OHSU School of Dentistry
Anthology
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Message from the School of Dentistry Dean

Ron Sakaguchi, D.D.S., M.S., Ph.D., M.B.A.,
OHSU School of Dentistry Anthology senior editor

Welcome to the second issue of the OHSU School of Dentistry Anthology, or SODA. This issue showcases research at the OHSU School of Dentistry and collaboration with Osaka Dental University in Osaka, Japan.

In March 2024, Associate Dean Hui Wu, Ph.D., and the Office of Research hosted a well-attended Research Day in the Robertson Life Sciences Building at the OHSU south waterfront campus. Thank you to professor Wu and Stefani Sheldon, Tippi Etzel and Tarn Allen in the research office for planning and presenting the event. Thank you to Samyia Chaudhry, D.M.D., and Christina Truong, D.M.D., for mentoring students in the caseCATs and competition. Also, thank you to Yifan Zhang, D.D.S., Ph.D., M.S., the student research group adviser.

This issue contains five caseCATs by our dental students who were mentored by our faculty. Following the caseCATs are manuscripts that were converted from posters and presented at Research Day. Thank you to Drs. Chaudhry and Truong and senior communicator Rhonda Morin, APR, for preparing the copy for this issue. Thank you to Pam Pierce, publishing and data services manager, in the OHSU Library for her guidance and advice throughout the publication process. We have a terrific team who are committed to bringing discoveries and ideas to you via the School of Dentistry Anthology.

In this edition and the inaugural issue, we included caseCATs written by D.M.D. students. A CAT or caseCAT is a format for reporting information in evidence-based practice that summarizes research evidence for a clinical question. The CAT provides a critique of the literature research and a clinical statement of the analysis.

Critically Appraised Topics, or CATs, became part of the D.M.D. evidence-based dentistry course in 2010 when the school received a National Institutes of Health R25 grant to enhance research education. The School of Dentistry partnered with the University of Texas Health Sciences Center San Antonio to publish OHSU CATs in their database in 2013. With the creation of the School of Dentistry Anthology in 2023, OHSU now publishes its caseCATS. We believe it is essential for clinicians to conduct accurate and efficient searches of peer-reviewed scientific literature to inform clinical decisions. Our students gain this experience early in their academic program and we are pleased to be able to share their analysis and conclusions with you. Students present their work at Research Day in March and at the Oregon Dental Conference each April. Nine caseCAT posters were presented at that conference this year.

As this issue goes to press, we're preparing issue three, which will focus on innovation at the School of Dentistry. The next issue will include presentations from Innovation Day and reports on novel activities that are fostering a culture of innovation at the school.

We're excited to bring SoDA to you, which will continue to showcase research, innovation and scholarly activity by our students, residents, staff and faculty. Thank you for following our work.

Highlights from the School of Dentistry Research Day 2024

By Hui Wu, Ph.D., professor and associate dean of the School of Dentistry Research

Dentistry is about the treatments we provide today and the innovative solutions we discover and develop for tomorrow.

This is where research bridges the gap between scientific discovery and clinical practice, ensuring that we continue to innovate and improve patient care and outcomes.

Research Day is a testament to the vibrant scholarly environment we've cultivated at the OHSU School of Dentistry. It's a day where we celebrate our accomplishments and showcase ongoing research and research training by our students, staff, and faculty.

The School of Dentistry continued its tradition by celebrating Research Day on March 7, 2024, highlighting 58 diverse research projects from pre-doctoral students, post-doctoral fellows, faculty, and staff members.

Led by the School of Dentistry Office of Research, the event was planned and executed in collaboration with Yifan Zhang, D.D.S., Ph.D., M.S., student research group faculty adviser and Samyia Chaudry, D.M.D., and Christina Truong, D.M.D., caseCAT mentors. The Oregon Dental Association, OHSU School of Dentistry Alumni Association, and Permanente Dental Associates provided financial support and assisted in judging the research poster competition.

Two keynote addresses were part of the activities. David Huang, M.D., Ph.D., from the OHSU Casey Eye Institute and Alireza Sadr, D.D.S., Ph.D., from the University of Washinton School of Dentistry, discussed the development of imaging technology called Optical Coherence Tomography, or OCT, and its application in dentistry and medicine. Dr. Huang shared his experience of developing the technology as a graduate student and his continued research as a faculty investigator at OHSU. Dr. Sadr shared how he has applied cutting-edge OCT technology in dentistry.

For the first time, faculty members and students from Osaka Dental University in Japan, who we began collaborating with in January 2024, submitted two posters of their research findings in oral cancer. The poster by Jie Min, Hiroki Takigawa, D.D.S., Ph.D., Yugo Maruyama, Ph.D., Takayuki Numbu, Ph.D., Chiho Mashimo, Ph.D., and Toshinori Okinaga, D.D.S., Ph.D., reported how oral bacteria influences cancer cell transformation. A second poster by Jinhao Cui, Tomoharu Okamura, D.D.S., Ph.D., Chihoko Ikeda, D.D.S., Ph.D., Kazuya Tominaga, D.D.S., Ph.D., and Akio Tanaka D.D.S., Ph.D., showcased the efficacy of photodynamic therapy in treating oral cancer.

An awards ceremony finished the day. Congratulations to the winners of the posters and caseCat presentations:

Best poster | D.M.D. students, Peter Nguyen and Marina Youssef (tied for first)

Best poster | Ph.D. student, Joao Batisa, Fugolin Lab

Best poster | Resident, Matt Jervis

Best poster | Postdoctoral scholar, Mauricio Sousa, Bertassoni Lab

Best poster | Staff, Emily Helliwell, Kreth Lab

Best poster | Faculty, Cristiane Miranda França

Best poster | Student choice, Marina Youssef

Best caseCAT | First place, Emily Tran and Branden Pelzer; **Second place,** Angela Hung; **Third place**, Jonathan Nguyen

In this issue of the School of Dentistry Anthology, discover research posters from Osaka Dental University, the best caseCATs and selected winning research posters from pre-doctoral students, post-doctoral fellows, faculty and staff members from the School of Dentistry Research Day and the Oregon Dental Conference, both in 2024.

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Efficacy of stannous fluoride toothpaste as a remedy for patients with dentinal hypersensitivity

Branden Pelzer and Emily Tran
Mentor: Richard L. Grabowsky, D.D.S.

Background

Dentinal hypersensitivity, or DH, is a common problem that many patients suffer from, and it can affect their quality of life. Stannous fluoride (SF2) is a compound that can relieve painful sensations from DH thanks to the stannous ion that interacts with dental hard tissue, which creates a layer that occludes exposed dentin tubules. Delivering stannous fluoride in the form of over-the-counter toothpaste could potentially be a great way to deliver this relief to a majority of patients.

Clinical question

In comparison to sodium fluoride and/or sodium monofluorophosphate containing toothpastes, does the use of stannous fluoride containing toothpaste effectively reduce hypersensitivity in patients suffering from dentinal hypersensitivity?

POPULATION
Patients suffering from dentinal hypersensitivity

INTERVENTION
Stannous fluoride toothpaste

COMPARISON
NaF and/or Na_2PO_3F

OUTCOME
Dentinal hypersensitivity relief

CAT 1

Article. Bioavailable gluconate chelated stannous fluoride toothpaste meta-analyses: Effects on dentine hypersensitivity and enamel erosion[1]
Authors. West, NX., et al.
Published. February, 2021

Methods. Eight randomized control trials from the Proctor and Gamble Oral Care Clinical archive were used to examine the effects of stannous fluoride as a method of relief for patients with dentinal hypersensitivity. Patients diagnosed with dentinal hypersensitivity were given a stannous fluoride or sodium fluoride/sodium monophosphate toothpaste to brush with twice daily for two to eight weeks. DH relief was tested using tactile and thermal air sensitivity.

Results/conclusion. A total of 453 of the 661 (69%) patients treated with the stannous fluoride toothpaste transitioned to the not sensitive group (Schiff score less than or equal to one). Thirty-one of the 374 (8%) patients treated with the sodium fluoride/sodium monofluorophosphate toothpaste

Evidence search strategy

MeSH Terms:

- Stannous fluoride
- Toothpaste
- Sensitivity

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transitioned to the not sensitive group. An increase in the average Yeaple score of 20.08 was observed in the experimental group, equating to a 142% benefit versus the negative control. Stannous fluoride toothpastes appear to be a more effective tool for relieving dentinal hypersensitivity.

Validity/applicability. All studies were randomized, controlled, and blinded.

Level of evidence. Level 1–Meta-analysis of RCT's

CAT 2

Article. Desensitizing toothpastes for dentin hypersensitivity: A network meta-analysis[2]
Authors. Martins, CC., et al.
Published. May, 2020

Methods. Seven databases were searched for randomized controlled trials, or RCTs, comparing various ingredients as remedies for dentinal hypersensitivity. The RCTs studied participants who had been diagnosed with DH via tactile, cold or air stimuli, and who had been treated with over-the-counter toothpastes. Fluoride was the most connected intervention and subsequently was chosen as the reference comparison. To compare the effects of fluoride versus other interventions, mean differences, or MDs, were calculated. Cohen's classification was then used to measure the magnitude of the MDs. Finally, the GRADE approach was taken to assess the certainty of evidence.

Results/conclusion. 125 RCTs, totaling 12,541 patients, were eligible to be included in the review. Toothpastes containing stannous fluoride showed large beneficial effects (MD = 2.31) for tactile stimuli with moderate certainty. Stannous fluoride showed large benefits (MD = 3.28) with high certainty when stimulated with air. No data was available that tested stannous fluoride's effect on cold stimuli.

Validity/applicability. All studies were randomized, controlled, blinded and screened for bias.

Level of evidence. Level 1—Systematic review and meta-analysis of RCTs

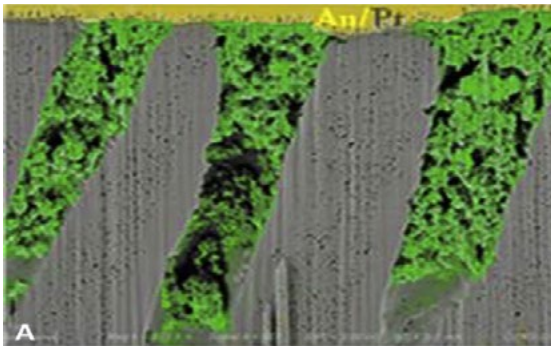

Image A. An electron microscopy cross-sectional view of dentin tubules after treatment with stannous fluoride toothpaste (A). This image indicates that stannous fluoride more effectively blocked material, represented by the yellow particles, from entering the tubule.

Hines D, Xu S, Stranick M, Lavender S, Pilch S, Zhang YP, Sullivan R, Montesani L, Montesani L, Mateo LR, Williams M. Effect of a Stannous Fluoride Toothpaste on Dentinal Hypersensitivity: In Vitro and Clinical Evaluation. J Am Dent Assoc. 2019 Apr;150(4S):S47-S59. doi: 10.1016/j.adaj.2019.01.006. PMID: 30797259.

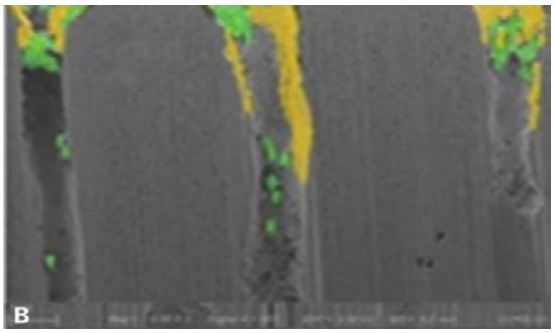

Image B. An electron microscopy cross-sectional view of dentin tubules after treatment with sodium monofluorophosphate toothpaste (B).

Hines D, Xu S, Stranick M, Lavender S, Pilch S, Zhang YP, Sullivan R, Montesani L, Montesani L, Mateo LR, Williams M. Effect of a Stannous Fluoride Toothpaste on Dentinal Hypersensitivity: In Vitro and Clinical Evaluation. J Am Dent Assoc. 2019 Apr;150(4S):S47-S59. doi: 10.1016/j.adaj.2019.01.006. PMID: 30797259.

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CAT 3

Article. Effect of a stannous fluoride toothpaste on dentinal hypersensitivity: In vitro and clinical evaluation[3]
Authors. Hines, D., et al.
Published. April, 2019

Methods. Forty patients with at least two hypersensitive teeth were designated to the test group (stannous fluoride) and 40 were designated to the control group (sodium monofluorophosphate). Participants brushed with their respective toothpaste for one minute, two times a day, and had their tactile and air blast sensitivity measured at four and eight weeks.

Results/conclusion. After eight weeks, the average tactile sensitivity score for the test group was 32.13. The score was 22.63 for the control group. Both entities had a significant increase from the baseline, but stannous fluoride was more effective (by 42%). After eight weeks, the average Schiff score for the test group was 1.34, and was 1.98 for the control group. Both groups had a significant decrease from the baseline, but stannous fluoride was more effective (by 32.3%). Although both toothpastes reduced dentinal hypersensitivity, stannous fluoride was more effective.

Validity/applicability. This study was randomized and double blinded.

Level of evidence. Level 1—Randomly controlled trial

Case significance

Brushing teeth is the foundation of oral hygiene. As such, incorporating an effective desensitizing agent into toothpaste could be a simple and accessible tool for reducing dentinal hypersensitivity. Most studies show significant improvement of DH using stannous fluoride over NaF or Na_2PO_3F. Especially for patients with DH from tactile or air stimuli, replacing a fluoride toothpaste with stannous fluoride could be a good method for reducing discomfort. However, more research should be conducted for patients affected by thermal-based sensitivity.

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Direct pulp capping on permanent teeth with carious pulp exposure

Angela Hung
Mentor: Ahmad Alkhazaleh, M.S., B.D.S.

Background

The goal of direct pulp capping or DPC, is to safeguard pulpal vitality of a tooth during pulp exposure. Ample research has been done on traumatized primary teeth, but when it comes to pulpal exposure through caries in adult patients, is it still plausible to use this technique to ensure pulpal preservation? This caseCAT evaluates the clinical success of the direct pulp capping technique using different capping materials on cariously exposed permanent teeth.

Clinical question

Can pulp exposure on permanent teeth due to deep dentinal caries be predictably treated with direct pulp capping?

POPULATION
Patients with cariously exposed pulp with reversible pulpitis

INTERVENTION
Direct pulp capping with MTA

COMPARISON
Direct pulp capping with calcium hydroxide or Biodentine

OUTCOME
Pulpal healing and absence of clinical symptoms

CAT 1

Article. Biodentine or mineral trioxide aggregate as direct pulp capping material in mature permanent teeth with carious exposure? A systematic review and meta-analysis[1]
Authors. Alsubait, S., et al.
Published. November, 2021

Methods. Four studies (3 RCTs and 1 retrospective) with at least a six-month follow-up that compared the clinical success of Biodentine and MTA in DPC.

Results/conclusion. There was no significant difference between the clinical success rates of Biodentine (91.1%) and MTA (94.1%), specifically for permanent carious teeth.

Validity/applicability. This study targets the specific clinical question being asked. However, the number of cases available (95) for evaluation limited this study.

Level of evidence. Level 2—Systematic review

Evidence search strategy

MeSH Terms:

- Direct pulp capping
- Carious
- Permanent

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CAT 2

Article. Efficacy of direct pulp capping for management of cariously exposed pulps in permanent teeth: A systematic review and meta-analysis[2]
Authors. Cushley, S., et al.
Published. April, 2021

Methods. Fourteen studies evaluated with at least a one-year follow up that evaluated clinical success on DPC outcomes.

Results/conclusion. MTA and biodentine demonstrated higher clinical success of 84% and 86%, respectively, at the two to three year follow up compared to calcium hydroxide, which had a 59% success rate. There was no statistically significant difference between MTA and calcium hydroxide at the six-month follow up but was significant at the subsequent follow ups.

Validity/applicability. The studies had clinical heterogeneity and some high risk of bias, but the results remain applicable in a clinical setting.

Level of evidence. Level 2—Systematic review

Image A. Preoperative radiograph depicting deep occlusal caries.

Linu, S., Lekshmi, M. S., Varunkumar, V. S., & Sam Joseph, V. G. (2017). Treatment Outcome Following Direct Pulp Capping Using Bioceramic Materials in Mature Permanent Teeth with Carious Exposure: A Pilot Retrospective Study. Journal of Endodontics, 43(10), 1635–1639. https://doi.org/10.1016/j.joen.2017.06.017

CAT 3

Article. Success of direct pulp capping using mineral trioxide aggregate and calcium hydroxide in mature permanent molars with pulps exposed during carious tissue removal: 1-year follow up[3]
Authors. Suhag, K., et al.
Published. July, 2019

Methods. Caries were removed, and the pulp was disinfected. Pulp capping material and IRM was placed. After 24 hours, RMGI liner and a direct composite restoration were placed. Also, 12-month follow-up results were obtained.

Results/conclusion. At the 12-month follow-up, calcium hydroxide had a 69% success rate while MTA had a 93% success rate.

Validity/applicability. This randomized controlled trial had a strict inclusion criterion and was highly controlled in its treatment protocol. However, it was limited to occlusal caries and the variation in age.

Level of evidence. Level 1—Randomized controlled trial

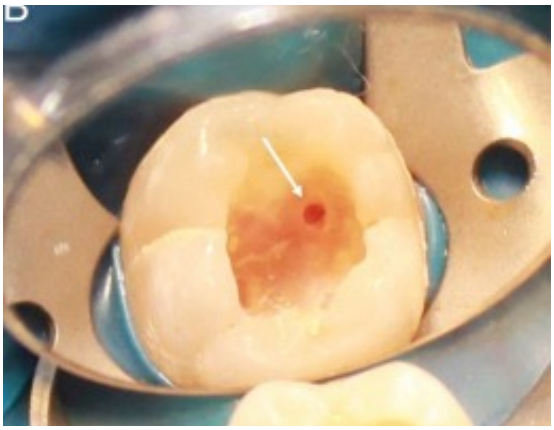

Image B. Pulp exposure indicated by the white arrow after caries removal.

Linu, S., Lekshmi, M. S., Varunkumar, V. S., & Sam Joseph, V. G. (2017). Treatment Outcome Following Direct Pulp Capping Using Bioceramic Materials in Mature Permanent Teeth with Carious Exposure: A Pilot Retrospective Study. Journal of Endodontics, 43(10), 1635–1639. https://doi.org/10.1016/j.joen.2017.06.017

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Case significance

Direct pulp capping is a viable option in treating patients with deep dentinal caries and exhibit reversible pulpitis.

- MTA is a superior pulp capping material to calcium hydroxide. MTA and biodentine have similar clinical success rates.
- Case selection of when to perform direct pulp capping or root canal therapy is important and crucial to the clinical success of the tooth. An important criterion to consider is the absence of irreversible pulpitis symptoms such as spontaneous pain as well as the absence of radiographic evidence of periapical lesions.
- More RCTs with strict inclusion criteria need to be done in order to have higher quality evidence for systematic reviews on this topic.

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1. Alsubait S, Aljarbou F. Biodentine or Mineral Trioxide Aggregate as Direct Pulp Capping Material in Mature Permanent Teeth with Carious Exposure? A Systematic Review and Meta-Analysis. Oper Dent. 2021 Nov 1;46(6):631-640. doi: 10.2341/20-277-LIT. PMID: 35507905.

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3. Suhag K, Duhan J, Tewari S, Sangwan P. Success of Direct Pulp Capping Using Mineral Trioxide Aggregate and Calcium Hydroxide in Mature Permanent Molars with Pulps Exposed During Carious Tissue Removal: 1-year Follow-up. J Endod. 2019 Jul;45(7):840-847. doi: 10.1016/j.joen.2019.02.025. Epub 2019 May 16. PMID: 31104819.

Image C. Postoperative radiograph after placement of biodentine.

Linu, S., Lekshmi, M. S., Varunkumar, V. S., & Sam Joseph, V. G. (2017). Treatment Outcome Following Direct Pulp Capping Using Bioceramic Materials in Mature Permanent Teeth with Carious Exposure: A Pilot Retrospective Study. Journal of Endodontics, 43(10), 1635–1639. https://doi.org/10.1016/j.joen.2017.06.017

Image D. One-year follow-up radiograph. Dentin bridge and pulp chamber calcification observed.

Linu, S., Lekshmi, M. S., Varunkumar, V. S., & Sam Joseph, V. G. (2017). Treatment Outcome Following Direct Pulp Capping Using Bioceramic Materials in Mature Permanent Teeth with Carious Exposure: A Pilot Retrospective Study. Journal of Endodontics, 43(10), 1635–1639. https://doi.org/10.1016/j.joen.2017.06.017

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Treatment efficacy of conservative and radical management on ameloblastoma

Jonathan V. Nguyen
Mentors: Srinivasa R. Chandra, M.D., B.D.S., FIBCSOMS, and Erik Richmond, D.M.D.

Background

Ameloblastomas are a local, odontogenic ectoderm-derived tumor which represent nearly 1% of all tumors in the oral cavity. It is rarely malignant, but its aggressive growth to surrounding soft and hard tissues can result in compromised cosmetics and functional impairment of the face and jaws. Opinions regarding treating ameloblastoma are divided due to its benign nature and high rate of recurrence if not adequately excised. This caseCAT aims to assess the outcomes of radical and conservative treatment approaches on ameloblastomas regarding recurrence and prognosis.

Clinical question

Is radical surgery a better choice for the unicystic and solid/multicystic types of ameloblastoma than conservative surgery in terms of recurrence rates?

POPULATION
Adult patients with ameloblastoma (unicystic, solid/multicystic)

INTERVENTION
Radical surgery

COMPARISON
Conservative approach

OUTCOME
Recurrence rate

CAT 1

Article. Surgical management of ameloblastoma. Review of literature[1]
Authors. Neagu, D., et al.
Published: January, 2019

Methods. Data was collected using the NIH/NLM. 241 articles were found but 14 articles were selected, excluding most case reports.

Results/conclusion. Surgical planning must consider variables such as patient comorbidities, size and location of tumor, techniques available for reconstruction, and surgeon's experience. Radical surgery was reported to be the most recommended option that minimizes recurrences of solid/multicystic ameloblastoma. Conservative surgery reserved for unicystic ameloblastoma supported high recurrence rates.

Validity/applicability. Selected articles were chosen based on impact factor of journal and relevance to title. Review is limited by C level of evidence.

Level of evidence. Level 1—Systematic review (with meta-analysis)

Evidence search strategy

MeSH Terms:

- Ameloblastoma, surgery
- Conservative, enucleation
- Radical

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CAT 2

Article. Radical versus conservative treatment of intraosseous ameloblastoma: Systematic review and meta-analysis[2]
Authors. Hendra, FN., et al.
Published. January, 2019

Methods. Four databases were screened: PubMed, Embase, SCOPUS, and Web of Science for articles published between 1969 to 2018. Twenty studies were selected among a yield search of 6,984 articles.

Results/conclusion. Recurrence rate of solid/multicystic ameloblastomas following radical treatment was 8%, while conservative treatment caused recurrences at 41%. Unicystic ameloblastomas were 3% and 21%, respectively.

Validity/applicability. Moderate sample size. Quality of assessment of selected articles were performed using the Quality Appraisal of Case Series Studies Checklist.

Level of evidence. Level 1—Systematic review (with meta-analysis)

CAT 3

Article. A network meta-analysis assessing the effectiveness of various radical and conservative surgical approaches regarding recurrence in treating solid/multicystic ameloblastomas[3]
Authors. Hendra, FN., et al.
Published. May, 2023

Methods. Four databases were utilized: PubMed (MEDLINE), ScienceDirect, Scopus, and Web of Science for articles until August 10, 2021. Seven observational studies with over 180 patients with solid/multicystic ameloblastoma were included. Studies were measured using a SUCRA value.

Results/conclusion. Segmental resection reported with the lowest recurrence rate (77.7%), followed by curettage with cryotherapy (66.9%), and marginal resection (49.3%).

Validity/applicability. Low sample size. Weak certainty of evidence may suggest results should be viewed with caution.

Level of evidence. Level 1—Systematic review (with meta-analysis)

Image 1. Panoramic radiograph, unicystic type

Mortazavi H, Baharvand, M. (2016) "Jaw Lesions Associated with Impacted Tooth: A Radiographic Diagnostic Guide." Imaging Science in Dentistry: 46, 147-157.

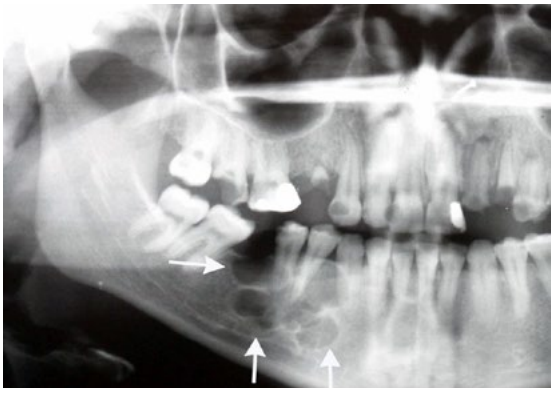

Image 2. Panoramic radiograph, multicystic type

McLean-Holden AC, Magliocca K. Ameloblastoma. PathologyOutlines.com. www.pathologyoutlines.com/topic/mandiblemaxillaameloblastoma.html

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Case significance

- Management continues to be a subject of debate among clinicians.
- Optimal surgical treatment of ameloblastoma should minimize recurrences, restore function and aesthetic, and present minimal morbidity at the donor area.
- Choice of treatment depends on the type of tumor and its clinical presentation.
- Surgery can impair facial growth and development of pediatric patients; thus, a conservative approach may be preferred (despite high recurrence rate).
- More clinical research should be dedicated towards molecular targeted therapies involving BRAF, RAS and SMO gene signaling pathways.

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Image 3. Coronal CT view, multicystic type

McLean-Holden AC, Magliocca K. Ameloblastoma. PathologyOutlines.com. www.pathologyoutlines.com/topic/mandiblemaxillaameloblastoma.html

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Utilizing TADs in conjunction with clear aligners to distalize maxillary molars in patients with class II malocclusion

Aleya Steckel and Valerie Truong
Mentor: Corey Shook, D.M.D., M.D.S.

Background

Twenty-four-year-old ASA I female presents with a moderate Class II, Division 1 malocclusion with no significant tooth size-arch length discrepancy. Patient refuses premolar extraction for Class II correction. Patient declines traditional fixed orthodontic appliances for esthetic reasons.

Clinical question

For patients with Class II malocclusion, does a combination of temporary anchorage devices, or TADs, and precision cutouts on clear aligners provide predictable maxillary arch distalization?

CAT 1

Article Title. En masse distalisation of maxillary arch using TADs (IZC); Passive self-ligating appliance versus clear aligner—A comparative cephalometric study[1]
Authors. Shahani, M., et al.
Published. July-September, 2019

Methods. Twelve patients with mild skeletal maxillary excess were divided into two groups. Group 1 (n=6) received a passive self-ligation appliance while Group 2 (n=6) received clear aligners. Both groups were indicated for distalization with infrazygomatic crest miniscrews for treatment. Distalization was quantified using a cephalometric software.

Results/conclusion. Both groups demonstrated similar correction of the inclination of the maxillary incisors and distal tipping of molars, with the significantly more incisor tipping in the self-ligation group compared to aligners. The difference observed can be credited to the complete coverage of the aligners around the tooth, providing more control in tipping.

Validity/applicability. Trial on a minimum, yet small sample size of adult patients may prevent the ability to extrapolate conclusions of the study to children and adolescents. Additionally, no control exists where distalization was attempted without TADs.

Level of evidence. Level 2—Quasi-experimental study

POPULATION
Patients requiring maxillary molar distalization for Class II correction with a concern for esthetics

INTERVENTION
Maxillary molar distalization utilizing a combination of orthodontic microscrews (TADs) and clear aligners

COMPARISON
Maxillary molar distalization using traditional braces in conjunction with Class II elastics

OUTCOME
Predictable distalization of the maxillary arch along with reduced reciprocal forces on anterior teeth

Evidence search strategy

MeSH terms:

- TAD
- Self-ligation appliance
- Aligners
- Distalization

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CAT 2

Article Title. Upper first molar and second premolar distalization with clear aligner and interradicular skeletal anchorage: A finite element study[2]
Authors. Castroflorio, T., et al
Published. August, 2023

Methods. Used Finite Element Method, or FEM, analysis, to fabricate a maxillary arch model obtained from a Cone Beam Computed Tomography, or CBCT, to simulate a 0.2 mm distalization of the upper second premolar and upper first molar. Nine miniscrews configurations were simulated between the roots of maxillary first and second molars to determine efficient and reliable tooth movements.

Results/conclusion. FEM analysis supports the use of TADs as anchorage units as it can enhance distalizing teeth via the use of Class II elastic while avoiding posterior anchorage loss. The simulations demonstrate that elastics anchored on the canine can be beneficial for promoting incisor proclination (Class II, Division II) while Class I elastics anchored on the first premolar are beneficial when the incisors need to be retroclined (Class II, Division 1).

Validity/applicability. Lack of randomization in trials and use of numerical method to simulate changes on non-human models may render results inapplicable to population.

Level of evidence. Level 2—Quasi-experimental study

CAT 3

Article Title. Distalisation of the dental arches using clear aligners and miniscrews[3]
Authors. Li, H., et al.
Published. January, 2021

Methods. Invisalign aligners with precision cutouts on maxillary canine and miniscrews were placed on both arches of patient with mild bimaxillary protrusion.

Elastics stretching from the cutouts to the TADs were used to achieve distalization of both arches. Teeth were distalised separately in a V-pattern (second molars, first molars, premolars, anteriors) while the entire arch was distalized using miniscrews.

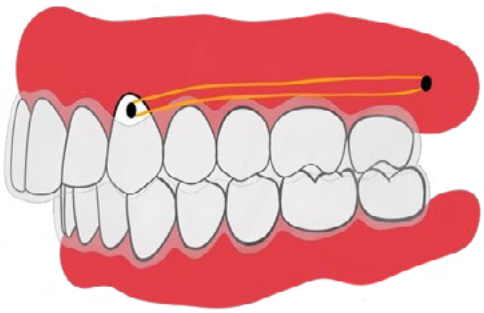

Image 1. Class II malocclusion corrected with clear aligners with precision cutouts in conjunction with TADs. Image by AleyaSteckel

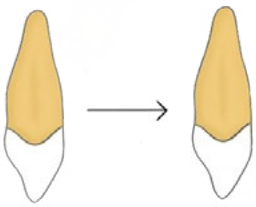

Image 2. Treatment with clear aligners resulting in bodily movement. Image by AleyaSteckel

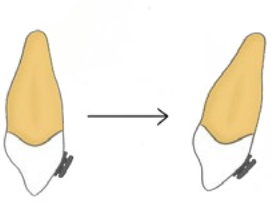

Image 3. Treatment with traditional metal brackets resulting in lingual tipping. Image by AleyaSteckel

Results/conclusion. Both dental arches were distalized approximately 3.0 mm after one year of treatment. The application of elastics from the TADs to the precision cutouts of the clear aligners was successful and the coverage prevented molar extrusion.

Validity/applicability. This is a case report without a control sample and may be subject to selection bias. Provided it is an observational study, the results may not be applicable to the general population.

Level of evidence. Level 5—Case study

Case significance

- Clear aligners offer an esthetic treatment option while producing similar long-term results as traditional fixed orthodontic appliances.
- TADs provide the ability to minimize unwanted reciprocal forces using skeletal anchorage. In addition, using TADs may reduce patient compliance issues when compared to Class II elastics.
- While TADS in conjunction with clear aligners are a viable treatment option for maxillary arch distalization, treatment success is dependent on patient selection, TAD design and location, and quality of alveolar bone.

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The impact of *F. nucleatum* modulation on colorectal cancer treatment

Daniel Kim and Daniel Chen
Mentor: Justin Merritt, Ph.D.

Background

Colorectal cancer, or CRC, comprises a complex mixture of malignant cells, non-transformed cells and microbes. CRC tissues develop unique microbiota, distinct from the surrounding colorectal microbiota, and recent studies have highlighted the importance of the microbes in the pathogenesis and treatment response of CRC. *Fusobacterium nucleatum*, or Fn, a common opportunistic bacteria of the oral cavity, is enriched in CRC tumors. An ongoing body of literature has shed light on its extensive relationship with CRC, affecting everything from initiation, progression, treatment outcomes and metastasis. The forefront of this line of research is improving the disease prognosis of CRC through the modulation of Fn in oral and gut microbiota. This caseCAT attempts to summarize the current studies regarding CRC and *F. nucleatum* to answer whether the manipulation of microbiota can potentially be considered as a treatment option for the disease.

Clinical question

Could the modulation of *F. nucleatum* lead to a better prognosis of colorectal cancer compared to a regular colorectal cancer case?

POPULATION
Patients with colorectal cancer

INTERVENTION
Modulation of *F. nucleatum* levels

COMPARISON
No changes to *F. nucleatum* levels

OUTCOME
Significant improvement in prognosis of colorectal cancer

Evidence search strategy

MeSH terms:

- Oral, microbiome
- Colorectal cancer
- Antibiotics
- *Fusobacterium nucleatum*
- Chemoresistance

CAT 1

Article Title. A prospective interventional trial on the effect of periodontal treatment on *Fusobacterium nucleatum* abundance in patients with colorectal tumors[1]
Authors. Yoshihara, T., et al.
Published. December, 2021

Methods. Twenty-seven patients were included in the study. They were diagnosed with colorectal cancer and periodontitis. Saliva, stool and colorectal tumor samples were collected for analysis. Patients were treated for periodontitis with scaling and root planning. They were grouped in improvement and non-improvement groups based on their treatment outcome. Bacterial analysis was performed to measure the abundance of Fn in saliva and stool, and the samples were compared pre- and post-treatment.

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Results. The results found that there was a statistically significant reduction in Fn levels in gut tissue and stool for the improvement group, while the non-improvement group saw no significant difference in Fn levels. The Fn levels in saliva samples remained unaffected before and after treatment.

Validity. This study is limited due to its small sample size, and there was no randomized control in the experiment design. The study also was limited to patients with non-advanced CRC.

Level of evidence. Level 2—Quasi-experimental study

CAT 2

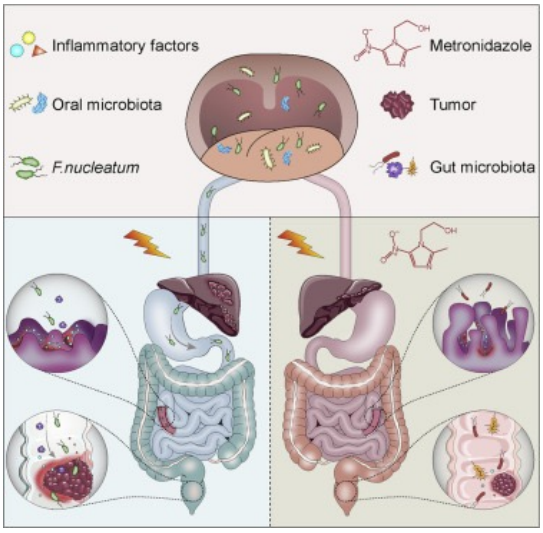
Article Title. Effects of metronidazole on colorectal cancer occurrence and colorectal cancer liver metastases by regulating *Fusobacterium nucleatum* in mice[2]
Authors. Wang, M., et al.
Published. November, 2023

Methods. Colorectal cancer, or CRC, and colorectal cancer live metastasis, or CRLM, mice model established using Male BALB/c mice injected intraperitoneally with Mouse CRC cell line CT26 (from ATCC). Mice were randomly assigned to groups with different combinations of treatments, including metronidazole administration and total abdominal irradiation. Tumor and liver tissues were separated, and volume and weight changes were measured. Hematoxylin-eosin was utilized to stain liver tissue to measure metastatic liver nodules. Immunohistochemistry/high throughput 16S rNA gene sequencing was used to detect Ki67 protein levels in the stool.

Results. The DAI and Fn DNA relative expression in feces and anal swabs of the CRC and CRLM groups were raised and repressed after MNZ intervention. MNZ repressed tumor occurrence and growth in mice to a certain extent, alleviated CRLM malignant degree (reduced liver metastases and Ki67-positive cell density/number) and suppressed CRC liver metastasis by regulating intestinal flora structure, which affected the intestinal characteristic flora of CRC and CRLM mice.

Validity. This is a study conducted on a mouse model and thus cannot be generalized to human cases. Treatment methods were not as efficient and precise as in humans due to the relative size of mice subjects.

Level of evidence. Level 1—Experimental study



Presence of *F. nucleatum* leads to worse prognosis and chemotherapy resistance. Modulation of *F. nucleatum* through the usage of metronidazole and oral microbiome transplant was shown to ameliorate the adverse effects to a certain degree (Dong, J., et al., 2021).

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CAT 3

Article Title. Oral microbiota affects the efficacy and prognosis of colorectal cancer in mouse models[3]
Authors. Dong, J., et al.
Published. October, 2021

Methods. Colorectal cancer, or CRC, was induced in C57BL/6J mice using azoxymethane and dextran sodium sulfate. Mice were randomly sorted into six groups receiving various combinations of treatments, including total abdominal irradiation, oral microbiota transplant and metronidazole administration. Bacterial analysis was conducted using DNA from fecal and oral samples. Prognosis after radiotherapy was assessed by monitoring body weight and inflammatory cytokine expression.

Results/conclusion. Bacterial analysis showed significantly elevated levels of *F. nucleatum* in CRC mice. Oral introduction of Fn to CRC mice led to a decreased treatment efficacy following TAI, suggesting that Fn can originate from the oral microbiota and be enriched in the gut. Metronidazole administration reduced the relative abundance of Fn in the gut. It also reduced the number and size of tumor compared to the control group.

Validity. This is a study conducted on a mouse model and thus cannot be generalized to human cases. Treatment methods were not as efficient and precise as in humans due to the relative size of mice subjects.

Level of evidence. Level 1—Experimental study

Case significance

- Recent discoveries linking *Fusobacterium nucleatum* to colorectal cancer tumors suggest that modulation of the microbiome found within these tumors could be a potential avenue to explore as a treatment option for colorectal cancer.
- More clinical studies are needed to evaluate the value and reliability of different antibiotics to treat and prevent colorectal cancer.
- The connection between oral and gut microbiota opens the door for dentists to become involved in the prevention of colorectal cancer.

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Effectiveness of near-infrared light photodynamic therapy on oral cancer cells

Jinhao Cui[1], Tomoharu Okamura,[1] D.D.S., Ph.D., Chihoko Ikeda,[1] D.D.S., Ph.D., Kazuya Tominaga,[1] D.D.S., Ph.D., Akio Tanaka,[2] D.D.S., Ph.D.
[1]Department of Oral Pathology,
[2]Department of Pathology, Osaka Dental University, Osaka, Japan

ABSTRACT
Oral cancer is a common malignant cancer, which is difficult to treat with traditional methods. Photodynamic therapy is a new alternative that is gaining widespread attention. We investigated the therapeutic effectiveness against oral cancer cells, and the mechanism of action of near-infrared photodynamic therapy (NIR-PDT) combined with the photosensitizer Chlorin e6 (Ce6) and up-conversion nanoparticles NaYF4:Yb/Er (UCNPs).

Introduction/objectives

Oral cancer is a common head and neck cancer with more than 300,000 cases worldwide each year.[1] Photodynamic therapy, or PDT, is a new means of diagnosing and treating this disease. It kills cancer cells by generating reactive oxygen species, or ROS, through the combination of light and a photosensitizer, or PS, and causes a series of oxidative stress reactions.[2] The light source used in this study was NIR at 980 nm. NaYF4:Yb/Er is a typical up-conversion nanoparticle that can convert long-wave radiation to short-wave radiation.[3] Ce6, a second-generation photosensitizer, is used in many diseases other than cancer.[4] The combined use of the two can produce better results under NIR conditions. We investigated the optimal combination for the concentrations of these two substances for direct use without chemical bonding, and the appropriate light intensity to observe the therapeutic effects.

Materials/methods

Adjustment of Ce6-UCNPs concentration.
[Ce6] 100mg was added to 1mL of FBS(-)high glucose DMEM and adjusted to 0.1, 0.5, 1.0, 10.0, 100.0 ng/μl.

[UCNPs] 10mg was added to 1 ml of distilled water and adjusted to 0.1, 1.0, 10.0, and 100.0 ng/μl by PBS.

Cell experiments. The human oral squamous carcinoma cells 3 (HSC-3 cells) were seeded in microplates. The next day, the culture medium was changed by Ce6 and UCNPs. After three hours, the cells were irradiated with NIR-PDT (0.5 W ×10 s).

Animal experiments. HSC-3 was adjusted to 5.0 × 107 cells/ml with Hank's buffer, and 0.05 ml of the cell solution was injected at the right lingual border at BALB/c nu/nu 8 mice. Ce6(100 μg/10 g BW) and UCNPs(20 μg/10 g BW) were injected into the abdominal cavity of mice two weeks later, and after 40 minutes the tongue margin was irradiated with a

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dental laser (NIR-PDT: 5W×10s). The next day, the mice were euthanized Tongue tissues were extracted, and specimens were prepared by a conventional method.

Detection methods

[in vitro] MTT assay; Calcein AM assay; the production of reactive oxyge species (ROS) and intracellular singlet oxygen; Flow cytometry. [in vivo] H&E staining; apoptosis staining (TUNEL); immunohistochemistry staining (anti-cyokeratin17: CK-17).

Result/discussion

[in vitro] After combining the Ce6 and UCNPs, and treating cells with NIR, the cell survival rate was inhibited (Figure 1). The production of ROS and intracellular singlet oxygen were increased (Figure 2). Compared with the control group, apoptotic cells increased after treatment and were positive for both Annexin V and PI (Figure 3).

[in vivo] After NIR-PDT, cancer cell death and inflammatory edema response can be seen. The apoptotic staining showed that the experimental group had apoptotic cells with brown nuclei and necrotic cancer cells with brown nuclei and cytoplasm (Figure 3).

It is generally accepted that apoptotic cells maintain membrane integrity and that membrane damage is observed at the onset of necrosis. These results suggest that NIR-PDT induces apoptosis followed by necrosis in cultured cancer cells. Recent studies have shown that apoptotic cells undergo necrosis secondary to plasma membrane damage,[5] which would support the results of this study.

Conclusion

Cell proliferation was significantly inhibited when Ce6 was combined at 0.5 ng/µl and UCNPs at 0.1 ng/µl. Under the same conditions, the amount of ROS and singlet oxygen was significantly elevated. Apoptosis was also induced by NIR-PDT. In vivo, H&E and apoptosis staining was applied to thin sections, and histopathological examination revealed that atypical cells were present at the tongue margin in focal structures. Immunohistochemistry using an anti-cyokeratin17 antibody can be used for standard pathologic diagnosis. After staining, cancerous tissue appears brown. NIR-PDT with Ce6 and UCNPs was able to destroy a part of the tongue carcinoma. These results suggest that NIR-PDT combined Ce6-UCNPs is useful in the treatment of oral cancer cells.

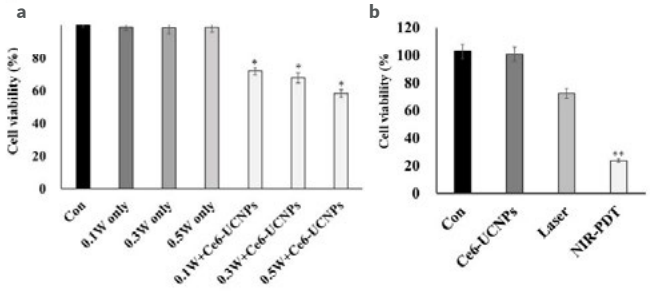

Figure 1a. Effect of different laser intensities on cell proliferation. Cell viability decreased with increasing light intensity. **b.** After NIR-PDT, percentage of viable cells decreased.(Ex490nm; Em515nm). *: p<0.05 **: p<0.01

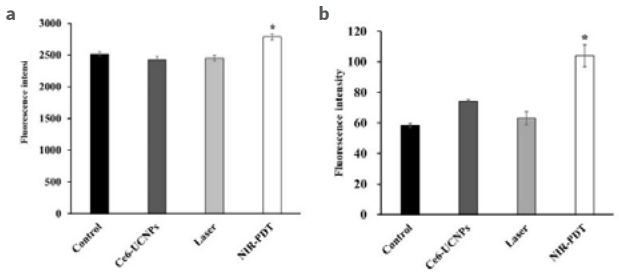

Figure 2. After NIR-PDT, fluorescence intensity of test group was increased. (**a.** ROS: Ex 490-520nm; Em510-540nm; **b.** Singlet Oxygen: Ex 490-520nm; Em510-540nm). *: p<0.05

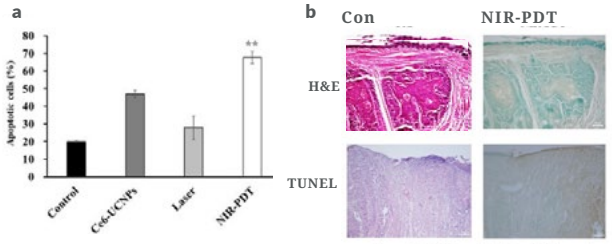

Figure 3a. Apoptotic HSC-3 cells were increased.*: p<0.05_ **b.** Cancer cell death and inflammatory edema response can be seen. The apoptotic staining showed that the apoptotic cells with brown nuclei and necrotic cancer cells with brown nuclei and cytoplasm. (Scale bar: 100µm)

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Resveratrol regulates *fusobacterium nucleatum*-induced epithelial-mesenchymal transition in cancer cells

Jie Min, Hiroki Takigawa, D.D.S., Ph.D., Yugo Maruyama, Ph.D., Takayuki Numbu, Ph.D., Chiho Mashimo, Ph.D., Toshinori Okinaga, D.D.S., Ph.D.
Department of Microbiology, Osaka Dental University, Osaka, Japan

Introduction/objectives

Fusobacterium nucleatum, or F. nucleatum, is an anaerobic oral opportunistic pathogen associated with periodontitis and thought to be relevant the development of oral squamous cell carcinoma, or OSCC. It has been reported that the initial host molecular alterations induced by *F. nucleatum* infection may promote predisposition to malignant transformation through epithelial-mesenchymal transition, or EMT.[1]

Resveratrol (trans-3,4,5-trihydroxystilbene) is a type of polyphenol that can regulate human lipid metabolism, inhibit platelet aggregation, protect cardiovascular tissue, and have anti-inflammatory and antioxidant effects.[2] Accumulating evidence shows resveratrol can reverse EMT and inhibit invasion and migration of human tumors via diverse mechanisms and signaling pathways.

In the present study, we monitored the ability of *F. nucleatum* to induce EMT. EMT transcription factor SNAIL was upregulated, while E-cadherin (CDH1) was decreased. Moreover, resveratrol mitigated cell migration caused by *F. nucleatum* in the OSCC cells.

Therefore, our study demonstrated that *F. nucleatum* could trigger EMT, and resveratrol may prevent the effect of F. nucleatum in OSCC cell line HSC-3.

Materials/methods

HSC-3. JCRB0623, human oral squamous carcinoma cell line.

THP-1. Human cell line derived from acute monocytic leukemia.

Resveratrol. FUJIFILM Wako Pure Chemical Corporation, 10μM in 99.5% ethanol for study.
Fusobacterium nucleatum animalis JCM11025
Fusobacterium nucleatum nucleatum JCM8532
Fusobacterium nucleatum polymorphum JCM12990
Fusobacterium nucleatum vincentii JCM11023

ABSTRACT

Fusobacterium nucleatum, or F. nucleatum, an anaerobic opportunistic pathogen implicated in various periodontal diseases, is believed to be involved in oral squamous cell carcinoma, or OSCC development. OSCC is characterized by the infiltration of tumors, spread to lymph nodes and a high rate of local recurrence, leading to poor patient outcomes and high mortality, profoundly affecting human health and the quality of life. The latest opinion is that alterations in host molecules linked to *F. nucleatum* could potentially contribute to the tendency toward malignant transformation by promoting epithelial-mesenchymal transition, or EMT. EMT can confer multiple malignant characteristics to cancer cells. Resveratrol is a naturally occurring phytoalexin synthesized by plants that has shown antitumor effects through multiple mechanisms. Although resveratrol inhibits EMT in many types of cancer, its impact on EMT associated with *F. nucleatum* in OSCC remains unclear. This study aimed to examine the role of the natural plant compound resveratrol in *F. nucleatum*-induced EMT of OSCC cells.

Results

We conducted a wound-healing assay to confirm the impact of resveratrol on *F. nucleatum*-induced EMT in HSC-3 cells. Light microscopy was employed to capture the appearance of the wound. The gaps in the *F. nucleatum* co-culture group were nearly completely closed after 24 hours, smaller than those in the control group, whereas resveratrol delayed gap healing (Figure 1).

Following a 24-hour co-culture with *F. nucleatum*, mRNA expression levels of EMT transcription factor SNAIL increased and the epithelial marker CDH1 decreased in the HSC-3 cells (Figure 2a). Western blotting demonstrated that the simultaneous addition of resveratrol to *F. nucleatum* co-culture reduced the expression of EMT-TF SNAIL and induced the expression of CDH1 (Figure 2b).

Conclusion/future studies

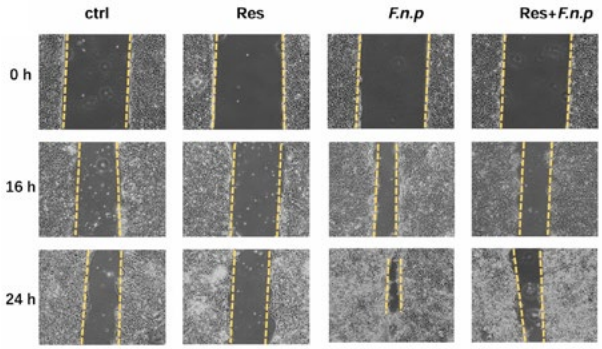

Figure 1. Cell migration was evaluated by scratch assay.

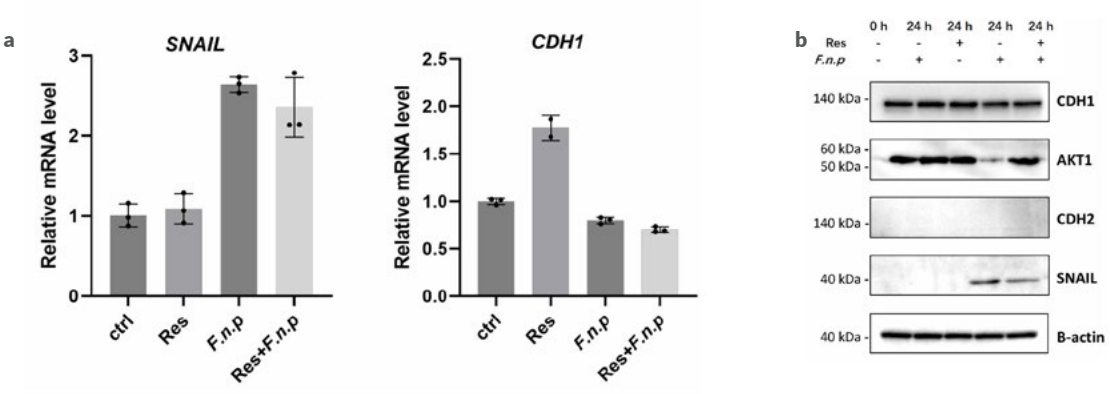

Figure 2. The mRNA and protein expressions of EMT markers. HSC-3 cells were co-cultured with resveratrol and F. nucleatum. (**a**) Co-cultured 24 h samples using the $2^{-\Delta\Delta}$CT method to analyze the relative mRNA expression data. (**b**) Western blotting of the protein expression levels.

Oral squamous cell carcinoma represents the predominant type of oral cancer and accounts for most cases. The prognosis of patients diagnosed with OSCC is notably poor, with a five-year survival rate of less than 50%. Over the past few decades, extensive research has highlighted the potent biological activities of natural compounds derived from medicinal herbs against a wide range of tumors. Our results provide preliminary evidence that resveratrol inhibits *F. nucleatum*-induced EMT in OSCC cells (Figure 3). Further studies could significantly contribute to the development of therapeutic or preventive methods for oral cancer. In vivo experiments could further substantiate our findings, providing a more comprehensive picture. Additionally, exploring the mechanism by which resveratrol impairs *F. nucleatum*-induced EMT is crucial.

References

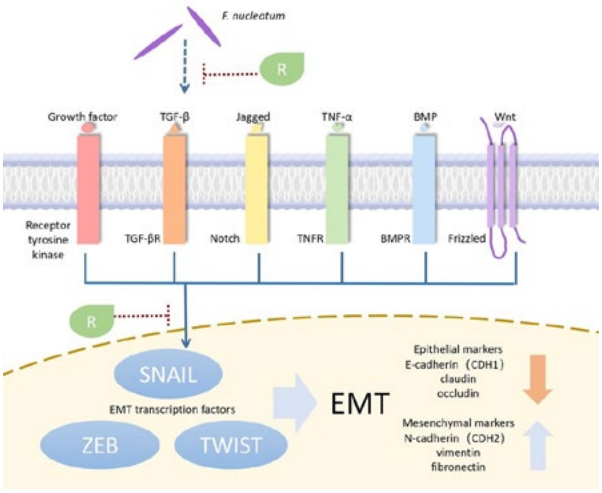

Figure 3. Our study highlights that resveratrol has an inhibitory effect on *F. nucleatum*-induced EMT in OSCC cells, and further studies may contribute to provide therapeutic or preventative methods for oral cancers.

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Fusobacterium nucleatum drives tumor-associated macrophage-like cells in an engineered oral squamous cell carcinoma on-a-chip

Mauricio Gonçalves da Costa Sousa, D.D.S.,M.S.,Ph.D.,[1,5] May Anny Alves Fraga,[1,5] Avathamsa Athirasala, B.S.E.,M.S.,[1,4,5] Dustin Higashi,[5,6] Justin Merritt, Ph.D.,[5,6] Luiz Eduardo Bertassoni, D.D.S., Ph.D.[1,2,3,4,5]

[1]Knight Cancer Precision Biofabrication Hub, Cancer Early Detection Advanced Research (CEDAR), Knight Cancer Institute, OHSU

[2]Division of Oncological Sciences, Knight Cancer Institute, OHSU

[3]Center for Regenerative Medicine, School of Medicine, OHSU

[4]Department of Biomedical Engineering, School of Medicine, OHSU

[5]Department of Oral Rehabilitation and Biosciences, School of Dentistry, OHSU

[6]Department of Molecular Microbiology and Immunology, OSHU

Introduction

Oral squamous cell carcinoma or OSCC is the sixth most prevalent cancer, representing 90% of all head and neck cancers.[1] Oral cancers are expected to cause more than 12000 deaths in the US in 2024.[2] OSCC comprises a complex microenvironment involving a 3D collagenous matrix, innate and adaptative immune cells, fibroblasts, and opportunistic microorganisms.[3,4] *Fusobacterium nucleatum*, for instance, is related to OSCC development in different aspects, such as inducing epithelial-to-mesenchymal transition and coordinating the immunological response in the tumor microenvironment (TME).[5] Although some advances were achieved in understanding the OSCC TME, there is an urge to develop advanced in vitro models to investigate the immunosuppressive role of opportunistic microorganisms in OSCCs. Offering a promising avenue for studying OSCCs, organs-on-a-chip serve as microphysiological platforms that closely emulate the complexities of biological tissues within the highly controllable microfluidic, cellular communication, and extracellular matrix.[6] Here, we developed an OSCC on-a-chip to understand the immunomodulatory profile of *F. nucleatum* on macrophages in the TME.

ABSTRACT

Tumor-resident microbes such as *Fusobacterium nucleatum* (Fn) are linked directly with the oral squamous cell carcinoma or OSCC tumor microenvironment (TME). Although advances were achieved in understanding OSCCs, the role of this microorganism in immune cells in the TME is still not completely elucidated. Here, we developed an OSCC on-a-chip to understand the immunomodulatory profile of *Fn* on macrophages in the OSCC TME. In the presence or absence of *Fn* heat-killed antigens, we cultivated oral squamous carcinoma cells in 3D in a collagen matrix in a polydimethylsiloxane microfluidic device. Macrophages were added in the lateral channel to evaluate their chemoattraction to the 3D matrix and profile. We noticed that macrophages in groups containing *Fn* expressed higher markers (CD163) and cytokines (TNF-α, MCP-1, IL-6, VEGF, and CCL5) compatible with tumor-associated macrophage-like cells. These results enable us to understand how the early interactions between opportunistic microorganisms and the immune system modulate the responses in the TME.

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Materials/methods

We cultivated oral squamous carcinoma cells in 3D in a collagen matrix (2.5 mg/mL) in a microfluidic polydimethylsiloxane or PDMS device that has a central chamber (1mm in width) and two lateral channels connected by triangular pillars (space between pillars of 115 µm). Our tested groups were collagen matrix containing OSCC (5.10^5 cells/mL) in the presence or absence of heat-killed antigens (1.10^6 CFUs/mL) from *F. nucleatum* (ATCC 23726). *F. nucleatum cells* were integrated with collagen gels and oral squamous carcinoma cells for three days. On the fourth day, we added 2.10^3 THP-1 derived macrophages (differentiated with PMA 100 ng/mL) in the lateral channel to evaluate their chemoattraction to the 3D matrix in the presence or absence of *F. nucleatum* for 48 hours (Figure 1).

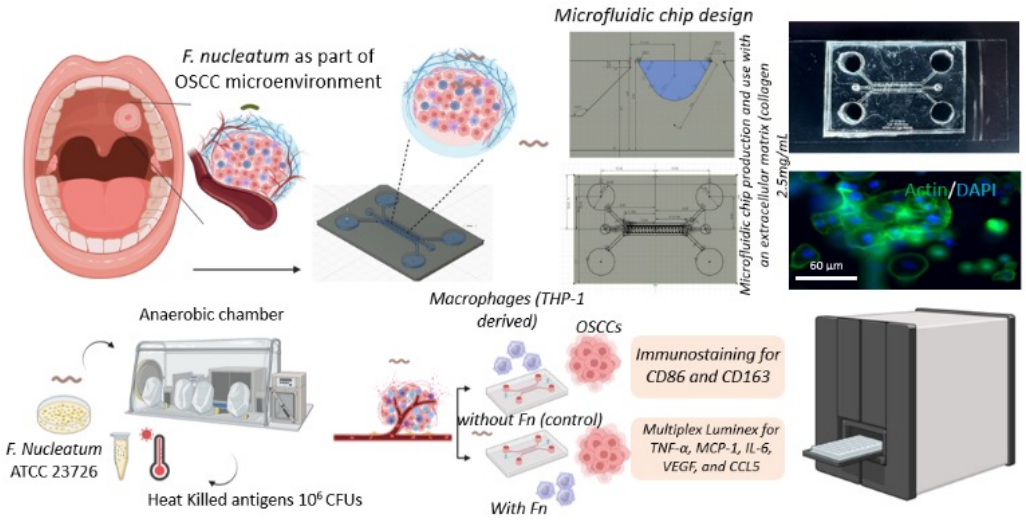

Figure 1. Setting the oral squamous cell carcinoma on a chip. Oral squamous cells are cultivated in a 3D collagen matrix in a PDMS chip with a central chamber connected to two channels. The oral squamous cell carcinoma on-a-chip was treated or not with F. nucleatum heat-killed antigens. Macrophages were added to the system and were characterized after three days by immunostaining or multiplex Luminex.

Results

We noticed a significantly higher number of macrophages invading the 3D matrices that had heat-killed antigens when compared to the groups containing just OSSCs (Figure 2A-D). By immunofluorescence, we stained the cells with markers for M1 (CD86) and M2 (CD163) and observed a significantly lower number of CD86 and a higher number of CD163-positive cells in the *F. nucleatum* stimulated group (Figure 2E-L). When cytokines and chemokines were measured from these chips by Luminex assay, we found that the presence of heat-killed bacteria upregulated TNF-α, MCP-1, IL-6, VEGF, and CCL5 significantly, showing that the presence of *F.nucleatum* might stimulate tumor-associated macrophages-like cells (Figure 2M-T). These results enable us to understand how the early interactions between opportunistic microorganisms and the immune system modulate the suppression responses in the tumor microenvironment.

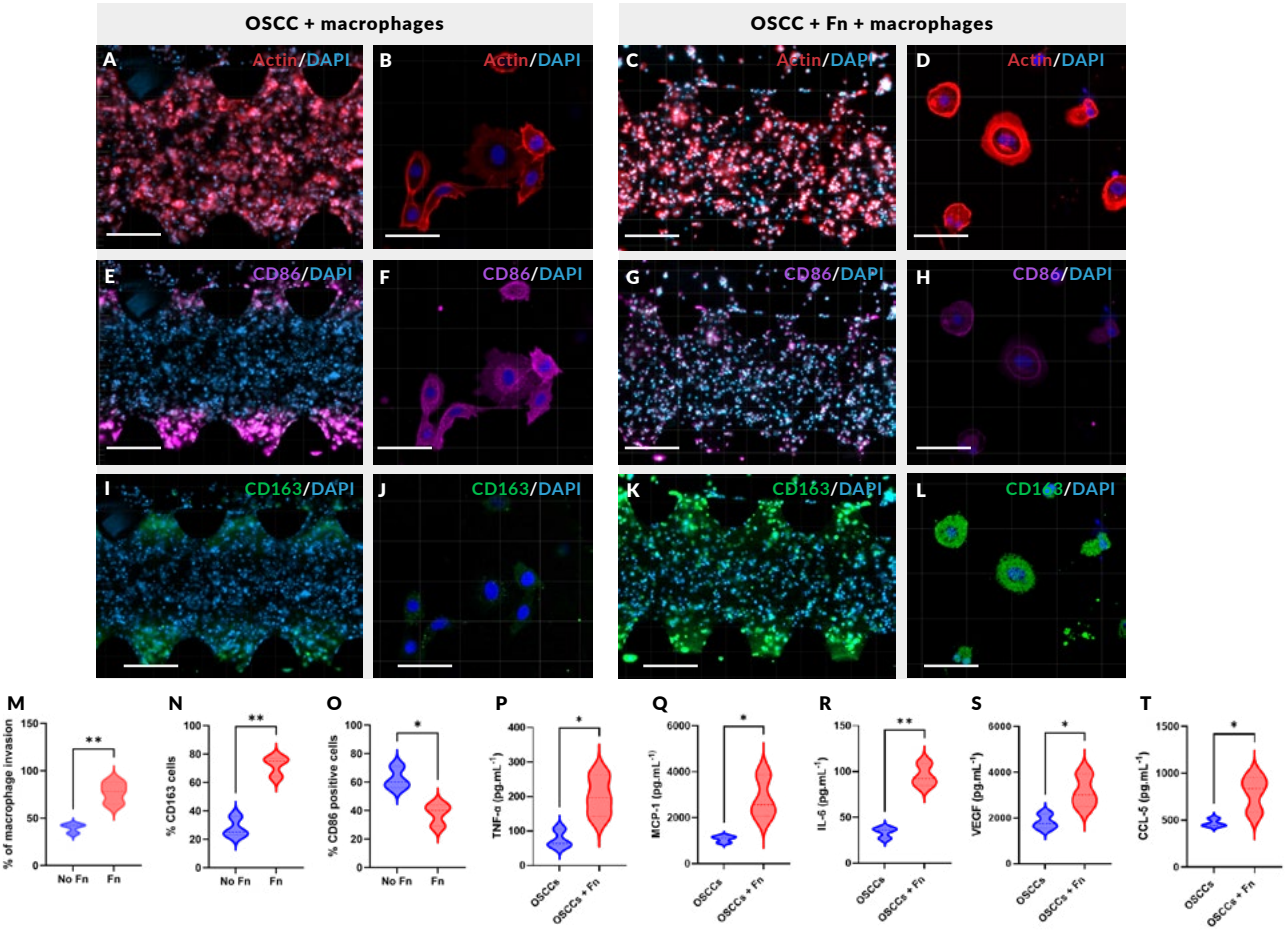

Figure 2. Interaction of macrophages with OCCs and *F. nucleatum* antigens in a microfluidic device containing a collagen extracellular matrix (2.5 mg/mL) stimulates M2 profile. In (A-L) cells were stained with actin, CD86 (M1), CD163 (M2), and DAPI. Scale bars in A, C, E, G, I, and K represent 400 µm while scale bars in B, D, F, H, J, and L represent 30 µm. M-O represents the average percentage of migrated macrophages and their profile M1 or M2, from three biological replicates. Images were quantified by ImageJ. P-T represents the average production of different cytokines and chemokines in pg/mL from the supernatants of the 3D matrix with OSCCs stimulated or not with *F. nucleatum* from three different replicates. Statistical differences in M-T are represented by * $p < 0.05$ and ** $p < 0.01$ after a t-test.

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Conclusion

These results enable us to understand how the early interactions between opportunistic microorganisms and the immune system modulate the suppression responses in the tumor microenvironment. In the next steps, we want to use live bacteria and personalized patient-derived samples, to identify mechanisms associated with the regulatory role of critical cells such as Tregs and tumor-associated macrophages in oral squamous cell carcinoma.

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Self-sterilizing surfaces using quaternary ammonium methacrylates and its zwitterion

Peter Nguyen, Fernanda Sandes de Lucena, D.D.S., M.S.,Ph.D., Steven Lewis, B.S., M.S., Matthew Logan, B.S., M.S., Carmem Pfeifer, D.D.S., Ph.D.
Department of Oral Rehabilitation and Biosciences, Biomaterial and Biomedical Sciences Division, Pfeifer Lab, School of Dentistry, OHSU

Introduction/objectives

Direct restorations using a self-sterilizing resin composite that prevents the formation of secondary caries would have increased longevity. Carboxybetaine methacrylate (CB-MA) is a monomer that switches between an antimicrobial cationic ring (QAM) and its antifouling linear zwitterion (ZWIT) (Figure 1). Previous research in the Pfeifer Lab has shown that increased CB-MA substituents can upshift pH at which the QAM-ZWIT switch occurs (Figure 2). The goal of this project was to decouple the role of charge concentration and side chain length on the antimicrobial effect of model QAM-ZWIT molecules.

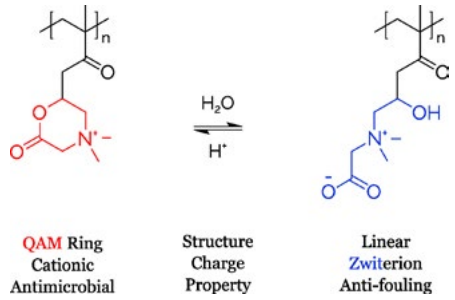

Figure 1. Carboxybetaine methacrylate's QAM and ZWIT form.[1]

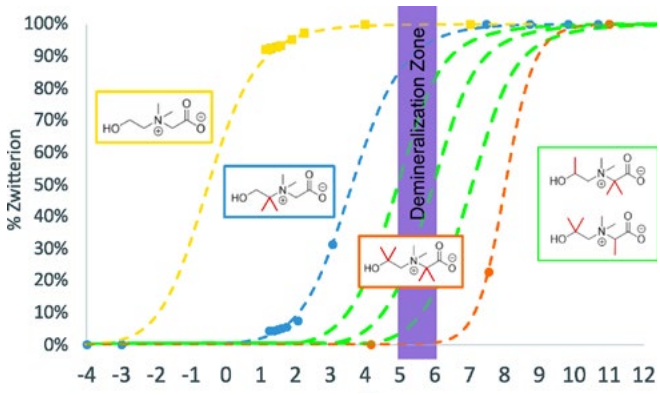

Figure 2. Carboxybetaine methacrylate with increasing substitutions.[2]

ABSTRACT

Carboxybetaine methacrylates (CB-MA) are monomers that can be utilized to create pH-sensitive resin composites. The primary objective was to verify that its antimicrobial property is independent of charge concentration and side chain length. *S. mutans* biofilm was grown on resin composite discs in static equilibrium of CB-MA's antimicrobial form (QAM) and its antifouling form. Biological assays showed decreased supernatant bacteria viability and surface biofilm mass as the percentage of QAM increased.

Materials/methods

A static CB-MA equilibrium was created with resin composite discs of 6% mass weight QAM and ZWIT at different mol ratios (0:100, 20:80, 40:60, 60:40, 80:20, 100:0; n = 6). Degree of conversion was assessed with FT-IR. Hydrophilic character of the surface was measured with contact angle experiments. *S. mutans* biofilm was grown on the discs for six hours in a 5% CO2 incubator. Supernatant bacteria levels were measured using planktonic optical density before being used to test bacteria viability with colony forming units. Disc-surface biofilm was measured using biofilm optical density, and a luciferase assay was used to measure metabolism. Finally, a crystal violet assay was used to quantify biomass. Data were analyzed with one-way ANOVA/Tukey's test (alpha=5).

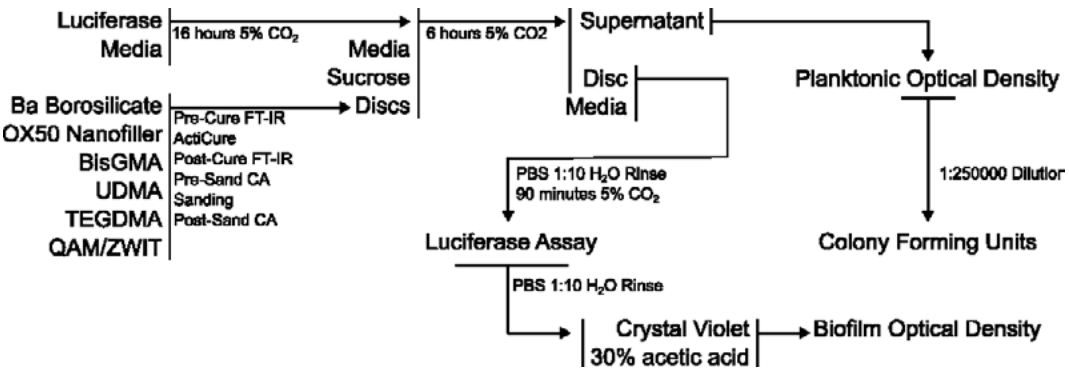

Figure 3. A summary of this project's methods.

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Results

The addition of QAM and ZWIT did not significantly affect the degree of conversion (Figure 4a) or the contact angle (Figure 4b). There was no significant difference in supernatant bacteria levels (Figure 5a), but the bacterial viability significantly decreased as QAM increased (Figure 5b). The bacteria on the discs showed no difference in metabolism (Figure 5c) even though there was significantly less biomass (Figure 5d & 6).

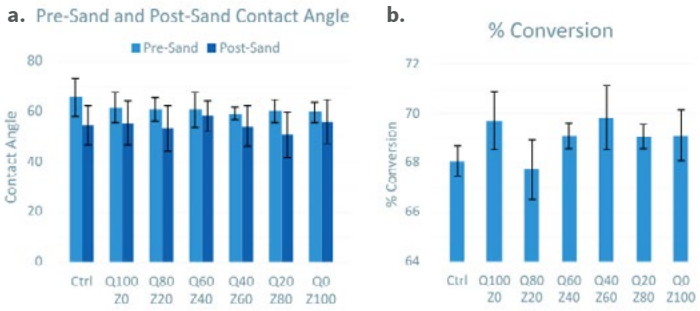

Figure 4a. Percent conversion was assessed using FT-IR before and after photocuring. There was no significant change in percent conversion between samples. **b.** Contact angle was used to measure hydrophilic character on the surface. There was no significant change in contact angle between sanding or samples.

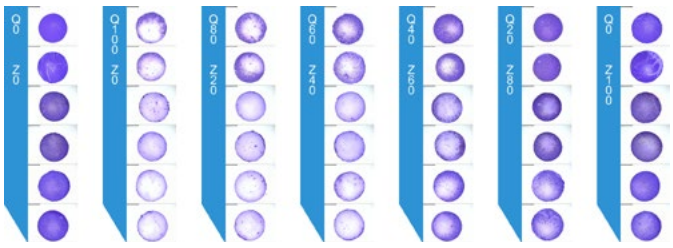

Figure 6. A crystal violet dye can be used stain attached biomass on the surface of the resin composite discs purple. As %QAM (Q%) increases, the amount of attached biofilm appears to decrease.

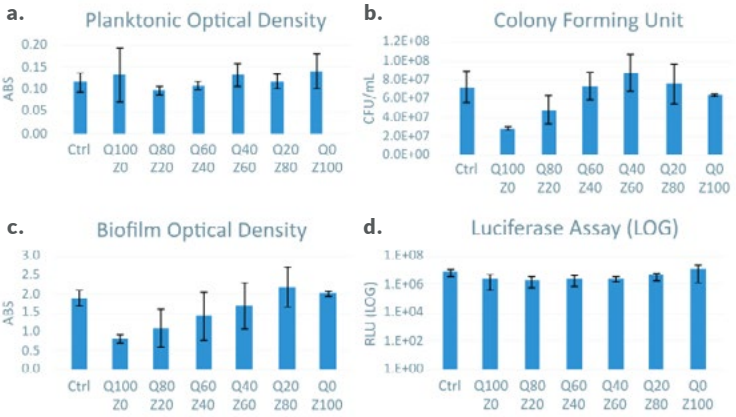

Figure 5a. Planktonic optical density measures the amount of biomass present in the supernatant. There was no significant difference in supernatant biomass between samples. **b.** Colony forming units measure the viability of bacteria present in the supernatant. Dilution Factor: 1:250000. There was a significant decrease in supernatant bacteria viability as %QAM increased. **c.** Biofilm optical density measures the amount of biomass present on the surface of the discs. There was a significant decrease in surface biomass as %QAM increased. **d.** Luciferase assay measures the viability of bacteria present on the surface of the disc. There was no significant difference in surface bacteria viability between samples.

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Conclusion/future studies

The results provide a starting point to determining the minimum percentage by mass weight of QAM required for an antimicrobial resin composite surface. A fluorescein assay combined with UV-vis spectroscopy will be used to measure how much of the QAM is on the surface of each resin composite disc (Figure 7a). An impingement test will be used to measure biofilm removed by water to correlate it to attachment strength (Figure 7b). Ultimately, the goal of this investigation is to design smart, pH-sensitive switching materials to maximize anti-biofilm potential in restorative applications.

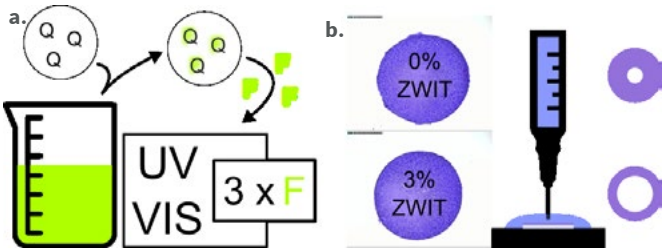

Figure 7a. An illustration of a fluorescein assay. **b.** Examples of a 0% ZWIT and 3% ZWIT resin composite disc after a crystal violet assay. An impingement test using the illustrated apparatus will help determine attachment strength.

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YouTube as a learning tool in dental education: student and faculty perspectives

Marina Youssef, Despoina Bompolaki, D.D.S., M.S., FACP, and Christina Truong, D.M.D.
Department of Oral Rehabilitation and Biosciences, Restorative Dentistry Division, School of Dentistry, OHSU

Introduction

Online video sharing platforms have become integral parts of students' daily lives, providing a vast array of information and serves as educational resources.[1,3,4,11,15-17] Dental students often turn to these popular portals to supplement their education, seeking to acquire new skills or gain a deeper understanding of concepts covered in their restorative and foundation courses.[2] The purpose of this study was to assess the usage of the most popular online video sharing platform (YouTube)[14] among predoctoral dental students, as well as present student and faculty perspectives on using YouTube as an adjunct of their preclinical and clinical education.

Materials/methods

Electronic surveys (Qualtrics) were distributed to all predoctoral dental students (DS1 and DS4) and full-time faculty members at the Oregon Health & Science University School of Dentistry. Participation in the survey was voluntary and anonymous. Before distributing the surveys to the entire sample, a pilot study was performed (including eight predoctoral students and two part-time faculty), to increase and confirm survey validity and reliability. Those invited to participate in the pilot study did not take part in the final study. Data collected through the surveys were analyzed using SPSS Statistics.

Results/discussion

After the pilot study, 76 full-time faculty members and 283 predoctoral students were invited to participate. In the end, 39 faculty members (20 males, 19 females) and 42 students (26 males, 15 females, 1 other) completed the survey for a 51.3% and 14.8% response rate respectively. Overall response rate was 22.6%.

ABSTRACT

The increase in popularity and accessibility of online video sharing platforms such as YouTube, has led dental students to use them as supplemental learning resources.[11,14-17] The objective of this study was to evaluate the role of YouTube in dental education for faculty and students and its potential effectiveness as an adjunct educational tool. Data were collected from all years of predoctoral dental students and all full-time faculty member via an anonymous, multiple choice Qualtrics survey. Descriptive and quantitative analyses were performed. Majority of faculty (79.5%) and students (88.1%) visit YouTube at least once weekly. A very small percentage (2.6%) of faculty, as opposed to a larger percentage of students (26.2%), stated they use YouTube to watch educational videos related to dentistry ($p = 0.002$). Faculty are more likely to recommend specific YouTube videos to students during preclinical education (first and second year), but less likely to do so during clinical education (third and fourth year). Most faculty and students stated that the ideal duration of an educational video is ten minutes or less. Overall, faculty had a worse perception of YouTube as an educational tool, as compared to students. Given the widespread use of YouTube for educational purposes, this study is significant in assessing its effectiveness as a learning resource in dental education. However, a creation of more peer-reviewed, reliable content on YouTube by dental educators is needed to enhance the quality of information available to public access globally.

The majority of faculty respondents (84.6%) had been in practice for more than 10 years. 23.1% stated they have never used YouTube to find information on clinical procedures.

Most faculty (79.5%) agreed that YouTube videos can be a helpful adjunct educational tool, whereas 10.3% disagreed and 10.3% were neutral. All student respondents (100%) agreed that YouTube videos can be a helpful adjunct educational tool, with 69% of them being in strong agreement with this statement.

Students stated they primarily prepare for clinical procedures by reviewing relevant course lecture handouts, consulting with peers experienced in the procedure, and watching related YouTube videos. The majority of student respondents (92.9%) stated they were likely to watch a YouTube video to prepare for a procedure they have never done before. 71.8% of faculty agreed that students would benefit by watching a YouTube video to prepare for a dental procedure they have never performed before, whereas 12.9% disagreed.

When faculty members were asked what types of clinical procedures students would benefit most from watching on YouTube, fixed prosthodontics was selected most frequently (n=30) and pediatric dentistry was selected least frequently (n=22). When students were asked the types of clinical procedures they prepare for by watching YouTube videos, operative dentistry was selected most frequently (n=34) and pediatric dentistry and radiographic acquisition and interpretation were selected least frequently (n=6).

59% of faculty have never recommended the use of YouTube videos for student learning, as it relates to clinical procedures. However, 61.5% of faculty agreed that dental school faculty should be recommending specific YouTube videos to students, to enhance their learning of clinical procedures. 45.2% of students reported that dental school faculty have never recommended the use of YouTube videos for their learning as it relates to clinical procedures. However, 61.9% of the student respondents stated that dental school faculty have previously provided them with specific links for YouTube videos related to clinical procedures. 83.3% of students agreed that dental school faculty should be recommending specific YouTube videos to enhance student learning of clinical procedures.

Only 17.9% of faculty members agreed that YouTube videos on clinical procedures are evidence based; 23.1% disagreed and 59% were neutral. 59.5% of student respondents agreed that YouTube videos on clinical procedures are evidence based; 2.4% disagreed; 26.2% were neutral; and 11.9% were unsure.

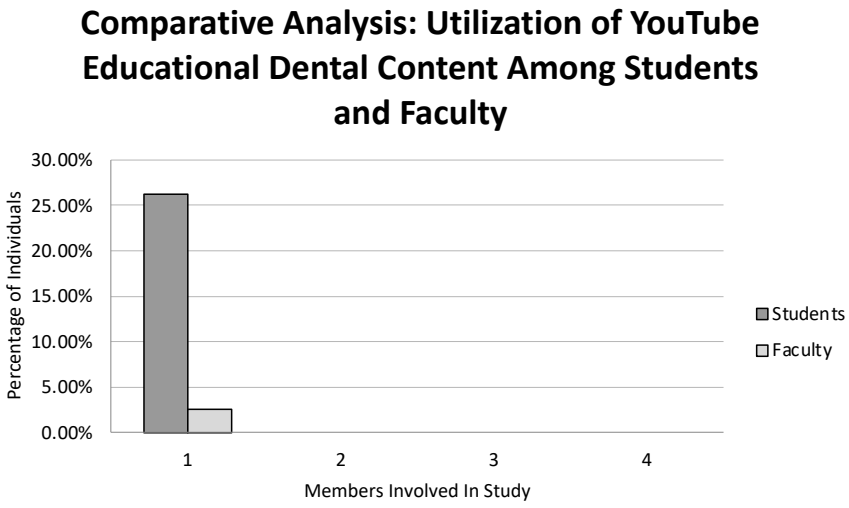
74.3% of faculty members expressed doubt regarding students' ability to accurately assess the content quality of YouTube videos on clinical procedures they had never performed. However, this percentage decreased to 25.6% for procedures students had previously executed a few times. On the other hand, the majority (73.8%) of student respondents reported that they can accurately assess the content quality of YouTube videos on clinical procedures they had never performed before; and nearly all student respondents (97.6%) reported they can accurately assess the content quality of YouTube videos on clinical procedures they had performed a few times before.

Faculty most frequently identified the consistency of the video content with the dental school courses (n=34), the vetting of the video content from themselves or another faculty member (n=25), and the technical quality of the video (n=23) as key factors in assessing the content quality of a YouTube video on a clinical procedure. Students most frequently identified the reputation of the content creator or YouTube channel (n=38), the consistency of the video content with dental school courses (n=36), and the technical quality of the video (n=31) as key factors in assessing the content quality of a YouTube video on a clinical procedure. Ninja Nerd, Mental Dental and Dr. Stevenson Dental Solutions were the YouTube channels that students most reported to have accessed during their dental education. Most students (85.7%) stated that the YouTube videos they choose to view are reflective of what they were taught in dental school.

Most faculty respondents (76.9%) and most student respondents (76.2%) stated that the most effective (viewer-friendly) for a YouTube video related to a clinical procedure was 10 minutes or less.

Most student respondents (88.1%) would like OHSU faculty to create and post their own videos on YouTube; 9.5% were unsure, and only one (2.4%) disagreed with the idea. However, only 15.4% of faculty stated they would be willing to create their own YouTube videos related to clinical procedures; about a third (33.3%) of faculty would not be willing to do so, and half of the faculty (51.3%) stated they were unsure.

In summary, the majority of faculty (79.5%) and students (88.1%) visit YouTube at least once a week. A small percentage (2.6%) of faculty, as opposed to a larger percentage of students (26.2%), stated they use YouTube to watch educational videos related to dentistry ($p = 0.002$) (Graph 1). Faculty are more likely to recommend specific YouTube videos to students during preclinical education (first and second year), but less likely to do so during clinical education (third and fourth year). Most faculty and students stated that the ideal duration of an educational video is 10 minutes or less. With easily accessible video content of limited duration, dental students can use the YouTube videos to help reduce gaps between confidence and knowledge.[6] Overall, faculty had a worse perception of YouTube as an educational tool, as compared to students. A reason for this is due to the uncertainty of the quality and resource of



Graph 1. In the study, students showed a notable engagement rate of 26.2% with YouTube educational dental content, contrasting with faculty's lower rate of 2.6%.

the information obtained online.[5, 7] Another reason may be due to bias of content uploaded by clinicians leading to potential misinformation or noncomprehensive and insufficient material.[8, 9, 12, 13, 18] If the information is from a reliable source, the findings from this study supports the potential for digital media integration to strengthen dental education.

Conclusion/future studies

Given the widespread acquisition and dissemination of dental related information on YouTube for educational purposes, this study is significant in assessing its effectiveness as an open access learning resource augment dental education. The findings of this study could significantly influence the integration of digital media in dental education, potentially leading to the development of guidelines for the use of YouTube as a supplementary educational tool.[10] It may also prompt the creation of more peer-reviewed, high-quality content on YouTube by dental educators, enhancing the quality of information available to students globally (Image 1).

Image 1. QR code above links to our inaugural YouTube dental educational video, with plans to expand the channel with additional content in the near future.

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Pages should have 1-inch margins and must be numbered consecutively throughout the document.

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Each manuscript should have a title page. The title page must include:

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- Variables are to be clearly defined and include the unit of measurement and values for any categories.
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Figures

- Each chart, graph or photograph will be counted as a separate illustration.
- Do all figures have an accompanying legend that describes the content and explains any abbreviations or symbols? Include your figure legends as a separate section in your main text file.
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- Remove any unnecessary white space around figures to reduce the file size.
- The School of Dentistry Anthology accepts digital files (see **Formats** below) of radiographs, magnetic resonance images and magnetic resonance angiograms).
- Are all figure files named with their appropriate figure number? Use only the figure number in the file name, such as Figure_1.eps
- Images are to obscure any feature that can identify the patient, including unique physical characteristics, files labeled with patient names or other identifiers.

General points for figures

- Use uniform lettering and sizing in original artwork.
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- Submit individual figure files larger than 10 MB separately.
- Include figure legends at the end of the manuscript file, not on the figure.

Formats for line art and images

Regardless of the application used to create figures, the final artwork should be saved as or converted to one of these formats:

For line art figures. Includes graphs, flowcharts, diagrams, bitmapped line drawings, scatter plots and other text-based figures that are not tables. **Important**: If a figure includes both line art and images, follow guidelines for line art.

- .EPS or PDF. When in doubt, submit a PDF.
- Resolution: 600 - 1000 dpi
- Separate, original files in their original file format are best.

Images. Includes photographs, drawings, imaging system outputs, like MRIs or ultrasounds, and similar graphical representations

- .EPS, .TIFF, .AI, PDF. When in doubt, submit a PDF.
- Resolution and color: Color or grayscale photographs (halftones). Minimum of 300 dpi
- Size: At least 80mm canvas size or 1800 pixels wide.
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Please

- Do not supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG).
- Do not supply files that are too low in resolution.
- Do not submit graphics that are disproportionately large for the content.

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This material should be submitted with each submission of the manuscript (original and revisions) to permit full review.

Manuscript style

Basic style/writing requirements

The School of Dentistry Anthology style is based on the 11th edition of the AMA Manual of Style. The purpose of any piece of writing is to deliver information. This requires authors to define their message and present it in a way that is readily understood by and engages the reader. Manuscripts should be written in active voice using declarative sentences for a clear, concise style. The overall tone of these reports should be factual and professional, and thus suitable for a scholarly journal. Authors are allowed to express a personal opinion as long as the basis for that opinion is stated plainly. For example, authors may express an opinion "based on long experience and intensive observation." Other statements of opinion and all statements of fact require references from the appropriate published literature (dental, medical, epidemiologic, practice management, etc.).

Manuscript title

The title should be brief while clearly conveying the main point or purpose of the article. Short subheads also should be used throughout the article to highlight key points. All submissions, including titles and subheads, are subject to change during the editing process.

Statistical methods reporting

Research manuscripts should include an a priori calculation of the sample size necessary to discern a minimally detectable and clinically meaningful effect and include a description of the methods used for primary and secondary analyses. A pre-specified analysis plan is preferred. Interpretation of observational studies should arise from the results of multivariable models or other methods

controlling for potential confounding effect modification and dependencies in the data. Interpretation of data from a randomized clinical trial should arise from the primary outcome measure, as analyzed in the pre-specified statistical analysis plan.

References

All published references should be cited in the text and numbered consecutively in the order in which they are referenced in the text. No references should be cited in the abstract. Each reference should be numbered only once; on subsequent citations, the original number should be used. Personal communications and unpublished data should not be numbered, but should be cited in the text as follows:

(O SoDA, D.M.D., oral communication, November 2023)

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Examples

Reference to a journal publication:
1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *J Sci Commun*. 2010;163(1):51-59. https://doi.org/10.1016/j.Sc.2010.00372

Reference to a journal publication with an article number:
2. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *Heliyon*. 2018;19:e00205. https://doi.org/10.1016/j.heliyon.2018.e00205

Reference to a book:
3. Strunk W Jr, White EB. *The Elements of Style*. 4th ed. Longman; 2000.

Reference to a chapter in an edited book:
4. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, eds. *Introduction to the Electronic Age*. E-Publishing; 2009:281-304.

Reference to a website:
5. Zika travel information. Centers for Disease Control and Prevention. January 26, 2016. Updated August 11, 2016. Accessed June 18, 2019. https://wwwnc.cdc.gov/travel/page/zika-travel-information

Reference to software:
7. Coon E, Berndt M, Jan A, et al. Advanced Terrestrial Simulator (ATS) v0.88 (Version 0.88). Zenodo; 2020, March 25. https://doi.org/10.5281/zenodo.3727209

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Journal abbreviations source

Journal names should be abbreviated according to the List of Title Word Abbreviations.

Data References

The School of Dentistry Anthology encourages authors to cite underlying or relevant data sets in the text and include a data reference in the reference list. Data references should include author names, data set title, data repository, version (where available), year and global persistent identifier. Add "[data set]" immediately before the reference so we can properly identify it as a data reference. The [data set] identifier will not appear in the published article.

Example

[data set] 5. Oguro, M, Imahiro, S, Saito, S, Nakashizuka, T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. http://dx.doi.org/10.17632/xwj98nb39r.1

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Ethical approval of studies and informed consent/assent

The School of Dentistry Anthology requires that all manuscripts reporting data from studies involving human participants, human specimens, animals or animal specimens include a description (blinded in the Methods section and in full detail on the separate title page) of formal review and approval or, if appropriate, formal review and waiver by an appropriate institutional review board or ethics committee. Authors may be asked to request that the institutional review board or ethics committee responsible for oversight of the study provide, directly to the editor, documentation of its formal review and recommendation. For investigations involving human participants, authors must state in the Methods section that study participants provided informed consent/assent.

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Author contributions

All authors are to have made substantial contributions to:

- Conceptions and designs of the study, acquisition of data or analysis and interpretation of data.
- Drafting the article or revising it critically for important intellectual content.
- Final approval of the version that is submitted.

All authors should be listed with their affiliations including positions, their academic degrees and their scientific or clinical contributions to the article. The editor and publisher reserve the right to ask for justification for each author's inclusion.

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Authors must ensure that the article describes the practical implications of the findings, answering the question, "What does this mean for oral health care?" This should be included in the abstract.

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