=0.014$ . The mean scores for ESSDAI in the sicca group 3.9 (2.96) was significantly less than the Sjögren's syndrome group 5.17 (3.53),  $p=0.039$ . Spearman correlation analysis of 132 subjects and their 12 domains revealed the existence of correlation between sum score of all domains ( $p=0.0001$ ), and glandular domain ( $p=0.011$ ) of ESSDAI and OSDI. The correlation in Sjögren's group (N=41), the sum score of the 12 domains and OSDI were ( $p=0.017$ ) and in sicca group (N=91), ( $p=0.0001$ ).

**CONCLUSIONS:** The ESSDAI and OSDI can be a useful tool to assess Sjögren's syndrome but also to assess sicca syndrome patients, who may have multiple systems involved along with xerostomia. Subjects with dry eyes should be examined for salivary glands and other domains. Larger studies may establish better correlation between OSDI and ESSDAI.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2092.*

### **Management of Dry Mouth: Assessment of Oral Symptoms after Use of a Polysaccharide-Based Oral Rinse**

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**OBJECTIVE:** Salivary dysfunction is associated with a range of oral/dental issues, and management of oral symptoms may improve oral function and overall quality of life. The purpose of this pilot study was to evaluate oral symptoms and function in a xerostomic population after use of a proprietary topical for dry mouth, Moisyn (Synedgen Inc., Claremont, California), which is a polysaccharide-based product.

**STUDY DESIGN:** A pre- and post-test survey was completed by 57 patients with xerostomia. Patients rated their common oral symptoms, based on the Vanderbilt Head and Neck Symptom Survey, before and after 1-week use of Moisyn rinse and spray. Saliva production under resting and chewing stimulation was also assessed.

**RESULTS:** Most patients reported relief from dry mouth symptoms and thick saliva (81.7% and 76.0%, respectively) for more than 30 minutes after product use. Statistically significant reductions were found in 15 of 33 oral symptoms. Symptom improvement ranged from 10.7% to 28.4% for thick saliva, 8.4% to 30.6% for pain, 5.5% to 30.4% for dry mouth, and 12% to 21.3% for taste/diet change. Whole unstimulated/resting saliva improved by 100%, and whole stimulated saliva improved by 23.8%.

**CONCLUSIONS:** These findings suggest that the product has utility in symptom control in patients with xerostomia and may lead to an increase in saliva production.

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## Comparison of FACIT, ESSDAI, OSDI in Sjögren's and Sicca Patients

*Athena Papas,\* Mabi Singh, Arwa Farag, Matthew Finkelman, and Sarah Pagni*

**OBJECTIVES:** Compare the level of fatigue, ocular dryness and disease activity in Sjögren's syndrome patients diagnosed by positive lip biopsy, Sjögren's patients diagnosed by positive Sjögren's specific antibody (SSA), and sicca patients.

**METHODS:** With IRB permission, the records of Tufts Oral Medicine 138 patients presenting with sicca (N=91) and diagnosed Sjögren's syndrome (N=47) were reviewed. Among the Sjögren's syndrome patients, 27 were SSA positive and 20 were lip biopsy positive with positive Schirmer or positive sialometry or both. The EULAR Sjögren's Syndrome Disease Activity Index (ESSDAI) administered to assess disease activity, Ocular Surface Disease Index (OSDI) used to assess ocular dryness, and Functional Assessment of Chronic Illness Therapy (FACIT) used to assess fatigue were completed by the patients. All questionnaires had been validated in Sjögren's patients.

**RESULTS:** The gender breakdown was 91.2% female for the sicca patient group, 88.9% female for the SSA+ group, and 95.0% female for the lip biopsy+ group. The Kruskal-Wallis test of OSDI across the groups was significantly different ( $p=0.030$ ) with the SSA+ group being higher than the sicca group ( $p=0.025$ ). The Kruskal-Wallis tests of the ESSDAI central nervous system problems, constitutional issues, and glandular across the groups were significantly different ( $p=0.004$ ,  $p=0.027$ , and  $p=0.037$ , respectively) with the lip biopsy group being higher than the sicca group in these tests. There were no statistically significant differences in FACIT or total ESSDAI score among the groups.

**CONCLUSIONS:** Statistically significant differences were seen on several of the disease activity measurement scales of ESSDAI and OSDI among some of the groups. These findings suggest that lip biopsy as well as SSA+ Sjögren's patients might be appropriate to include in clinical trials. Further analysis with a larger study population is necessary.

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## Comparing the Side Effects and Adherence Rates to Sialogogues in Patients with Hyposalivation

*Elizabeth Tzavaras,\* Joseph Cimmino, Mabi Singh, Tamar Roomian, Athena Papas, and Arwa Farag*

**OBJECTIVES:** In patients with hyposalivation, cholinergic sialogogues are the only pharmacological agents that have proven to stimulate salivary flow. The reporting of side effects may vary and has been understudied. The objective of this investigation is to compare the adherence rate and the side effects of these medications in the dry mouth population.

**METHODS:** A retrospective record review for patients seen at the Oral Medicine Clinic at TUSDM was conducted between January 2000 and August 2016. Information about patients' demographics, medical history, medication, and salivary flow rate prior to sialogogues prescription were collected. Related side effects and drug discontinuation rates in patients prescribed pilocarpine versus cevimeline were compared using logistic and multinomial logistic regression, respectively.

**RESULTS:** A total of 44 patient records were reviewed. All patients were females; mean age 61 and 71% of them were Caucasians. Twenty-five patients were started on cevimeline while the other 19 were started on pilocarpine.

The adherence rate in the cevimeline group was 92% with only 1 patient discontinuing the medication and 1 patient reducing the frequency of administration. On the other hand, the pilocarpine group encountered a lower adherence rate (52.7%) where 4 patients stopped the medication and 5 patients had to reduce the dose or frequency. The most commonly encountered side effects were gastrointestinal irritation, excessive sweating, and flushing. Frequent urination and worsening asthma were rare and reported in the pilocarpine group only.

**CONCLUSIONS:** This study demonstrates the limited reporting of side effects and higher adherence rate to cevimeline compared to pilocarpine in dry mouth patients. This can be explained by the higher specificity of cevimeline in targeting muscarinic receptors. Confirming the reproducibility of this result with larger scale studies can help in negotiating better insurance coverage for patients prescribed cevimeline without the need for an initial pilocarpine trial.

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### Comparing OSDI and FACIT in a Xerostomic Population

*Elizabeth Tzavaras, Pamela Corrado,\* Deanna Buonomo, Joseph Cimmino, Mabi Singh, Sarah Pagni, and Athena Papis*

**OBJECTIVES:** Dry eyes and fatigue are frequently encountered complaints in dry mouth clinics. The objective is to analyze the correlation between Ocular Surface Disease Index (OSDI) and Functional Assessment of Chronic Illness Therapy (FACIT, or the Fatigue Scale version 4) in patients with dry mouth.

**METHODS:** Xerostomic patients (N=132) who attended the Oral Medicine Clinic at TUSDM assessed for OSDI and FACIT. The FACIT is collected as part of the clinical exam with salivary measurements. Pearson correlation coefficients used between OSDI sum score and fatigue score. Values to determine dry eye severity were calculated using the OSDI: (sum of scores)  $\times$  25  $\div$  (# of questions answered), where sum score is the scores of all questions answered.

**RESULTS:** In sicca group (N=91), 91% were female, mean age was 65 (range 29–87); in Sjögren's syndrome group (N=41), 92% were female, mean age was 62 (range 33–80). Pearson correlation between OSDI and FACIT were statistically significant in both sicca (p=0.0001) and diagnosed Sjögren's syndrome patients (p=0.003). Similarly, there was a high degree of correlation between the FACIT and OSDI in both groups: sicca (p=0.000), Sjögren's syndrome (p=0.0001). The mean score for OSDI in the sicca group was 28.46 (21.05). This was significantly less than the Sjögren's syndrome group [38.92 (24.96)] (p=0.014). Mean score for FACIT in sicca group was 15.58 (7.44), and in Sjögren's syndrome group [16.43 (8.93)] (NS p=0.578).

**CONCLUSIONS:** The FACIT and OSDI are useful tools in dry mouth clinics to assess fatigue and dry eyes, which are not only the cardinal signs of Sjögren's syndrome, but also may help sicca patients. Those subjects with dry eyes and fatigue should be examined for potential autoimmune disorders. Larger studies may explain better correlation between OSDI and FACIT.

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## ORTHODONTICS RESEARCH

### Smile Esthetics: Evaluation of Long-Term Changes in the Transverse Dimension

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**OBJECTIVE:** To analyze the long-term changes in maxillary arch widths and buccal corridor ratios in orthodontic patients treated with and without premolar extractions.

**METHODS:** The study included 53 patients who were divided into the extraction (N=28) and nonextraction (N=25) groups. These patients had complete orthodontic records from the pretreatment (T1), posttreatment (T2), and postretention (T3) periods. Their mean retention and postretention times were 4 years 2 months and 17 years 8 months, respectively. Dental models and smiling photographs from all three periods were digitized to compare the changes in three dental arch width measurements and three buccal corridor ratios over time between the extraction and nonextraction groups. Data were analyzed using analysis of variance tests. Post hoc multiple comparisons were made using Bonferroni correction.

**RESULTS:** Soft-tissue extension during smiling increased with age in both groups. The maximum dental width to smile width ratio (MDW/SW) also showed a favorable increase with treatment in both groups ( $p < 0.05$ ), and remained virtually stable at T3 ( $p > 0.05$ ). According to the MDW/SW ratio, the mean difference in the buccal corridor space of the two groups was  $2.4 \pm 0.2\%$  at T3. Additionally, no significant group  $\times$  time interaction was found for any of the buccal corridor ratios studied.

**CONCLUSIONS:** Premolar extractions did not negatively affect transverse maxillary arch widths and buccal corridor ratios. The long-term outcome of orthodontic treatment was comparable between the study groups.

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### Patterns of Non-Syndromic Permanent Tooth Agenesis in a Large Orthodontic Population

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**OBJECTIVE:** The aim of this study is to explore patterns of non-syndromic permanent tooth agenesis in a large orthodontic patient group.

**DESIGN:** A record review was performed in various orthodontic clinics to identify white patients with non-syndromic permanent tooth agenesis, excluding third molars. Four hundred and fourteen subjects fulfilled the inclusion criteria.



**RESULTS:** In the 414 subjects with tooth agenesis, approximately 70% presented 1 or 2 missing teeth. Symmetric agenesis patterns were often observed in the sample (by jaw, by side, or crossed quadrants), with prevalence approaching 30% for cases with contralateral tooth agenesis within a jaw. In cases with 1 or 2 missing teeth, from the total number of potential tooth agenesis patterns in the sample, a certain part was evident, limiting the variation to 27.8% (44/158). In the entire sample, both in the maxilla and the mandible a certain incisor/premolar agenesis phenotype was observed in 59.0% of cases in isolated form.

**CONCLUSIONS:** Although there was variation in the tooth agenesis patterns, our findings suggest the involvement of particular genetic, epigenetic, and/or environmental factors in the formation of the entire dentition, which often lead to specific tooth agenesis phenotypes in cases where this process is disrupted. The present study provides a comprehensive categorization of orthodontic cases with tooth agenesis and can assist in planning future epidemiological and genetic studies.

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### **Perceptions of Orthodontic Case Complexity among Orthodontists, General Practitioners, Orthodontic Residents, and Dental Students**

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**INTRODUCTION:** Our aims were to assess the perceptions of orthodontic case complexity among orthodontists, general dentists, orthodontic residents, and dental students and to compare their perceptions with the American Board of Orthodontics Discrepancy Index (DI).

**METHODS:** Orthodontists, general dentists, orthodontic residents, and dental students (N=343) participated in a web-based survey. Pretreatment orthodontic records of 29 cases with varying DI scores were obtained. Respondents were asked to evaluate case complexity on a 100-point visual analog scale. Additional information was collected on participants' orthodontic education and orthodontic treatment preferences. Pearson correlation coefficients were used to assess the relationship between the average complexity score and the DI score. Repeated measures analysis with linear mixed models was used to assess the association between the average complexity score and the DI score and whether the association between the 2 scores varied by level of difficulty or panel group. The level of significance for all analyses was set at  $p < 0.05$ .

**RESULTS:** The results showed that 71.6% of general dentists provided some orthodontic services, with 21.0% providing full fixed appliances and 38.3% providing clear aligners. DI score was significantly associated with complexity perceptions ( $p = 0.0168$ ). Associations between average complexity and DI score varied significantly by provider group ( $p = 0.0033$ ), with orthodontists and residents showing the strongest associations. When the DI score was greater than 15, orthodontists and residents perceived cases as more complex than did the other provider groups.

**CONCLUSIONS:** Orthodontists and orthodontic residents had better judgments for evaluating orthodontic case complexity. The high correlation between orthodontic professionals' perceptions and DI scores suggested that additional orthodontic education and training have an influence on the ability to recognize case complexity.

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## Influence of Interradicular and Palatal Placement of Orthodontic Mini-Implants on the Success (Survival) Rate

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**BACKGROUND:** The purpose of this retrospective cohort study was to investigate the success rates of orthodontic mini-implants (OMIs) placed in different insertion sites and to analyze patient- and site-related factors that influence mini-implant survival.

**METHODS:** Three hundred eighty-seven OMIs were inserted in 239 patients for orthodontic anchorage and were loaded with a force greater than 2 N. Two different insertion sites were compared: 1) buccal inter-radicular, and 2) palatal, at the level of the third palatal ruga. Survival was analyzed for location and select patient parameters (age, gender and oral hygiene). The level of statistical significance was set at  $p < 0.05$ .

**RESULTS:** The overall success rate was 89.1%. There were statistically significant differences between insertion sites; success rate was 98.4% for OMIs placed in the anterior palate and 71% for OMIs inserted buccal between roots ( $p < 0.001$ ).

**CONCLUSIONS:** Success rate of OMIs was primarily affected by the insertion site. The anterior palate was a more successful location compared to buccal alveolar bone.

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## Comparison of Closure Occlusal Force Parameters in Postorthodontic and Nonorthodontic Subjects Using T-Scan® III DMD Occlusal Analysis

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**OBJECTIVE:** Balanced occlusal force distribution is a critical factor for restorative, prosthetic, or orthodontic treatment. It has been postulated that orthodontic treatment may lead to occlusal discrepancies in the arch due to changing the occlusal relationships. This study was conducted to compare the occlusal force parameters between natural dentition patients and a postorthodontic treatment group.

**METHOD AND MATERIALS:** Fifty Thai subjects were divided into nonorthodontic and postorthodontic groups comprised of 25 subjects each (mean age 24.8 years). The T-Scan® III computerized occlusal analysis system was used to record a multibite closure for each subject. The initial occlusal contact location, the bilateral percentage force distribution, the percentage force in the anterior and posterior quadrants, and the individual tooth force percentages were calculated for both groups. The student's paired *t*-test compared the in-group differences, while a one-way ANOVA analyzed the differences between the two groups.

**RESULTS:** The initial tooth contacts in both groups were found on the second molars and central incisors. Maximum force was most frequently observed on the left second molar tooth (15.9% nonorthodontic; 25.4% postorthodontic). The bilateral right-to-left side force distribution (51.36% right, 48.96% left) was not statistically different for all subjects, nor was it statistically different between the nonorthodontic (48.67% right, 51.36% left) and the postorthodontic groups (48.96% right, 51.05% left). Statistically significant differences were

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found between the quadrants in both the groups (22.46% anterior, 77.57% posterior in nonorthodontic subjects; 10.58% anterior, 89.42% posterior in postorthodontic subjects) ( $p < 0.01$ ).

**CONCLUSION:** A significant occlusal force discrepancy was found in the postorthodontic subjects, with higher force percentages observed posteriorly and much less percentage force anteriorly, when compared to the natural dentition subjects. T-Scan® III digital occlusal analysis may be recommended for orthodontic case finishing, to make visible to the clinician the severity of the orthodontically created occlusal force imbalance, such that it can be minimized during orthodontic case finishing.

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## PERIODONTOLOGY RESEARCH

### The Role of Varicella Zoster Virus in the Development of Periapical Pathoses and Root Resorption: A Systematic Review

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**INTRODUCTION:** Varicella zoster virus (VZV) and subsequent herpes zoster (HZ) infection has been proposed as a causative agent of periapical pathoses and root resorption. This review aimed to identify, synthesize, and present a critical analysis of the available data on the association among VZV, subsequent HZ infection, and the development of periapical pathoses and root resorption and to analyze the level of evidence of available studies.

**METHODS:** The literature search covered MEDLINE, Science Citation Index Expanded, and Scopus. A qualitative critical appraisal of the included articles was performed.

**RESULTS:** The electronic database search yielded 66 hits from PubMed, 73 hits from Web of Science, and 107 from Scopus. Seven case reports and 3 cross-sectional studies were included in the final review. When summarized, in 7 patients with a history of a previous HZ attack and with no other apparent cause, 23 teeth were diagnosed with apical periodontitis and 8 teeth with internal and 1 tooth with external root resorption. The cross-sectional studies investigated the presence of VZV DNA in samples of acute apical abscess. The VZV DNA was found only in 2 of 65 samples.

**CONCLUSIONS:** All studies included in this systematic review had a low level of evidence (4 and 5). Still, the potential role of VZV in the etiopathogenesis of periapical pathoses and root resorption cannot be ruled out. Future investigations should be directed toward the analysis of VZV pathologic effects on pulp blood vessels, which might cause local ischemia and tissue necrosis.

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### Association between Sinus Membrane Thickness and Membrane Perforation in Lateral Window Sinus Augmentation: A Retrospective Study

Andrew Lum, Yumi Ogata, Sarah Pagni, and Yong Hur

**BACKGROUND:** Association between Schneiderian membrane thickness and membrane perforation is examined in lateral window sinus augmentation.

**METHODS:** This retrospective study reviewed records of 551 patients who underwent lateral sinus augmentation at TUSDM from June 1, 2006, to May 31, 2015. Preoperative cone-beam computed tomography images were analyzed to evaluate possible association among membrane thickness, residual bone height, and membrane perforation. Data were evaluated using Mann-Whitney *U* test at  $p < 0.05$ .

**RESULTS:** Total 167 patients (95 males and 72 females) met the eligibility criteria and were included in the study. Among them, 47 patients had Schneiderian membrane perforation (perforation group). Mean membrane

thickness was  $0.84 \pm 0.67$  mm in the perforation group and  $2.65 \pm 4.02$  mm in the non-perforation group. There was a statistically significant difference in membrane thickness between groups ( $p < 0.001$ ). Mean residual ridge thickness was  $2.78 \pm 1.37$  mm in the perforation group and  $4.21 \pm 2.09$  mm in the non-perforation group. There was a statistically significant difference in residual alveolar bone height ( $p < 0.001$ ).

**CONCLUSIONS:** Patients who experienced membrane perforation had a thinner membrane compared with patients without membrane perforation. Schneiderian membrane perforation was associated with decreased residual bone height.

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### **Efficacy of Collagen Matrix Seal and Collagen Sponge on Ridge Preservation in Combination with Bone Allograft: A Randomized Controlled Clinical Trial**

*Zuhair Natto, Andreas Parashis, Bjorn Steffensen, Rumpa Ganguly, Matthew Finkelman, and Natalie Jeong*

**AIM:** To test whether the use of collagen matrix seal (CMS) results in similar hard and soft tissue remodelling to that with collagen sponge (CS) used as barriers 4 months following alveolar ridge preservation (ARP), in combination with freeze-dried bone allograft (FDBA).

**MATERIALS AND METHODS:** Twenty-eight patients were randomly assigned to the 2 groups. Clinical and radiographic measurements were recorded with the same stent at baseline and 4 months for standardization. The flapless technique following a traumatic extraction was used for the two types of barriers.

**RESULTS:** All patients completed the study, 14 in the CMS group and 14 in the CS group. Reduction in coronal ridge width (1.21 mm 14.91% CMS and 1.47 mm 20.40% CS) and vertical buccal bone resorption (0.30 mm CMS and 0.79 mm CS) were not significantly different. A slight increase in buccal gingival thickness at the coronal part was observed in both groups (0.9 mm CMS and 0.5 mm CS).

**CONCLUSIONS:** Collagen matrix seal and CS, when combined with FDBA, significantly minimized ridge resorption in all dimensions and maintained buccal soft tissue thickness in sockets with a buccal plate loss of  $< 2$  mm in comparison to previously reported findings recorded after tooth extraction without ARP.

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### **SOCS-3 Regulates the Anti-inflammatory Actions of Resolvin E1**

*Evangelos Papathanasiou, \* Alpdogan Kantarci, Antonis Konstantinidis, Danielle Stephens, Hongwei Gao, and Thomas Van Dyke*

**OBJECTIVES:** Specialized proresolving mediators (SPMs), including Resolvin E1 (RvE1), drive the resolution of inflammation and effectively treat inflammatory periodontitis in animal models. One proposed intracellular target to mediate the proresolving actions of SPMs was the family of suppressor of cytokine signaling (SOCS) proteins. SOCS are inhibitors of cytokine-signaling pathways and play a role in restraining periodontal inflammation. We hypothesized that the anti-inflammatory actions of RvE1 on the *P. gingivalis* LPS-induced inflammatory response of macrophages are SOCS-3 dependent.

**METHODS:** Peritoneal macrophages were elicited with 4% thioglycolate broth and isolated from 8-week-old myeloid SOCS-3-knockout (KO) and SOCS-3-wild-type (WT) C57Bl6-B.129 mice by differential centrifugation. Macrophages were cultured at a concentration of  $1.5 \times 10^6$  cells/ml in 6-well plates. After 2 hours, non-adherent cells were discarded and the remaining adherent cells were treated with 100ng/ml *P. gingivalis* A7436 LPS or with 100ng/ml *P. gingivalis* A7436 LPS and RvE1 100nM; culture medium alone and 100nM RvE1 alone served as controls ( $n \geq 3$  wells per group). Supernatants and cells were collected after 12 hours. Cytokine levels were assessed using Luminex multiplex-bead-immunoassay and RNA was extracted by Trizol and processed for qRT-PCR.

**RESULTS:** SOCS-3-KO mice exhibit higher *P. gingivalis* LPS-induced inflammatory responses with increased secretion of IL-1 $\beta$ , IL-6, TNF- $\alpha$  and KC (IL-8) by peritoneal macrophages ( $p < 0.05$ ). In WT mouse macrophages, 100nM RvE1 resulted in a significant decrease in *P. gingivalis* LPS-induced secretion of IL-6, TNF- $\alpha$  and KC (IL-8) by increasing mRNA expression of SOCS-3 and ERV1, the receptor for RvE1 ( $p < 0.05$ ).

**CONCLUSIONS:** We have previously reported that SOCS-3 is a critical negative regulator of alveolar bone loss in experimental periodontitis and the *P. gingivalis* LPS-induced inflammatory response. The results of this study support the conclusion that SOCS-3 regulates, at least in part, the anti-inflammatory actions of RvE1.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 0331.*

## Family History of Myocardial Infarction and Risks of Periodontal Disease

*Yau-Hua Yu,\* Lynn Doucette-Stamm, Kenneth Kornman, Bjorn Steffensen, Paul Ridker, and Daniel Chasman*

**OBJECTIVES:** Periodontal disease (PD) patients with unusually rapid disease progression and/or more severe disease often present with other comorbid conditions such as diabetes and cardiovascular disease (CVD). Our hypothesis was that having a family history of myocardial infarction (MI) could be a novel independent risk factor for PD.

**METHODS:** The Women's Genome Health Study (WGHS) is an NIH-funded prospective cohort of U.S. female healthcare professionals, age  $\geq 45$  years, who provided blood samples at the baseline. The WGHS was originated from a  $2 \times 2$  clinical trial investigating vitamin E and aspirin in prevention of CVD. PD was ascertained in the WGHS over 12 years of follow-up. Cox proportional hazard models with multi-variate adjustment including age, education, BMI, hormone replacement therapy, and time-varying incident diabetes status ( $N=1,239$ ) were used to assess the risk of developing incident PD among women of European ancestry according to strata of family history of MI and smoking habit. Analysis was restricted to women without prevalent diabetes nor prevalent PD at baseline ( $N=16,562$ ), among whom 1,375 new cases of PD occurred during follow-up.

**RESULTS:** The multivariate risk factor adjusted hazard ratios (HRs) of developing self-reported PD were highest among women who smoked plus a family history of MI (HR=1.6; 95% confidence interval [CI]=1.3–1.9;  $p < 0.001$ ) compared to reference non-smokers with no family history of MI, with intermediate risk for those who only smoked (HR=1.4; 95% CI=1.2–1.5;  $p < 0.001$ ) or only had family history of MI (HR=1.3; 95% CI=1.0–1.06;  $p=0.042$ ).

**CONCLUSIONS:** In our population of middle-aged women, family history of MI was a risk factor for incidence of PD in multivariate adjusted analysis. Women who smoked in addition to having a family history of MI showed the highest risk of developing PD.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 2396.*

## PHARMACOLOGY/THERAPEUTICS/TOXICOLOGY

### Comparing the Efficacy of Pilocarpine and Cevimeline in Patients with Hyposalivation

Arwa Farag,\* Joseph Cimmino, Tamar Roomian, Mabi Singh, and Athena Papas

**OBJECTIVES:** Pilocarpine HCl and cevimeline HCl are muscarinic acetylcholine receptor agonists that are known to stimulate salivary glands function. The objective of this investigation is to compare the efficacy of pilocarpine and cevimeline in stimulating salivary production in patients with clinical hyposalivation.

**METHODS:** Medical records of patients seen at the Oral Medicine Clinic at TUSDM between January 1999 and August 2016 were retrospectively reviewed. The diagnosis of hyposalivation was determined by unstimulated sialometric flow (US) less than 0.2 ml/minute. Information about patients' demographics, medical history/medications and baseline US and stimulated saliva (SS) were collected. Improvement in SS and US flow in patients using pilocarpine versus cevimeline was compared at 3- and 6-month follow-ups. The *t*-test and Mann-Whitney *U* test were used to compare parametric (SS changes at 3 months) and nonparametric variables (US changes at 3 month, US and SS changes at 6 months), respectively.

**RESULTS:** A total of 45 female patients were included in this study of which 26 were treated with cevimeline (15–30 mg) and 19 were on pilocarpine (5–7.5 mg) 1–4 times a day. At 3-month follow-up, cevimeline was superior to pilocarpine in improving salivary flow (US:  $p=0.05$ ; SS:  $p=0.027$ ). However, at 6-month follow-up there was no significant difference in salivary flow improvement between both groups (US:  $p=0.56$ ; SS:  $p=0.09$ ). Positivity of Sjögren's syndrome serological markers (SS-A and SS-B) or minor salivary gland biopsy did not play a confounding effect in the responsiveness to these two medications.

**CONCLUSIONS:** Cevimeline might have a superior and faster effect on salivary gland stimulation compared to pilocarpine. However, the long-term effect of both medications seems to be similar. Further investigations with larger sample sizes may provide better clarity regarding the effects of the 2 medications and the existence of any confounding factors.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1172.*

### Safety and Tolerability of Topical Clonazepam Solution for Management of Oral Dysesthesia

Michal Kuten-Shorner,<sup>1</sup> Nathaniel Treister,<sup>1</sup> Shannon Stock,<sup>2</sup> John Kelley,<sup>3</sup> Yisi Ji,<sup>1</sup> Sook-Bin Woo,<sup>1</sup> Mark Lerman,<sup>4</sup> Stefan Palmason,<sup>5</sup> Stephen Sonis,<sup>1</sup> and Alessandro Villa<sup>1</sup>

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**OBJECTIVES:** The aim of the study was to determine the absolute and relative safety of treatment with 2 concentrations of topical clonazepam solution (0.1 mg/mL, 0.5 mg/mL) for management of oral dysesthesia.

**STUDY DESIGN:** The study was a retrospective chart review of patients diagnosed with oral dysesthesia and managed with topical clonazepam solution (swish and spit) between 2008 and 2015. The relative safety of the 2 concentrations was evaluated in terms of occurrence of adverse drug reactions (ADRs) and occurrence of change to treatment plan secondary to ADRs.

**RESULTS:** For the study, 162 patients were included (84 patients in the 0.1 mg/mL cohort and 78 in the 0.5 mg/mL cohort) who were evaluated for a median follow-up period of 6 weeks. Thirty-eight patients (23%) developed ADRs. The most frequently reported ADR was sedation (62% of ADRs), followed by altered mental status and dizziness (7% each). Dose adjustments were required in 9 patients (6%) and treatment discontinuation in 13 (8%). ADRs were more frequently reported in the 0.5 mg/mL cohort, but no significant difference was found in terms of occurrence of ADRs, change to treatment plan secondary to ADRs, or types of ADRs ( $p>0.05$ ).

**CONCLUSIONS:** Treatment with topical clonazepam solution in either 0.5 mg/mL or 0.1 mg/mL concentration appears to be safe and well-tolerated. Future prospective studies are needed to confirm this finding.

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## **An Open-Label Phase II Randomized Trial of Topical Dexamethasone and Tacrolimus Solutions for the Treatment of Oral Chronic Graft-vs.-Host Disease**

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**ABSTRACT:** The objective of this study was to evaluate the safety and efficacy of single-agent dexamethasone or tacrolimus topical solution as first-line treatment for symptomatic oral chronic graft-versus-host disease (cGVHD). This was a prospective, single-center, open-label, randomized phase II trial of patients with symptomatic oral cGVHD without prior topical therapy. Subjects were randomly assigned 1:1 to either topical dexamethasone (0.5 mg/mL) or tacrolimus (0.5 mg/mL) solution and instructed to rinse with 5 mL for 5 minutes, 4 times a day, for 4 weeks. Oral cGVHD assessments (National Institutes of Health [NIH] criteria) were completed at baseline and end of treatment (NIH criteria, global response, and tolerability). The primary endpoint was the response rate defined as  $\geq 3$ -point reduction in patient-reported sensitivity score (range, 0 to 10). A parallel 2-stage design was employed so that a less efficacious arm could be terminated early. The accrual goal was 60 evaluable patients (30 in each arm), accruing 14 in the first stage and 16 in the second stage. If both arms were regarded as efficacious, a “pick the winner” method would be employed to choose a better treatment for future investigation. Forty-six subjects were randomized to receive either dexamethasone (N=28) or tacrolimus (N=18). Six subjects were excluded from the analysis because of changes in systemic immunosuppression (dexamethasone=1, tacrolimus=3) or lack of end-of-treatment visit (1 per arm). After the first stage evaluation, the tacrolimus arm was terminated because of lack of activity (3 of 14 responses; response rate, 21%). Twenty-six subjects in the dexamethasone arm completed both study visits and were included in the response analysis, with a 58% (15 of 26) response rate, compared with 21% (3 of 14) in the tacrolimus arm ( $p=0.05$ ). The response rates according to the NIH score in the dexamethasone and tacrolimus arms were 50% (13 of 26) and 2% (2 of 14), respectively ( $p=0.04$ ). From the onset of therapy, 31% versus 21% patients reported feeling “much better” and 38% versus 36% reported feeling “slightly better,” giving an overall global response rate (“much better” or “slightly better”) of 81% (21 of 26) versus 71% (10 of 14), in the dexamethasone



and tacrolimus arms, respectively. Dexamethasone rinses were well-tolerated and taste was reported as “very pleasant” or “tolerable” in most subjects (96%). Intensive topical therapy with dexamethasone solution is effective for managing patients with new-onset symptomatic oral cGVHD and should be considered for first-line therapy. Topical tacrolimus solution appears less effective, at least for first-line therapy.

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## PROSTHODONTICS RESEARCH

### Micro-CT Evaluation of Ceramic Inlays: Comparison of the Marginal and Internal Fit of Five- and Three-Axis CAM Systems with a Heat Press Technique

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**OBJECTIVES:** To evaluate the marginal and internal adaptation of CAD/CAM lithium-disilicate inlay restorations fabricated by 2 milling systems (5- and 3-axis), and a traditional heat-press technique.

**METHODS:** Fifteen premolar teeth with an MOD cavity preparation were fabricated. Lithium-disilicate inlay restorations were obtained by 3 fabrication techniques and fitted to their dies (N=15/gp) as follows: group 1, 3-axis milling system; group 2, 5-axis milling system; group 3, conventional heat-press technique. Gaps were evaluated by X-ray microtomography. Marginal gap (MG), occlusal-marginal gap (OMG), proximal-marginal gap (PMG), gingival-marginal gap (GMG), absolute marginal discrepancy (AMD), axial-internal gap (AIG), and occlusal-internal gap (OIG) were evaluated at 120 different points per inlay. Data were analyzed using repeated measures ANOVA. Pairwise comparisons were conducted for post hoc tests and the Bonferroni correction was used to adjust for multiple comparisons ( $\alpha=0.007$ ).

**RESULTS:** The heat-press group demonstrated significantly smaller mean-values amongst all outcomes compared with CAD/CAM groups except for GMG, where there was no statistically significant difference between groups in the ANOVA ( $p=0.042$ ). Within the CAD/CAM groups, the 5-axis group showed significantly lower OMG mean-value compared with the 3-axis group ( $p<0.001$ ), and lower AIG mean-value compared with the 3-axis group ( $p<0.001$ ). There was no significant difference between the 5-axis and the 3-axis groups' AMD, MG, PMG, and OIG locations.

**CONCLUSION:** Different fabrication techniques affected the marginal and internal adaptation of ceramic inlay restorations. The heat-press group showed the best marginal and internal adaptation results; however, in every group, all samples were within the clinically acceptable MG limit (100  $\mu\text{m}$ ).

**CLINICAL SIGNIFICANCE:** The marginal fit and internal adaptation of inlay ceramic restorations fabricated by a 5-axis milling system have not been tested or compared with those fabricated by 3-axis machines and the conventional heat-press method. The preferred method of inlay fabrication, whether in the lab or chair side, may be influenced by the results of this study and could affect future clinical decision-making.

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### Full-Mouth Implant Rehabilitation with Monolithic Zirconia: Benefits and Limitations

Sarah Amin, Hans-Peter Weber, Yukio Kudara, and Panos Papaspyridakos

**ABSTRACT:** As increased chipping rates have been reported with porcelain-fused-to-zirconia fixed dental prostheses, monolithic zirconia has been introduced in an effort to reduce the technical complications associated with bilayered ceramics. This clinical report illustrates the steps for achieving full-mouth implant

rehabilitation with monolithic zirconia prostheses and minimal facial porcelain veneering. The benefits and limitations of this technique are also discussed. The incisal edges and occluding surface areas comprised monolithic zirconia to reduce the possibility of breakage and improve the esthetic outcome. Up to 1 year in function, no porcelain fracture was found.

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### ***In Vitro* Assessment of Retention and Resistance Failure Loads of Two Preparation Designs for Maxillary Anterior Teeth**

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**STATEMENT OF PROBLEM:** Parallel labiolingual walls and the preservation of the cingulum in anterior tooth preparations have been advocated. However, their contribution to retention and resistance form has not been evaluated.

**PURPOSE:** The purpose of this *in vitro* study was to evaluate the retention and resistance failure loads of 2 preparation designs for maxillary anterior teeth.

**MATERIALS AND METHODS:** Forty metal restorations were fabricated and paired with 40 cobalt-chromium prepared tooth analogs. Twenty of the specimens had parallel buccolingual walls at the cervical part (group PBLW; the control group), whereas the remaining 20 had converging buccolingual walls (group CBLW; the experimental group). The restorations were cemented to the tooth analogs with a resin-modified glass ionomer luting agent. Ten specimens from each group were subjected to tensile loading with a universal testing machine; the rest were subjected to compression loading until failure. Descriptive statistics and the independent *t*-test ( $\alpha=0.05$ ) were used to determine the effect of failure loads in the tested groups.

**RESULTS:** The independent *t*-test revealed statistically significant differences between the tested groups in tensile loading ( $p<0.001$ ) and in compressive loading ( $p<0.001$ ). The PBLW group presented a higher tensile failure load than the CBLW. On the contrary, the PBLW group presented a smaller compression failure load than the CBLW.

**CONCLUSIONS:** Parallelism of the buccolingual axial walls in anterior maxillary teeth increased the retention form but decreased the resistance form.

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### **Digital vs. Conventional Impressions for Fixed Prosthodontics: A Systematic Review and Meta-Analysis**

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**STATEMENT OF PROBLEM:** Limited evidence is available for the marginal and internal fit of fixed dental restorations fabricated with digital impressions compared to those fabricated with conventional impressions.

**PURPOSE:** The purpose of this systematic review was to compare marginal and internal fit of fixed dental

restorations fabricated with digital techniques to those fabricated using conventional impression techniques and to determine the effect of different variables on the accuracy of fit.

**MATERIAL AND METHODS:** Medline, Cochrane, and EMBASE databases were electronically searched and enriched by hand searches. Studies evaluating the fit of fixed dental restorations fabricated with digital and conventional impression techniques were identified. Pooled data were statistically analyzed, factors affecting the accuracy of fit were identified, and their impact on accuracy of fit outcomes were assessed.

**RESULTS:** Dental restorations fabricated with digital impression techniques exhibited similar marginal misfit to those fabricated with conventional impression techniques ( $p>0.05$ ). Both marginal and internal discrepancies were greater for stone die casts, whereas digital dies produced restorations with the smallest discrepancies ( $p<0.05$ ). When a digital impression was used to generate stereolithographic (SLA)/polyurethane dies, misfit values were intermediate. The fabrication technique, the type of restoration, and the impression material had no effect on misfit values ( $p>0.05$ ), whereas die and restoration materials were statistically associated ( $p<0.05$ ).

**CONCLUSIONS:** Although conclusions were based mainly on *in vitro* studies, the digital impression technique provided better marginal and internal fit of fixed restorations than conventional techniques did.

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## Digital Evaluation of Three Splinting Materials Used to Fabricate Verification Jigs for Full-Arch Implant Prostheses: A Comparative Study

*Panos Paspapyridakos, Yong-Jeong Kim, Matthew Finkelman, Khaled El Rafie, and Hans-Peter Weber*

**PURPOSE:** The primary aim of this study was to assess the accuracy of different splinting materials to make implant cast verification jigs. The secondary aim was to assess the effect of 20° implant angulation on the accuracy of casts.

**MATERIALS AND METHODS:** An edentulous mandibular arch with five internal connection tissue level implants served as control. The three implants in the anterior region were parallel to each other and the two implants in the posterior region were distally tilted 20° bilaterally. Verification jigs were fabricated with 3 different materials by splinting prefabricated bars to temporary abutments, resulting in 3 different groups (N=15 specimens). Test casts were fabricated with low expansion type IV stone, and subsequently digitized with reference scanner. The STL files from the test casts and the control were superimposed, in order to determine the three-dimensional (3D) deviations.

**RESULTS:** Group 1 (GC Pattern Resin) had a mean (SD) value of 36.59 (12.47)  $\mu\text{m}$ ; group 2 (Fixpeed Resin) had a mean (SD) value of 35.9 (10.13)  $\mu\text{m}$ ; and group 3 (Triad Gel) had a mean (SD) of 34.12 (7.10)  $\mu\text{m}$ . One-way ANOVA showed no statistically significant difference between groups ( $p=0.790$ ). For the comparative analysis of the effect of implant angulation, data were normally distributed for groups 1 and 3 (GC Resin and Triad Gel), but not for group 2 (Fixpeed Resin). The difference between parallel and tilted implants was significant for all 3 groups: GC Resin ( $p=0.024$ ; paired *t*-test); Fixpeed Resin ( $p=0.002$ ; Wilcoxon signed-rank test); and Triad Gel ( $p=0.002$ ; paired *t*-test).

**CONCLUSIONS:** There were no statistically significant differences between the 3D deviations of the test casts fabricated from verification jigs made by three materials (GC Pattern Resin, Fixpeed Resin, and Triad Gel).

## Prosthodontics Research

Parallel implants had nominally significantly less 3D deviations compared with 20° distally tilted implants, but this was not clinically significant.

**CLINICAL SIGNIFICANCE:** The results of the present study indicate that more than 20° of angulation has an effect on the 3D accuracy. However, even though the tilted implants had nominally significantly more 3D deviation, it was not clinically significant. The clinical implications of this *in vitro* study are relevant to the popular full-arch implant rehabilitation concept of tilted and axial implants such as the all-on-four concept. Tilting the posterior implants to increase the anteroposterior spread increases the implant angulation, which is then corrected with 30° angulated abutments. This *in vitro* study shows that even after correction with angulated abutments, if the remaining angulation is up to 20°, framework fit may still be achieved. Verification jig is essential tool to achieve the framework fit.

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## SALIVARY AND LACRIMAL GLAND RESEARCH

### Delivery of Bone Marrow-Derived Mesenchymal Stem Cells Improves Tear Production in a Mouse Model of Sjögren's Syndrome

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**ABSTRACT:** The purpose of the present study was to test the potential of mouse bone marrow-derived mesenchymal stem cells (BD-MSCs) in improving tear production in a mouse model of Sjögren's syndrome dry eye and to investigate the underlying mechanisms involved. NOD mice (N=20) were randomized to receive i.p. injection of sterile phosphate buffered saline (PBS, control) or murine BD-MSCs (1 × 10<sup>6</sup> cells). Tears production was measured at baseline and once a week after treatment using phenol red impregnated threads. Cathepsin S activity in the tears was measured at the end of treatment. After 4 weeks, animals were sacrificed and the lacrimal glands were excised and processed for histopathology, immunohistochemistry, and RNA analysis. Following BD-MSC injection, tears production increased over time when compared to both baseline and PBS injected mice. Although the number of lymphocytic foci in the lacrimal glands of treated animals did not change, the size of the foci decreased by 40.5% when compared to control animals. The mRNA level of the water channel aquaporin 5 was significantly increased following delivery of BD-MSCs. We conclude that treatment with BD-MSCs increases tear production in the NOD mouse model of Sjögren's syndrome. This is likely due to decreased inflammation and increased expression of aquaporin 5.

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### Evaluating the Responsiveness of Sjögren's Syndrome Population to Sialagogues

Joseph Cimmino,\* Arwa Farag, Mabi Singh, Tamar Roomian, and Athena Papas

**OBJECTIVES:** Oral sialagogues are the only pharmacological agents available to stimulate salivary function in patients with hyposalivation. However, the biologically challenging salivary glands environment in Sjögren's syndrome patients can hinder the success of this therapeutic approach. The objective of this study is to compare the responsiveness of Sjögren's syndrome patients (SjS) and sicca syndrome patients to oral sialagogues.

**METHODS:** A retrospective chart review was conducted for patients seen at the Oral Medicine Clinic at TUSDM between September 2000 and August 2016. Information about patients' demographics, medical history, and medication were collected. The status of Sjögren's syndrome was confirmed according to the American-European Consensus Group and the American College of Rheumatology criteria. Sialometric measurements for unstimulated (US) and stimulated saliva (SS) were collected at baseline and at follow-up visits scheduled at 3 month and beyond after the initiation of sialagogues (standard doses of pilocarpine or cevimeline; frequency ranged from 1 to 4 times a day).

**RESULTS:** A total of 45 patients were included in this study. All patients were female, and the mean age was 65

years. At follow-up, patients with Sjögren's syndrome showed no statistically significant differences in salivary flow when using cevimeline versus pilocarpine (US:  $p=0.66$ ; SS:  $p=0.28$ ). On the other hand, those with negative Sjögren's status had better improvement when using cevimeline compared to pilocarpine (US  $p=0.05$ ; SS  $p=0.04$ ).

**CONCLUSIONS:** The destruction of the salivary glands over time due to a positive status of Sjögren syndrome may hinder the responsiveness of salivary glands to certain sialogogues. Further studies are needed to evaluate if biological modifiers in salivary glands environments (such immunosuppressant therapy) can improve responsiveness to sialogogues.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1038.*

### **Human Postmortem Lacrimal and Submandibular Glands Stored in RNAlater Are Suitable for Molecular, Biochemical, and Cell Biological Studies**

*Dillon Hawley, Hema Aluri, Helene Armaos, Gina Kim, Claire Kublin, and Driss Zoukhri*

**PURPOSE:** Gene expression and protein analysis studies require high-quality human tissue, which is a challenge because it is difficult to obtain through live human biopsies. Human postmortem lacrimal gland (LG) and submandibular gland (SMG) tissues have the potential to provide an invaluable source for studying the mechanisms involved in LG and SMG dysfunction. Therefore, we aimed to test the suitability of postmortem LG and SMG for molecular, biochemical, and cell biological studies.

**METHODS:** LG and SMG tissue from healthy donors was collected and immediately placed in RNAlater solution and then shipped overnight at 4°C. After receipt, each gland was divided into three pieces for RNA, protein, and histological analysis, respectively. Total RNA isolated from each LG and SMG was analyzed for RNA integrity using an Agilent Bioanalyzer and reverse transcription-PCR (RT-PCR). For histology, tissues were embedded in paraffin and stained with hematoxylin and eosin. For protein analysis, lysates were prepared and processed for sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and Western blotting.

**RESULTS:** When the LG and SMG samples were preserved in RNAlater, the RNA integrity number (RIN) values from the LG and SMG were  $>7.0$  from all 3 donors, while the RNAs from tissue not preserved in RNAlater were of poorer quality. The gene and/or protein expression of E-cadherin, aquaporin 5, alpha-smooth muscle actin ( $\alpha$ -SMA),  $\beta$ -actin, and GAPDH was preserved in all samples. In addition, histological analyses showed normal tubuloacinar structures of all glands with serous and mucous producing acini within lobules interspersed with adipose fat.

**CONCLUSIONS:** In this study, we determined that RNA, protein, and histological sections obtained from postmortem human LG and SMG tissue preserved in RNAlater were of high quality. This would provide a viable source of human LG and SMG tissue suitable for studies of diseases that affect these glands, such as Sjögren's syndrome.

*Published in Mol Vis. 2016 Oct 17;22:1221-1228. eCollection 2016.PMID: 27777501.*

## RNA-Seq and CyTOF Immunoprofiling of Regenerating Lacrimal Glands Identifies a Novel Subset of Cells Expressing Muscle-Related Proteins

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**ABSTRACT:** The purpose of the present studies was to use CyTOF and RNA-Seq technologies to identify cells and genes involved in lacrimal gland repair that could be targeted to treat diseases of lacrimal gland dysfunction. Lacrimal glands of female BALB/c mice were experimentally injured by intra-glandular injection of interleukin 1 alpha (IL-1 $\alpha$ ). The lacrimal glands were harvested at various time points following injury (1 to 14 days) and used to either prepare single cell suspensions for CyTOF immunophenotyping analyses or to extract RNA for gene expression studies using RNA-Seq. CyTOF immunophenotyping identified monocytes and neutrophils as the major infiltrating populations 1 and 2 days post injury. Clustering of significantly differentially expressed genes identified 13 distinct molecular signatures: 3 associated with immune/inflammatory processes included genes upregulated at days 1–2 and 3 associated with reparative processes with genes upregulated primarily between days 4 and 5. Finally, clustering identified 65 genes that were specifically upregulated 2 days post injury, which was enriched for muscle specific genes. The expression of select muscle-related proteins was confirmed by immunohistochemistry, which identified a subset of cells expressing these proteins. Double staining experiments showed that these cells are distinct from the myoepithelial cells. We conclude that experimentally induced injury to the lacrimal gland leads to massive infiltration by neutrophils and monocytes which resolved after 3 days. RNA-Seq and immunohistochemistry identified a group of cells, other than myoepithelial cells, that express muscle-related proteins that could play an important role in lacrimal gland repair.

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## STEM CELL RESEARCH

### Dental Cell Differentiation on Silk Hydrogel Tooth Bud ECM Scaffolds

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**OBJECTIVES:** Silk is one of the natural materials used for tissue engineering. Silk scaffolds have been used for a variety of applications in tissue and organ regeneration due to their superior biocompatibility, biodegradability, mechanical strength and elasticity, water permeability, and ability to promote cell attachment and proliferation. Our objective was to determine whether incorporation of tooth bud derived extracellular matrix (ECM) into silk hydrogels would enhance dental pulp derived dental mesenchymal stem cell (DMSC) differentiation.

**METHODS:** Nine different types of silk scaffolds were fabricated: 1) 6% silk; 2) 6% silk+tECM; 3) 6% silk+collagen; 4) 3% silk 4g salt; 5) 3% silk 4g salt+tECM; 6) 3% silk 4g salt+collagen; 7) 3% silk 2g salt; 8) 3% silk 2g salt+tECM; and 9) 3% silk 2g salt+collagen. Porcine DMSCs (pDMSCs) at passage 2 were seeded into silk scaffolds ( $3 \times 10^5$  cells/scaffold,  $\sim 3 \times 10^3$  cells/mm<sup>3</sup>) and cultured *in vitro* in osteogenic media for 24 hours, or for 2 and 4 weeks. Unseeded silk scaffolds were used as controls. Three replicates were used for each experimental condition and controls.

**RESULTS:** Preliminary bright field light microscopic analyses revealed pDMSC attachment and proliferation of stem cells after 2 and 4 weeks *in vitro* culture. Histological and immunohistochemical (IHC) analyses of paraffin embedded and sectioned constructs are being conducted on all experimental groups to better characterize pDMSC morphology and differentiation.

**CONCLUSIONS:** Silk scaffolds are suitable to support the attachment and proliferation of seeded pDMSCs. Ongoing IHC is being used to characterize and compare pDMSC differentiation on each type of scaffold.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1879.*

### Generation of Induced Pluripotent Stem Cells from Diabetic Foot Ulcer Fibroblasts Using a Nonintegrative Sendai Virus

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Diabetic foot ulcers (DFUs) are nonhealing chronic wounds that are a serious complication of diabetes. Since induced pluripotent stem cells (iPSCs) may offer a potent source of autologous cells to heal these wounds, we studied if repair-deficient fibroblasts, derived from DFU patients and age- and site-matched control fibroblasts, could be reprogrammed to iPSCs. To establish this, we used Sendai virus to successfully reprogram 6 primary fibroblast cell lines derived from ulcerated skin of 2 DFU patients (DFU8, DFU25), nonulcerated foot skin from 2 diabetic patients (DFF24, DFF9), and healthy foot skin from 2 nondiabetic patients (NFF12, NFF14). We confirmed reprogramming to a pluripotent state through 3 independent criteria: immunofluorescent staining for SSEA-4 and TRA-1-81; formation of embryoid bodies with differentiation potential to all three embryonic

germ layers *in vitro*; and formation of teratomas *in vivo*. All iPSC lines showed normal karyotypes and typical, nonmethylated CpG sites for OCT4 and NANOG. The iPSCs derived from DFUs were similar to those derived from site-matched nonulcerated skin from both diabetic and nondiabetic patients. These results have established for the first time that multiple, DFU-derived fibroblast cell lines can be reprogrammed with efficiencies similar to control fibroblasts, thus demonstrating their utility for future regenerative therapy of DFUs.

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## Human iPSC-Derived Patient-Specific Tissue Grafts to Activate a Repair Phenotype for Diabetic Foot Ulcers

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Diabetic foot ulcers (DFUs) are non-healing wounds that are a debilitating complication of diabetes that can lead to lower extremity amputation in patients. There is a large unmet need to find novel and efficient therapies to treat DFUs. To address this, we have developed a new tissue engineering approach by fabricating patient-specific, 3D FIB-iPSC-derived tissue grafts (GRiPS) that incorporate bioactive fibroblasts that were differentiated from induced pluripotent stem cells (FIB-iPSCs). FIB-iPSCs were derived from reprogrammed human primary diabetic foot fibroblasts (DFFs), diabetic foot ulcer fibroblasts (DFUFs), and primary normal foot fibroblasts (NFFs), which were then differentiated into fibroblasts (iDFUFs, iDFFs, iNFFs). FIB-iPSCs assembled an extracellular matrix (ECM) when grown using *in vitro*, 3D tissue engineering principles generating 3D GRiPS. We then evaluated capacity of these GRiPS to activate a prorepair phenotype. We performed side-by-side comparisons to establish the *in vitro* and *in vivo* phenotypes of these GRiPS. GRiPS generated from iDFUFs, iDFFs, and iNFFs show a unique acellular, non-fibrillar morphology when compared to tissues constructed from primary DFUFs, DFFs, and NFFs. GRiPS were characterized by: (1) decreased levels of major wound healing collagens Type I and Type III; (2) increased levels of fibronectin and Type IV collagen; (3) increased amounts of sulfated glycosaminoglycans; and (4) decreased amounts of hyaluronic acid when compared to 3D scaffolds fabricated from their primary cell counterparts. All types of iPSC-derived fibroblasts demonstrated these phenotypic features suggesting “phenotypic convergence” after reprogramming and differentiation. When GRiPS were transplanted to mice, tissue grafts persisted, underwent limited remodeling and showed increased wound closure in diabetic mice, suggesting the utility of FIB-iPSC-derived ECM for DFU repair. The development of these new tissue engineered platforms from iPSC-derived fibroblasts can now be used to impact compromised wound repair where tissue grafts can provide a pre-formed, structural ECM and viable growth factor-producing cells needed to stimulate healing of chronic wounds.

Presented at the International Society for Stem Cell Research Annual Meeting (ISSCR), June 14-17, 2017, Boston.

## Reprogramming of Diabetic Foot Ulcer Fibroblasts to iPSCs Reveals an Altered Wound Healing Potential

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Diabetic foot ulcers (DFUs) are non-healing wounds that can lead to amputation. Currently, there is no effective therapy to treat DFUs. To address this need, we reprogrammed primary diabetic, diabetic ulcer, and normal fibroblasts (Fibs) into induced pluripotent stem cells (iPSCs) and then differentiated them into fibroblasts (iPSC-Fibs). We hypothesize that iPSC-Fibs will improve wound healing when returned to DFUs. We showed that diabetic fibroblasts produce aberrant extracellular matrix (ECM). We investigated phenotypic differences in wound healing potential between Fibs and iPSC-Fibs. PCA and hierarchical clustering using global gene expression grouped Fibs separately from iPSC-Fibs. GO analysis revealed that differentially expressed genes between Fibs and iPSC-Fibs primarily belong to ECM, suggesting that reprogramming and differentiation modified genes essential for wound healing. iPSC-Fibs put into *in vitro* 3D endogenous ECM tissue model (SA) showed an acellular, non-fibrillar morphology different from Fibs. SA tissues with iPSC-Fibs showed decreased Type I and Type III collagens, and hyaluronic acid, increased fibronectin, Type IV collagen, and sulfated GAGs. iPSC-Fibs from all origins showed similar phenotypic features in SA tissues. These results suggest a “phenotypic convergence” in iPSC-Fibs from all primary sources. Thus, reprogramming and differentiation may alter the wound healing phenotype in diabetic cells to enable repair. Next we will identify epigenetic mechanisms responsible for this shift and test the ability of ECM from iPSC-Fibs to improve wound healing

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## Changes in H3K27me3 Associated with Wound Healing Properties in iPSC-Derived Diabetic Foot Ulcer Fibroblasts

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Diabetic patients exhibit poor wound healing that leads to debilitating complications such as diabetic foot ulcers (DFUs). Fibroblasts are critical to normal wound healing but show abnormal functions in DFUs. However, it is not known how epigenetic changes in diabetic primary fibroblasts lead to poor wound healing outcomes or if they can be reversed. The repressive H3K27me3 mark is one of the major histone marks that changes during reprogramming and differentiation. We have reprogrammed both normal and diabetic fibroblasts into induced pluripotent stem cells (iPSCs) and have subsequently differentiated them into fibroblasts, with the goal of understanding the epigenetic profile linked to improved wound healing. Our goal is to determine how

epigenetic changes can impact wound healing after reprogramming of fibroblasts to iPSCs and subsequent differentiation to fibroblasts. Previously, we identified that diabetic primary ulcer-derived fibroblasts (DFUFs) deposit thin extracellular matrix (ECM) rich in Type I collagen and fibronectin in 3D *in vitro* self-assembled tissues that mimic the connective tissue seen in chronic wounds. In addition, DFUFs are limited in inducing angiogenic response and secrete decreased levels of pro-angiogenic cytokines CXCL12, IL6, and CCL2. We analyzed whether genes involved in phenotypes associated with chronic wound healing are being regulated by H3K27me3. We performed ChIP-qPCR analysis and identified that DFUFs had greater H3K27me3 levels in COL1A1 and FN promoters compared to NFFs and iPSC-derived fibroblasts. H3K27me3 was increased in DFUFs and iPSC-derived fibroblasts in CXCL12 and IL6 promoters. We found that CCL2 and Serpine 1 promoters showed increased levels of H3K27me3 in DFUFs that were erased by reprogramming to iPSC and subsequent differentiation. We also determined that total levels of H3K27me3 protein were lower in diabetic primary fibroblasts compared to normal primary fibroblasts. Overall, we observed the differential presence of H3K27me3 mark in the genes involved in chronic wound healing by DFUFs and identified their modulation upon reprogramming and differentiation.

*Presented at the International Society for Stem Cell Research Annual Meeting (ISSCR) June 14–17, 2017, Boston.*

## Characterization of Biomimetic Dental Cell Sheet GelMA Tooth Bud Mineralization

*Nelson Monteiro, Elizabeth Smith, Winnie Costa, Shantel Angstadt, and Pamela Yelick\**

**OBJECTIVES:** Our long-term goal is to create functional biomimetic tooth buds for eventual tooth replacement in humans. The objective of this study was to characterize mineralized dental tissue formation in a novel 3D biomimetic tooth bud model consisting of dental epithelial (DE), dental mesenchymal (DM) and HUVEC cell sheets (DE-HUVEC, DM-HUVEC), combined with dental cell-HUVEC encapsulated gelatin methacrylate (GelMA) hydrogel scaffolds.

**METHODS:** Porcine DM or DE cells were seeded onto UpCell thermo-responsive tissue culture plates at cell densities of 0.114 and 0.228 cell  $10^6/\text{cm}^2$ , and HUVECs were seeded on top of each after 12 days *in vitro* culture. DE-HUVEC and DM-HUVEC cell sheets were harvested after 14 days. Biomimetic tooth buds were created from stacked DE-HUVEC/DM-HUVEC cell sheets sandwiched between GelMA encapsulated DE-HUVEC and DM-HUVEC cells (CS), and cultured in Osteogenic Media for 7 days prior to implantation *in vivo* for 1, 3 and 6 weeks. Acellular GelMA (G), GelMA encapsulated DE-DM cell constructs (GC), GelMA encapsulated DM cells (GM), and DM cell sheets + GelMA encapsulated DM cells (CSMG) constructs were also examined. *In vivo* mineralization was assessed and quantified using microCT (Bruker). Dental cell differentiation and neovascularization were assessed using histological and immunohistochemical analyses.

**RESULTS:** *In vivo* implanted 3D tooth bud constructs exhibited mineralized tissue formation of specified size and shape, and mineralized tissue density increased over *in vivo* implantation time. The greatest volumes and highest density mineralized tissue formed in the CS-GelMA constructs after 6 weeks, as compared to other construct types. Evaluations of paraffin embedded and serial sectioned biomimetic tooth bud constructs are being performed to characterize dental cell differentiation marker and neo-vasculature formation.

**CONCLUSIONS:** We propose our biomimetic 3D Gelma-CS tooth buds as models for dental cell differentiation and mineralized dental tissue formation leading to the formation of functional biomimetic replacement teeth.

*Presented at the 2017 IADR Annual Meeting in San Francisco, California. Abstract 1113.*

## **Multipotent Differentiation of Human Dental Pulp Stem Cells: A Literature Review**

*Niccolò Nuti,<sup>1</sup> Claudio Corallo,<sup>1</sup> Benjamin Chan,<sup>2</sup> Marco Ferrari,<sup>1</sup> and Behzad Gerami-Naini<sup>2</sup>*

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The advent of regenerative medicine has brought us the opportunity to regenerate, modify, and restore human organ function. Stem cells, a key resource in regenerative medicine, are defined as clonogenic, self-renewing, progenitor cells that can generate into one or more specialized cell types. Stem cells have been classified into three main groups: embryonic stem cells (ESCs), induced pluripotent stem cells (iPSCs), and adult/postnatal stem cells (ASCs). The present review focused the attention on ASCs, which have been identified in many perioral tissues such as dental pulp, periodontal ligament, follicle, gingival, alveolar bone, and papilla. Human dental pulp stem cells (hDPSCs) are ectodermal-derived stem cells, originating from migrating neural crest cells and possessing mesenchymal stem cell properties. During the last decade, hDPSCs have received extensive attention in the field of tissue engineering and regenerative medicine due to their accessibility and ability to differentiate in several cell phenotypes. In this review, we have carefully described the potential of hDPSCs to differentiate into odontoblasts, osteocytes/osteoblasts, adipocytes, chondrocytes, and neural cells.

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## TISSUE ENGINEERING

### Organotypic Culture to Assess Cell Adhesion, Growth, and Alignment of Different Organs on Silk Fibroin

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Glass sheets covered with aligned electrospun silk fibroin (*Bombyx mori*) were compared to tissue culture-treated Thermanox® coverslips, using an organotypic culture method. Different chick embryo organ behaviors were analyzed in terms of circularity, cell growth, and cell adhesion after being cultivated in contact with these two materials. The circularity (cell layer shape corresponding to the trend of the biomaterials to induce a specific directionality) depends on the organ used when in contact with silk fibroin. This biomaterial induced higher cell adhesion (kidney) or lower cell adhesion (spine) compared to Thermanox. Cell growth, represented by the cell layer area (mm<sup>2</sup>), was also drastically reduced (gonad) or increased (blood vessel) on the silk fibroin. Organotypic culture is a rapid, cost effective, and relatively simple method to evaluate different parameters, allowing prescreening of morphology and cytocompatibility to select the appropriate applications for new biomaterials. In the present study we compared the morphology of different organotypic cultures on orientated silk and Thermanox as growth supports to rapidly evaluate the benefit of a silk-based biomaterial for tissue engineering.

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### Progress in Bioengineered Whole Tooth Research: From Bench to Dental Patient Chair

Elizabeth Smith and Pamela Yelick

**ABSTRACT:** Tooth loss is a significant health issue that affects the physiological and social aspects of everyday life. Missing teeth impair simple tasks of chewing and speaking and can also contribute to reduced self-confidence. An emerging and exciting area of regenerative medicine based dental research focuses on the formation of bioengineered whole tooth replacement therapies that can provide both the function and sensory responsiveness of natural teeth. This area of research aims to enhance the quality of dental and oral health for those suffering from tooth loss. Current approaches use a combination of dental progenitor cells, scaffolds, and growth factors to create biologically based replacement teeth to serve as improved alternatives to currently used artificial dental prosthetics. This article is an overview of current progress, challenges, and future clinical applications of bioengineered whole teeth.

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## Developing a Biomimetic Tooth Bud Model

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**ABSTRACT:** A long-term goal is to bioengineer fully functional, living teeth for regenerative medicine and dentistry applications. Biologically based replacement teeth would avoid insufficiencies of the currently used dental implants. Using natural tooth development as a guide, a model was fabricated using post-natal porcine dental epithelial (pDE), porcine dental mesenchymal (pDM) progenitor cells, and human umbilical vein endothelial cells (HUVEC) encapsulated within gelatin methacrylate (GelMA) hydrogels. Previous publications have shown that post-natal DE and DM cells seeded onto synthetic scaffolds exhibited mineralized tooth crowns composed of dentin and enamel. However, these tooth structures were small and formed within the pores of the scaffolds. The present study shows that dental cell-encapsulated GelMA constructs can support mineralized dental tissue formation of predictable size and shape. Individually encapsulated pDE or pDM cell GelMA constructs were analyzed to identify formulas that supported pDE and pDM cell attachment, spreading, metabolic activity, and neo-vasculature formation with co-seeded endothelial cells (HUVECs). GelMA constructs consisting of pDE-HUVECS in 3% GelMA and pDM-HUVECs within 5% GelMA supported dental cell differentiation and vascular mineralized dental tissue formation *in vivo*. These studies are the first to demonstrate the use of GelMA hydrogels to support the formation of post-natal dental progenitor cell-derived mineralized and functionally vascularized tissues of specified size and shape. These results introduce a novel three-dimensional biomimetic tooth bud model for eventual bioengineered tooth replacement teeth in humans.

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## Overexpression of MiR-335-5p Promotes Bone Formation and Regeneration in Mice

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MicroRNAs (miRNAs) and the Wnt signaling pathway play critical roles in regulating bone development and homeostasis. Our previous study revealed high expression of miR-335-5p in osteoblasts and hypertrophic chondrocytes in mouse embryos and the ability of miR-335-5p to promote osteogenic differentiation by downregulating Wnt antagonist Dickkopf-1 (DKK1). The purpose of this study was to investigate the effects of miR-335-5p constitutive overexpression on bone formation and regeneration *in vivo*. To that end, we generated a transgenic mouse line specifically overexpressing miR-335-5p in osteoblasts lineage by the osterix promoter and characterized its bone phenotype. Bone histomorphometry and  $\mu$ CT analysis revealed higher bone mass and increased parameters of bone formation in transgenic mice than in wild-type littermates. Increased bone mass in transgenic mice bones also correlated with enhanced expression of osteogenic differentiation markers.

Upon osteogenic induction, bone marrow stromal cells (BMSCs) isolated from transgenic mice displayed higher mRNA expression of osteogenic markers than wild-type mice BMSCs cultures. Protein expression of Runx2 and Osx was also upregulated in BMSC cultures of transgenic mice upon osteogenic induction, whereas that of DKK1 was downregulated. Most important, BMSCs from transgenic mice were able to repair craniofacial bone defects as shown by  $\mu$ CT analysis, H&E staining, and osteocalcin (OCN) immunohistochemistry of newly formed bone in defects treated with BMSCs. Taken together, our results demonstrate constitutive overexpression of miR-335-5p driven by an osterix promoter in the osteoblast lineage induces osteogenic differentiation and bone formation in mice and support the potential application of miR-335-5p-modified BMSCs in craniofacial bone regeneration.

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## **Decellularized Tooth Bud Scaffolds for Tooth Regeneration**

*Weibo Zhang, Betsy Vazquez, Daniel Oreadi, and Pamela Yelick*

Whole tooth regeneration approaches currently are limited by our inability to bioengineer full-sized, living replacement teeth. Recently, decellularized organ scaffolds have shown promise for applications in regenerative medicine by providing a natural extracellular matrix environment that promotes cell attachment and tissue-specific differentiation leading to full-sized organ regeneration. We hypothesize that decellularized tooth buds (dTBs) created from unerupted porcine tooth buds (TBs) can be used to guide reseeded dental cell differentiation to form whole bioengineered teeth, thereby providing a potential off-the-shelf scaffold for whole tooth regeneration. Porcine TBs were harvested from discarded 6-mo-old pig jaws, and decellularized by successive sodium dodecyl sulfate/Triton-X cycles. Four types of replicate implants were used in this study: 1) acellular dTBs; 2) recellularized dTBs seeded with porcine dental epithelial cells, human dental pulp cells, and human umbilical vein endothelial cells (recell-dTBs); 3) dTBs seeded with bone morphogenetic protein (BMP)-2 (dTb-BMPs); and 4) freshly isolated nondecellularized natural TBs (nTBs). Replicate samples were implanted into the mandibles of host Yucatan mini-pigs and grown for 3 or 6 mo. Harvested mandibles with implanted TB constructs were fixed in formalin, decalcified, embedded in paraffin, sectioned, and analyzed via histological methods. Micro-computed tomography (CT) analysis was performed on harvested 6-mo samples prior to decalcification. All harvested constructs exhibited a high degree of cellularity. Significant production of organized dentin and enamel-like tissues was observed in dTB-recell and nTB implants, but not in dTB or dTB-BMP implants. Micro-CT analyses of 6-mo implants showed the formation of organized, bioengineered teeth of comparable size to natural teeth. To our knowledge, these results are the first to describe the potential use of dTBs for functional whole tooth regeneration.

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