Spotlight on Dental Student Research

Alice Goodwin, DDS, PhD, and Kyle Jones, DDS, PhD
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Spotlight on Dental Student Research
An introduction to the issue.
Alice Goodwin, DDS, PhD, and Kyle Jones, DDS, PhD

Minimally Invasive Veneer Restorations: Effect of Restorative Material on Traumatic Impact Strength
This article discusses how modern restorative materials and adhesive techniques are capable of restoring traumatized teeth to the impact strength of natural intact teeth.
Michelle Yang, BS; Erik Balinghassay, BS; Johnny Huynh, BS; Xuehui Liu, DDS; Chunling Ge, DDS PhD; and Shane Newport White, BDentSc, MS, MA, PhD

Titanium-Oxide Nanoparticles and Nanofibers Used Alone or With UV Light Activation
This study evaluated the change in oxidation potential of synthesized TiO$_2$ nanofibers (NFs) compared to commercial TiO$_2$ nanoparticles (NPs).
Christina Chi, BA, DDS; Brittnay N. Springer, BS; Elvin Walemba, BSc, MRes, PhDc; Kevin E. Nick, PhD; Christopher C. Perry, PhD; and So Ran Kwon, DDS, MS, PhD, MS

Clinical and Microbial Changes in Orthodontic Patients Using Clear Aligners Vs. Fixed Appliances
This pilot study investigated the clinical and microbial changes that occur in patients undergoing orthodontic treatment using fixed appliances and clear aligners.
Joseph Mullen, BS; Melissa Agnello, PhD; Edward Viloria, DDS; Kenneth Chang Chien, BS; Emily Duong, BS; Masuma Rizvi, BDS; Pega Hajian, BS; Huying Li, PhD; Baochen Shi, PhD; Kang Ting, DMD, DMedSc; Wen Yuan Shi, PhD; Renate Lux, PhD; and Tingxi Wu, DDS, PhD

10-Year Institutional Retrospective Case-Control Study of Medication-Related Osteonecrosis of the Jaw
This study looked at the association between ART and MRONJ for cancer therapy.
Pardis Barati Mahvar, BSc; Amna Imran, DDS, MPhil, BDS; Reyes Enciso, PhD; Andrew Sanapanya, BS; Mohammad Khalifeh, DDS, MS; Parish P. Sedghizadeh, DDS, MS; and Laurel Henderson, DDS, MS

Circadian Behaviors of Oral and Skin Fibroblasts
This study reports fibroblasts derived from mouse palatal mucosa and dorsal skin and suggests that oral wound healing involving fibroblast repopulation and contraction may follow a diurnal cycle.
John Ngo, BS; Hodaka Sasaki, DDS, PhD; and Ichiro Nishimura, DDS, DMSc, DMD
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Earworns and Merciful Acts

Kerry K. Carney, DDS, CDE

Everyone has had it happen. You hear a tune and cannot get it out of your mind. This phenomenon has been described as a cognitive itch or an earworm. Once ensconced in your thoughts, it is very difficult to drive out. It can wake you up at night. It can weave its way into every thought you have. The song can be in and of itself annoying, like a certain commercial about donating your cars to children, or, as in my case, the song can be simply cognitively sticky (like almost any song by Phil Collins).

Online, there are several suggestions for how to get rid of these earworms. My personal remedy involves either non-lexical vocables to the theme from “Bonanza” or the insistent refrain from Edwin Starr’s 1969 hit “War.”

The other day, I experienced a visual analog of this auditory tic. I was on my way to a meeting of dental editors in San Francisco. I was scanning the familiar urban scene through the car window when I marked a street vignette. A youngish woman with no visible means of support and a large backpack and a bedroll was leaning against a storefront wall. As I watched, she reached into her backpack, pulled out a toothbrush and toothpaste and proceeded to brush her teeth and spit over the curb into the street. She was as discrete as possible under the circumstances. It made me wonder about her backstory. How did she get there? What vagaries of nature, nurture and fortune had led to this point? Since that moment, that scene has returned again and again to my thoughts.

There is no way to discern how that woman is living from day to day. She was like a time-lapse video where she is crystal clear and the rest of the population is a blur. People walk past her on their way to a temporally structured day in a life with a reliable social structure. But she seemed disconnected, like a planet without an orbit.

When things break down so completely that you are living on the street, how does dental health still come to the fore? In a situation with no social backstop, how does the morning ritual of toothbrushing still endure?

When we are presented with a picture and no information, we have a tendency to fill in the backstory based on our own experience or fears. I kept thinking: What kind of little girl was she? Who showed her how to brush her teeth? Who instilled the importance of oral hygiene? Was it a hygienist, a dentist, a parent? Or was it just the continuing echo of Ipana’s Bucky Beaver ad campaign of the 1950s that directed the American population to “brush regularly and see your dentist every six months.”

Or maybe her oral hygiene ritual was an attempt to normalize her situation as much as possible. Maybe it helped bring a little order to a chaotic situation. Whatever the reason for her present circumstances, her image stayed with me like an earworm.

Singing the theme from “Bonanza” or the refrain from “War” did not eliminate the image from the recurring loop stuck in my head. However, I think I have discovered a possible antidote: CDA Cares. I started thinking about CDA Cares.

San Francisco has just over 8,000 homeless individuals. California as a whole has just under 130,000 homeless. That represents about a quarter of the national homeless population.1 This population makes up only a portion of the people that CDA Cares helps.

In 2012, the CDA Foundation held its first free dental clinic, CDA Cares, in Modesto, Calif. This original experiment was a collaboration with the national organization Missions of Mercy. The CDA Foundation has now held 16 CDA Cares events. The most recent was held in September in San Bernardino. CDA Cares was located twice in Modesto, Sacramento and Solano County. It has also been held in San Jose, San Diego, Pomona, Fresno, Ventura, Stockton, San Mateo, Bakersfield and Anaheim.

These events are amazing. They are like a military operation. The planning begins months in advance. Local connections are made to outreach organizations that get the word to folks who need help.
Before the first patient is seen, the location is a beehive of activity. Large exhibition halls are converted into a maze of specialized operations.

After a day of erecting privacy barriers, laying electrical cables, connecting pipes, setting up chairs and organizing the sterilization and supplies area, there is palpable excitement and expectation. The first patients show up the night before so they can be triaged and ready to be seen first thing in the morning. It is very moving to see people standing in line long before daybreak so they can be ready to receive care as soon as the event opens.

Once the gate opens, the operation runs smoothly, moving patients through intake, medical history and medical evaluation on to triage, radiographs and treatment. After the procedures are completed, the patient is guided to the pharmacy area, if necessary, and then on to an exit interview. Patients are provided with contacts to seek ongoing dental care, and often, community partners are on-site to provide information on additional local resources.

Many times I have seen patients in their exit interview ask how they can volunteer to help with the next event. Heartwarming though that is, my favorite memory is of a crusty legislator whom I was guiding on a tour of the event. He was amazed at the donated service he witnessed. He was astounded that not only had dentists come from all over California to donate their time and expertise, but in many cases had closed their offices and brought their staff with them to the event. He was very appreciative, but the emotional moment came when he watched a denture patient radiant with surprise and pleasure admiring his new smile in the mirror. The patient had not had teeth for years and that day he got his smile back. He beamed and the legislator got tears in his eyes.

It was at that moment that I reflected on how great it is to be a dentist and to be able to give someone the gift of their smile. It was a very touching moment that reminds me of the importance of every single merciful act.

CDA Cares has transformed the lives of more than 30,000 people. Through CDA Cares, California dentists have provided oral health services valued at more than $25 million to individuals who would otherwise go without. With tremendous attention from the media, policymakers and the public, organized dentistry has increased leveraging power for policymaking issues like adding adult Denti-Cal back into the state’s budget and bringing to light the importance of oral health for Californians.

Millions of Californians still experience barriers to care. With every CDA member’s support, the CDA Foundation continues to build on this momentum and create lasting change for our state’s most vulnerable citizens.

If you have never been involved with a CDA Cares event, you are missing out. As dentists, we have the immediate gratification of helping relieve pain and restore smiles every day. But the gratification that one feels at the end of a CDA Cares event is that feeling magnified a thousandfold.

The Journal welcomes letters

We reserve the right to edit all communications. Letters should discuss an item published in the Journal within the last two months or matters of general interest to our readership. Letters must be no more than 500 words and cite no more than five references. No illustrations will be accepted. Letters should be submitted at editorialmanager.com/jcaldentassoc. By sending the letter, the author certifies that neither the letter nor one with substantially similar content under the writer’s authorship has been published or is being considered for publication elsewhere, and the author acknowledges and agrees that the letter and all rights with regard to the letter become the property of CDA.

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WEST PORTAL ORAL & FACIAL SURGERY CENTER
Dean L. Duncan, D.D.S. (left); Eric M. Scharf, D.D.S. (right)
I applaud the CDA and Dr. Rothman for the two journal editions dedicated to safety in dentistry. As an officer of the American Society of Dentist Anesthesiologists and the California Society of Dentist Anesthesiologists, we have long been dedicated to advocating for patient safety in the realm of anesthesia and sedation within dentistry.

Drs. Stevens and Sarasin’s article titled “Medication Safety: Reducing Errors and Adverse Drug Events in Dentistry” (September 2019) addresses medication errors in dentistry. Medical errors and, more specifically, medication errors are certainly problematic. These errors can lead to patient harm and even death. The exact numbers may be debatable, but every doctor should consider adopting every policy meant to prevent these errors from happening. Even one death or injury from a preventable medication error is one error too many.

However, Drs. Stevens and Sarasin’s article has a glaring omission of a systemic potential for medication errors permitted by law in California. Specifically in California, a “dental sedation assistant” can draw up, label and even administer irreversible sedative medications into an existing intravenous line in a patient. To become a dental sedation assistant, there is no need for any higher educational degree. This is on-the-job training in the office of approved oral surgeons. According to the Dental Board of California’s website, there are only 13 approved offices to obtain this training. Ten of these offices do not offer the course to other dental assistants outside of their practices. No other health care model would delegate such critical duties such as medication identification, preparation and administration to essentially a layperson with no medical or nursing background. This is a duty that should only be done by individuals with an advanced professional degree and health care license such as a nurse, pharmacist or doctor.

Unfortunately, last year the California legislature passed and the governor signed SB 501. This law reinforced, continues and further codified the legality of this dangerous practice. This should be an affront to anybody who is invested in patient safety and seeks to reduce medical errors.

I wholeheartedly encourage any dental assistant, or for that matter anyone in dentistry, who takes on the task of additional training and education. The more that our assistants know and understand about the procedures we are doing, the better we are as doctors. But entrusting this important responsibility of sedation and anesthesia medication administration to minimally trained dental assistants cannot replace the rigorous and accredited education that all licensed doctors and nurses have undergone.

It is high time that California dentists take patient safety seriously. This can start by abolishing a system in place in California that allows unqualified and unlicensed personnel to be responsible for the preparation, labeling and administration of potentially dangerous sedative medications. This would be a start that we take patient safety seriously.

LENNY NAFTALIN, DDS
Vice President, American Society of Dentist Anesthesiologists
President, California Society of Dentist Anesthesiologists

The Editor-in-Chief and Guest Editor Respond
Thank you for your letter Dr. Naftalin; we are pleased that you found Drs. Stevens and Sarasin’s article informative. Your letter expressed concerns regarding dental sedation assistants (DSAs), which provides an opportunity to describe for our readers the qualifications of this California dental team member.

The DSA, enacted in 2009 by the California Legislature, must complete a Dental Board of California approved course of instruction detailed in California Code of Regulations, Section 1070.8, and must pass a permitting examination to practice. A DSA’s education and training requires sedation-specific instruction of not less than 110 hours, and at a minimum must include 38 hours of clinical instruction and 20 supervised sedation cases.

The DSAs’ primary role is to monitor the sedated patient and be a second pair of eyes, ears and hands for the dentist providing sedation services. The DSA’s duties, which are described in detail in the Dental Practice Act, Section 1750.5, require direct supervision as described further here (italics added):
(b) Monitor patients undergoing conscious sedation or general anesthesia utilizing data from noninvasive instrumentation …

(b) Monitor patients undergoing conscious sedation or general anesthesia utilizing data from noninvasive instrumentation. Evaluation of the condition of a sedated patient shall remain the responsibility of the dentist or other licensed health care professional authorized to administer [sedation], who shall be at the patient’s chairside while [sedation] is being administered.

(c) Drug identification and draw, limited to identification of appropriate medications, ampule and vial preparation, and withdrawing drugs of correct amount as verified by the supervising dentist.

(d) Add drugs, medications and fluids to intravenous lines using a syringe, provided that a supervising licensed dentist is present at the patient’s chairside. The exception to this duty is the initial dose of a drug or medication shall be administered by the supervising licensed dentist. Further, current law requires a DSA to be dedicated to monitoring and sedation assisting functions and cannot also be assisting the dentist for the dental treatment. Your assertion that California law allows “unqualified and unlicensed personnel to be responsible for the preparation, labeling and administration of potentially dangerous sedative medications” is unfounded and not consistent with the requirements of the law.

We appreciate your continuing leadership and interest in patient safety and the series of articles on safety. Thank you again for taking time to participate in the forum of ideas that the Journal of the California Dental Association promotes. Discussions such as this can only bring more light on the subject and promote positive change.

KERRY K. CARNEY, DDS, CDE
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Anesthetic Approaches for Special Needs Patients

A recent study found that safe, successful dental treatments in special needs patients depend on choosing the right anesthetic methods and equipment and having a skilled staff. The study was published in the *Journal of Dental Anesthesia and Pain Medicine* in August.

Researchers found that the use of local anesthesia is sufficient for completing simple dental treatments, with 90% of patients in the study tolerating it. About 7% of patients needed additional analgesia and about 3% of patients were given narcotic analgesics in treatments that caused severe pain.

The study aimed to provide content about the different anesthetic approaches used in patients with special needs and included the medical records of 710 patients with special needs who were treated with general anesthesia or sedation. The patients ranged in age from 1 to 68.

For comparisons, the patients were evaluated according to the following groups: Down syndrome, other syndromes, psychiatric disorders, physical disabilities and complicated medical stories. Complicated medical stories included those patients who had conditions that affected their mental and motor abilities, such as cerebral palsy and spina bifida.

About 73% of patients were given general anesthesia and approximately 22% were sedated, according to the study. The mean duration of anesthesia was about 43 minutes.

Simple dental treatments were performed in patients in all groups, but the most common complications were found in those from the other-syndromes group.

The patients with other syndromes underwent maxillofacial procedures to correct facial deformities caused by self-injurious behaviors. Clinicians shortened anesthesia periods as much as possible for those in this group due to their life-threatening conditions.

Despite taking these steps, the author found that clinicians could not provide optimal treatments for these patients and only performed symptomatic and not restorative treatments.

Due to the difficult vascular access in other-syndrome patients, sevoflurane inhalation was used to extract teeth. Though very few patients were administered general anesthesia, this group experienced the highest complication rates, according to the author.

Patients with Down syndrome had specific diseases and conditions, such as respiratory system-related anomalies and severely low heart rates, that affected the types of anesthetic approaches used. Sedation was chosen for patients with Down syndrome due to intubation difficulties.

Although this is a complex subject, the common point was that all these patients required special care during dental procedures, according to the study.

Learn more about this study in the *Journal of Dental Anesthesia and Pain Medicine* (2019); doi.org/10.17245/jdapm.2019.19.4.191.
Ultrasound Tops CBCT in Peri-Implant Bone Imaging

Cone beam CT (CBCT) is considered the gold standard for imaging peri-implant bone, but researchers from RWTH Aachen University Medical School in Aachen, Germany, wondered if another modality without the radiation dose might be more accurate. They tested CBCT against high-frequency ultrasound and reported a surprising conclusion.

Ultrasound had a lower mean measurement error compared with CBCT, while both modalities had the same maximum error, leading the researchers to conclude that high-frequency ultrasound may be useful clinically, according to the study published in the Journal of Clinical Medicine.

“Within the simulated limited conditions of this study, high-frequency ultrasound, with optical scanning used as a reference, presented higher accuracy in comparison to CBCT, and seems to be a promising tool for measuring peri-implant bone,” wrote the authors, led by Juliana Marotti, DDS, MSc, PhD.

CBCT is the gold standard for imaging peri-implant bone because it can provide cross-sectional images. However, any artifacts seen on images may jeopardize the viewing of the bone-implant interface and make it challenging to assess peri-implant bone. Researchers also noted that CBCT is not recommended for evaluating asymptomatic implants in periodic exams to avoid patient exposure to high levels of radiation.

Because of these limitations, researchers wanted to see if high-frequency ultrasound could measure bone thickness in the buccolingual region of dental implants with the same accuracy as CBCT. Previous research has shown that ultrasound can reliably evaluate soft tissues, bone surfaces and dental implants without ionizing radiation, according to the authors.

Researchers placed four dental implants in eight porcine bone samples. Each implant was scanned by a high-frequency ultrasound scanner (a prototype developed at RWTH Aachen University), a CBCT unit (Sirona Galileos, Dentsply Sirona) and an extraoral optical scanner (D250, 3Shape) for comparison.

“Ultrasound showed a higher accuracy in comparison with CBCT, while its measurement error was closer to the optical scan values to a small degree,” the authors concluded.

Learn more about this study in the Journal of Clinical Medicine (2019); doi.org/10.3390/jcm8101539.

Periodontitis Associated With Hypertension Risk

People with periodontitis have a greater likelihood of hypertension, according to a study conducted by researchers from the UCL Eastman Dental Institute in the U.K. and published in Cardiovascular Research.

This study compiled the best available evidence to examine the odds of high blood pressure in patients with moderate and severe gum disease. A total of 81 studies from 26 countries were included in the meta-analysis.

Moderate-to-severe periodontitis was associated with a 22% raised risk for hypertension, while severe periodontitis was linked with 49% higher odds of hypertension, according to the study.

“We observed a positive linear relationship, with the hazard of high blood pressure rising as gum disease became more severe,” said lead author Eva Munoz Aguilera, MClinDent.

Average arterial blood pressure was higher in patients with periodontitis compared to those without. This amounted to 4.5 mmHg higher systolic and 2 mmHg higher diastolic blood pressures.

“The differences are not negligible,” said Dr. Munoz Aguilera. “An average 5 mmHg blood pressure rise would be linked to a 25% increased risk of death from heart attack or stroke.”

Hypertension, which affects 30% to 45% of adults and is the leading global cause of premature death, is the main preventable cause of cardiovascular disease. Periodontitis affects more than 50% of the world’s population and has been associated with increased risk of heart attack and stroke.

While the study investigated gum disease as a potential risk factor for hypertension, the reverse could also be true. Further research is needed to examine whether patients with high blood pressure have a raised likelihood of gum disease, but in the meantime, it would be prudent for health care professionals to provide oral health advice to those with hypertension, according to the authors.

Learn more about this study in Cardiovascular Research (2019); doi.org/10.1093/cvr/cvz201.
Researchers in Japan have developed a removable dental appliance that can reduce vocal and motor tics in children and adults who have Tourette syndrome, according to a study published in Movement Disorders. The ability to ameliorate tics could positively impact the everyday lives of individuals with Tourette syndrome, a neurological disorder characterized by vocal and motor tics.

While there is no cure for Tourette syndrome, several options are available to treat severe tics. These options include behavioral, pharmacological and more intrusive surgical interventions. However, the efficacy of these treatments can vary, and patients still frequently suffer from physical, mental and social disabilities.

As an alternative treatment option, researchers at Osaka University developed a custom-made oral splint. These are typically used for unconscious teeth clenching and grinding and for temporomandibular disorders such as misalignment of the teeth or jaw. The oral splint is applied to the molars to increase the occlusal vertical dimension and to alter the alignment of the nose, lips and chin.

Biting down on the device immediately improved both motor and vocal tics in 10 of the 14 children and six of the eight adults who participated in the study. “What’s more, these effects were long lasting. Long-term improvements in motor tics after more than 100 days were especially evident in patients who were younger when their tics first started,” said Jumpei Murakami, DDS, PhD, joint first author of the study.

While it isn’t yet clear how the oral splint exerts these effects, the action of biting down could serve as a sensory trick. Sensory tricks are voluntary maneuvers that usually involve touching parts of the face and head and can alleviate involuntary movements.

Read more of this study in Movement Disorders (2019); doi.org/10.1002/mds.27819.

Oral Health’s Role in Overall Health of Elderly

Oral health is a critical component to overall health for all ages, but vigilance is especially critical for the elderly, according to a review article recently published in the Journal of the American Geriatrics Society. Without good oral hygiene, the use of fluoride and regular dental care, older adults are more prone to damage to the oral cavity and the extension of infection into surrounding tissues.

In the article, researchers from the UConn School of Medicine outline the potential complications that can arise from poor oral hygiene in older adults and emphasize the role of all health care professionals in working to promote good oral hygiene in this population.

Data from the National Center for Health Statistics indicate that the prevalence of cavities is more than twice as high in older adults than younger adults. And as many as 64% of older adults in the U.S. have periodontitis, which is associated with a variety of medical conditions including cardiovascular disease and diabetes.

Researchers noted several populations of older adults who are at increased risk for oral health problems, including patients with diabetes, patients with dementia and those in long-term care settings.

Patients with replacement heart valves and prosthetic joints should be particularly careful regarding their oral hygiene, according to the authors. Manipulation of teeth and their support structures can result in bacteria present in the oral cavity being released into the bloodstream, which may lead to infections in parts of the body far removed from the oral cavity.

Patrick Coll, MD, professor of family medicine and medicine at the UConn School of Medicine and lead author, said health care professionals should consider an oral examination during an annual wellness visit, especially for those patients who are not receiving regular dental care.

Read more of this review article in the Journal of the American Geriatrics Society (2019); doi.org/10.1111/jgs.16154.
Spotlight on Dental Student Research

Alice Goodwin, DDS, PhD, and Kyle Jones, DDS, PhD

As dental educators, we are sometimes asked by dental students and seasoned clinicians alike why research during dental school is important, particularly for those who wish to pursue clinical careers outside of dental academia. While it is clear to most that dental research is critical for training the next generation of basic and clinical scientists who will move the dental profession forward, we strongly believe that it also imparts many important skills that are vital for clinical practice and continued professional and personal development. We believe exposure to research teaches dental students to think critically, evaluate scientific literature, critique their own work and collaborate with mentors and colleagues, which are all essential skills in clinical practice.

The ability to think critically is key to providing individualized patient care and improving clinical outcomes. Basic and clinical research during dental school fosters this skill by exposing students to the scientific method. Dental student researchers learn to be curious, make thoughtful and quantifiable observations and develop questions and methods to answer them. These skills have wide-ranging practical applications in clinical practice, from treatment planning to quality assurance programs, all of which are important in an increasingly competitive business environment.

Lifelong learning founded on evidence-based dentistry is vital for clinicians to provide the safest, most effective treatments for their patients. Dental student researchers learn to seek out and critically evaluate information in an ever-evolving scientific literature. Whether looking up an optimal assay to run for an experiment or investigating which dental material is best for a particular clinical scenario, the ability to critically evaluate research studies is important and directly impacts decision-making in clinical practice.
Furthermore, research teaches students to critically evaluate their own work and to not give up when times are difficult. These important traits are directly applicable to clinical training and practice, especially when learning to master new clinical skills. Providers should continually strive for improvement through self-reflection and evaluation of their own work and business practices, which can improve the quality and efficiency of care provided to patients.

Finally, research teaches students the need to create strong collaborative working relationships. Science is truly a team pursuit and often requires expertise from multiple people in order to answer challenging scientific questions. Similarly, dentists can utilize this spirit of collaboration in their own practices, whether consulting with a group of specialists on a complicated case or developing a strong and cohesive office team. For these and many other reasons, we feel strongly that research opportunities during dental school provide myriad learning experiences to dental students that are directly applicable to their futures in clinical practice and patient care.

We appreciate that research is not an undertaking for the faint of heart; it is often fraught with challenges, failures and frustrations. Therefore, we would like to acknowledge the hard work and determination of the dental student researchers who took on complex scientific questions and pursued challenging projects, which resulted in these peer-reviewed manuscripts. Additionally, we would like to thank the mentors of these students, because mentorship and guidance is essential at every step in one’s training, especially as a burgeoning scientist.

In this issue, we are excited to present scientific articles on a wide range of dental-related topics from students and mentors at multiple dental schools. We believe that the breadth of topics highlighted in this issue reflects the immense variety of topics in the broader field of dental research. Thank you again to all of the dental student researchers, mentors and their collaborators for the hard work that went into preparing these articles. We hope our readers enjoy this issue as much as we have.
Minimally Invasive Veneer Restorations: Effect of Restorative Material on Traumatic Impact Strength

Michelle Yang, BS; Erik Balinghassay, BS; Johnny Huynh, BS; Xuehui Liu, DDS; Chunling Ge, DDS, PhD; and Shane Newport White, BDentSc, MS, MA, PhD

ABSTRACT Traumatic tooth fracture is extremely common in adolescent patients and restorations need to be long-lasting, aesthetic and resistant to repeated trauma. Direct resin-composite restorations have generally been used, but minimally invasive veneers (MIV) now are a conservative and stable alternative. MIVs made of two different ceramic materials were compared to intact teeth and to resin-composite controls. Modern restorative materials and adhesive techniques were capable of restoring traumatized teeth to the impact strength of natural intact teeth.

AUTHORS

Michelle Yang, BS, is a dental student at the University of California, Los Angeles, School of Dentistry. Conflict of Interest Disclosure: None reported.

Erik Balinghassay, BS, is a dental student at the University of California, Los Angeles, School of Dentistry. Conflict of Interest Disclosure: None reported.

Johnny Huynh, BS, is a dental student at the University of California, Los Angeles, School of Dentistry. Conflict of Interest Disclosure: None reported.

Xuehui Liu, DDS, is a visiting scholar at the University of California, Los Angeles, School of Dentistry and an assistant professor at the Peking University School of Stomatology, Third Dental Center. Conflict of Interest Disclosure: None reported.

Chunling Ge, DDS, PhD, is a visiting scholar at the University of California, Los Angeles, School of Dentistry and an associate professor at the Peking University School of Stomatology. Conflict of Interest Disclosure: None reported.

Shane Newport White, BDentSc, MS, MA, PhD, is a professor at the University of California, Los Angeles, School of Dentistry. Conflict of Interest Disclosure: None reported.
Veneer Restorations

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772

Veneer restorations (Figure 1). Ceramic materials are inherently brittle, but no more brittle than human tooth enamel. Feldspatic porcelain has long been used for the fabrication of porcelain veneers because it is widely available, simple to use and allows layering and internal characterization for optimal aesthetics. More recently, monolithic glass ceramics have become widely used; these materials are stronger than porcelain or tooth enamel, but generally cannot be internally characterized.

Traumatic injury, such as falling off a bicycle or skateboard and hitting a tooth on a sidewalk, entails much higher forces, stresses and loading rates than chewing. So, the investigation of traumatic tooth fracture necessitates duplication of extreme conditions, quite different from the routine testing of restored teeth when simulating normal masticatory function. Impact testing of incisor teeth has only rarely been reported.

We modeled individuals with a history of maxillary incisor trauma and a proclivity to repeated trauma, evaluating minimally invasive ceramic restorations through impact testing. We hypothesized that teeth restored using minimally invasive ceramic restorations would have equal impact strength compared to intact unrestored teeth and to teeth restored using a conventional direct resin-composite material.

Methods

Sixty-four intact maxillary incisors that had been kept wet since extraction were given simulated traumatic defects (Figure 2A). A high-speed diamond bur (TR-13, MANI, Utsunomiya, Japan) with copious water spray was used to make standardized Class IV preparations with a 60-degree facial bevel of 2 mm to 3 mm in length (TR-13, MANI) and a 45-degree lingual bevel of 1 mm in length (TR-13EF, MANI) (Figure 1B tooth No. 8 and Figure 2A). Sixteen teeth were arbitrarily assigned to each of the four groups: intact control, direct resin-composite control, minimally invasive feldspatic porcelain veneer and minimally invasive glass-ceramic veneer. A power analysis based on pilot specimens suggested that 11 specimens per group would be sufficient to detect clinically meaningful differences among restoration materials. Restorations were made using direct resin-composite (Filtek Z350, 3M ESPE, St. Paul, Minn.), feldspatic porcelain (VMK Master, VITA, Bad Säckingen, Germany) or glass ceramic (IPS e.max, Ivoclar Vivadent, Schaan, Liechtenstein). An adhesive cement system bonding agent (Adper Single Bond Plus, 3M ESPE, St. Paul, Minn.) was used for the direct restorations, and the indirect restorations were adhesively cemented (Variolink N with Syntac and Helioskad, Ivoclar Vivadent). An artificial periodontal ligament was not included because it would not have provided substantial dampening at the high-impact speed used.

A model for incisal trauma illustrated by Andreasen and Andreasen was followed. Teeth were mounted in acrylic resin to simulate bone support at an angle of 135 degrees ± 5 degrees to the horizontal. This angle was chosen so as to produce incisal fracture whereas, prior impact studies had generally used an angle of 90 degrees to produce cervical or root fracture. An artificial periodontal ligament was not included because it would not have provided substantial dampening at the high-impact speed used.

An impact tester, previously described by Trabert et al., was used to apply a hammer to the teeth 1 mm ± 0.2 mm below the incisal edge (Figure 2C). The pendulum hammer, 800 g in weight, was lifted to an elevation of 64 degrees on a pivot point radius of 0.49 m. Acceleration due to gravity (9.81 m/sec²) would provide the hammer with a certain amount of kinetic energy at the bottom of the swing. By securing the tooth specimen at the bottom, the pendulum would strike...
and break the specimen’s incisal aspect. The pendulum would continue to swing onward and upward after the impact to an elevation somewhat lower than that of a free swing. Impact strengths in kJ/m⁻² were determined by how much kinetic energy the hammer lost during impact as assessed by the difference in energy between the pendulum’s initial release angle and its maximum terminal angle divided by the area of the fracture.28 The energy absorbed at fracture is a reflection of the relative strength of the whole system enduring an impact force.14 This approach was verified in pilot testing to produce incisal fracture rather than cervical or root fracture (FIGURE 2D). A priori, data from specimens with only minor injuries < 3.0 mm² were to be censored because the traumatic injuries would be too small, just chips rather than fractures, to be considered clinically relevant to the aim of this study.9

Mean group impact strengths and their standard errors were calculated. All four groups were compared for impact strength using one-way analysis of variance (ANOVA) (α < 0.05). The specimens were qualitatively evaluated for fracture patterns, whether the line of fracture involved tooth structure, restoration or both.

Results
One-way ANOVA did not discern any differences among the four groups (p = 0.2, F = 1.6) (FIGURE 3). Teeth restored using minimally invasive ceramic restorations had equal impact resistance compared to intact unrestored teeth and to teeth restored using a conventional direct resin-composite material.

Restorations behaved like tooth structure with respect to impact damage. Fractographic analysis indicated that fractures were generally subhorizontal to diagonal, removing part or all of the incisal edge and that enamel was generally involved (96% of fractures); dentin was less frequently fractured (21%, FIGURE 2D, FIGURES 4). Occasionally, scallop-shaped defects in enamel or restorative ceramic were produced indirectly on the palatal aspects of the incisors (4Cr).

Experimental variance was extremely high (FIGURE 3). The effect of impact trauma was strongly influenced by the characteristics of the individual tooth. Data from five specimens was censored because the traumatic injuries were too small to be considered clinically relevant to the aim of this study. One specimen was removed from the intact natural tooth group, three from the glass-ceramic group and one from the feldspathic porcelain group.
veneer restorations

Discussion

This in vitro study suggests that minimally invasive porcelain or glass-ceramic veneers are a clinical option in repairing fractured or carious incisors. Minimally invasive ceramic veneers conserve more precious tooth structure than conventional veneers and considerably more than full crowns. Their finish lines are usually above the gingiva, leaving the natural emergence profile and contour unaffected, promoting gingival health and a natural appearance. They also provide more dimensional stability, wear resistance and color stability than direct resin-composite restorations.

The results were consistent with findings of prior studies insofar as they intersected. An impact study of incisors restored with partial coverage glass-ceramic restorations determined that their fracture resistance and severity of crown fracture did not differ from intact unrestored teeth. An impact study of fragment rebonding on sheep incisors found no difference between teeth with rebonded coronal fragments and intact control teeth. A quasistatic study found no difference in fracture resistance of teeth restored with either feldspathic porcelain or resin-composite veneers. The restorative materials and adhesives used in this study, and in prior studies, were not weak links. Thus, modern restorative materials and adhesive techniques are capable of restoring traumatized teeth to the impact strength of natural intact teeth.

Generally, quasistatic load-to-failure tests have been used to assess the strength of restored teeth, but such methods do not simulate the very high load rates of impact that lead to traumatic injury. Impact testing, as used in this study, is a clinically relevant model of both trauma and accidentally biting on hard substances, but has only very rarely been used in dental studies. Impact testing is used to model situations that manifest severe shock loads, such as those caused by instantaneous arrest of a falling mass or the shock meeting of two objects with an exceptionally rapid build-up of stress. In contrast to quasistatic testing, the loading velocity in a pendulum test is typically several m/sec⁻¹ with a duration of m/sec, many orders of magnitude faster that in routine mechanical tests. Some “impact” strength tests on reattached anterior tooth fragments used a conventional universal testing machine at a crosshead rate of 0.5 m/min⁻¹, but that was still several orders of magnitude slower than in this current pendulum test or in real-world impact trauma. High velocity is important because the material at the tip of a growing crack is strained extremely rapidly and may offer lesser or greater resistance to crack growth and fracture than at routine low quasistatic strain rates.

At the high load rates and stress intensities inherent to impact trauma, all of the bonded restorative materials behaved remarkably like tooth structure itself; cracks did not have a preference for tooth, restoration or their interface. This finding may appear to be somewhat surprising; however, materials such as resin composite, which exhibit toughness at low strain rates, can behave differently at high strain rates. Conversely, inherently brittle materials, such as ceramics, may become tougher at high strain rates. These results may also apply to other clinical situations where high strain rates are encountered, such as accidents that cause the teeth to smash together or unexpected biting on a shard of bone, a grain of sand or on lip- or tongue-piercing jewelry.

Impact testing typically produces high experimental variance, even more so when brittle materials are evaluated. The problem of variance can be addressed...
by placing sharp notches in uniform test specimens to localize and standardize stresses when characterizing bulk material properties. However, natural and artificial crowns come in a wide variety of anatomical shapes and do not naturally contain notches; moreover, the presence of a notch substantially alters the measured impact strength. Hence, high variance was inherent to our test method, which simulated real-world incisal trauma. The considerable variability in within-group impact strength (Figure 3) is typical of tooth impact studies; twofold to fifityfold ranges of impact strengths within test groups have been reported, one study censored, or excluded, approximately 42% of its test specimens because those impacts did not produce the type of fracture being modeled. In this current study, 8% of the test specimens were censored because only minor chipping was produced. All other impact studies have been silent on the issue of data censoring even when disparate fracturing was reported.

Clinical impact trauma produces considerable variability in fracture location and course. Conclusions

Teeth restored using minimally invasive ceramic restorations had equal impact resistance compared to intact virgin teeth and to teeth restored using a conventional direct resin-composite material. Fracture lines did not show any marked preference to tooth structure, restoration or their interface; restorations behaved like tooth structure with respect to impact damage. Impact fracture was highly variable with respect to impact strength and damage produced. Modern restorative materials and adhesive techniques are capable of restoring traumatized teeth to the impact strength of natural intact teeth.

REFERENCES

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Titanium-Oxide Nanoparticles and Nanofibers Used Alone or With UV Light Activation

Christina Chi, BA, DDS; Brittney N. Springer, BS; Elvin Walemba, BSc, MRes, PhDc; Kevin E. Nick, PhD; Christopher C. Perry, PhD; and So Ran Kwon, DDS, MS, PhD, MS

ABSTRACT Advances in nanotechnology are making a significant impact on dentistry. This study evaluated the change in oxidation potential of synthesized TiO$_2$ nanofibers (NFs) compared to commercial TiO$_2$ nanoparticles (NPs). TiO$_2$ NFs had higher oxidation potential compared to TiO$_2$ NPs when activated with ultraviolet (UV) light using a yellow tartrazine dye. Therefore, it is expected that replacement of TiO$_2$ NPs to NFs as a photocatalyst in bleaching systems could enhance the efficacy and speed of the bleaching process.

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AUTHORS
Christina Chi, BA, DDS, is a recent graduate of the Loma Linda University School of Dentistry.
Conflict of Interest Disclosure: None reported.

Brittney N. Springer, BS, is a Master of Science student in the department of earth and biological sciences at Loma Linda University.
Conflict of Interest Disclosure: None reported.

Elvin Walemba, BSc, is a PhD candidate in the department of earth and biological sciences at Loma Linda University.
Conflict of Interest Disclosure: None reported.

Kevin E. Nick, PhD, is a professor in the department of earth and biological sciences at Loma Linda University.
Conflict of Interest Disclosure: None reported.

Christopher C. Perry, PhD, is an assistant professor in the division of biochemistry at the Loma Linda University School of Medicine.
Conflict of Interest Disclosure: None reported.

So Ran Kwon, DDS, MS, PhD, MS, is a professor and director of the student research program at the Loma Linda University School of Dentistry.
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Dental disease prevention systems, such as dentifrices and mouthwashes, incorporate nanosized calcium carbonate or hydroxyapatite crystals similar to the structure of enamel to remineralize early cavities and desensitize abraded surfaces. Bone regeneration can be accomplished using biocompatible composite bone graft scaffolds and calcium sulfate nanocrystals.

Metal and metal oxide semiconductor nanomaterials are emerging as a new therapeutic strategy for the treatment of bacterial infections and the prevention of biofilm formation. Titanium dioxide (TiO$_2$) is among the most investigated transition metal oxides. Titanium dioxide is a natural oxide of titanium with low toxicity and negligible biological effects and is found in food products, cosmetics and pharmaceutical products.
crystalline anatase phase of TiO₂ is highly active photochemically. Moreover, TiO₂ nanomaterials serve as ideal carriers and also exert enhanced photo-induced oxidation potentials from doping of other metals such as silver or gold.¹¹,¹² TiO₂ nanomaterials are promising in the following applications: photocatalysis,¹³ solar cells,¹⁴ water purification¹⁵ and antimicrobial coatings.¹⁰,¹⁶,¹⁷ In dentistry, the photocatalytic property of TiO₂ has been used in in-office bleaching materials to lower the hydrogen peroxide concentration without compromising bleaching efficacy. It is expected that the photo-sensitive TiO₂ absorbs the energy from light activation units and speeds up the oxidation reaction of hydrogen peroxide, consequently enhancing the effectiveness and speed of the bleaching process.¹⁸

The two most investigated TiO₂ morphologies are zero-dimensional (nanoparticles) and one-dimensional solids (nanofibers, nanotubes). One-dimensional nanostructures are good candidates for optimized titania because of their inherent surface areas and porosities compared with commercially available TiO₂ nanoparticles (NPs). Nanofibers (NFs) are made via hydrothermal, template-mediated, anodization and electrospinning approaches.¹⁴ Specifically, hydrothermally synthesized titania NFs are responsive to scale-up, have inherent low toxicity and are stable to moisture. We showed previously that hydrothermally synthesized TiO₂ NFs result in approximately threefold higher adsorption to organophosphorus compounds, which comprise a class of environmental pollutants.¹⁹ This increase is attributed to morphological roughness, greater crystallographic nanoscale variation and active site competition between parent and daughter species.

We expected that hydrothermally synthesized TiO₂ NFs would also have higher oxidation potential compared to TiO₂ NPs because morphologically they may have more active surface oxidation sites.¹⁹ Therefore, the purpose of this study was to explore dental photobleaching applications of TiO₂ NFs and evaluate its relative photocatalytic activity against anatase TiO₂ NPs using a yellow tartrazine dye solution. We hypothesized that TiO₂ NFs would degrade dye solutions at faster rates than the TiO₂ NPs when activated with UV irradiation.

Materials and Methods

Synthesis of Titania Nanofibers

Anatase titanium(IV) oxide (Sigma-Aldrich, St. Louis) anatase NPs (crystallite size = 25 nm; surface area 45–55 m² g⁻¹) was the starting material. One gram of TiO₂ anatase nanoparticle powder was suspended in 5 M NaOH (20 mL; using ultrapure water (18.2 MΩ cm⁻² resistivity)) and placed in a stainless-steel enclosed Teflon autoclave (100 mL volume size) containing a Teflon-coated stir bar as previously described.¹⁹ The Teflon autoclave was ≈ ¾ submerged in an oil bath at ~ 120–130 C (autoclave internal temperature ~ 170 C) on a magnetic hot plate with continuous stirring for approximately 48 to 72 hours. We used a base concentration range and temperature known to synthesize titanate nanofibers.²¹ Stirring with a Teflon-coated stir bar is required to get fibers of several micrometers in length.²²,²³ Following heating, the autoclave in the oil bath was allowed to cool to room temperature over several hours. Excess base was separated by centrifugation then vacuum filtrated with acid (1 M HCl), followed by water to remove excess sodium and chloride. The washed precipitate was then oven dried at 110 C overnight (~ 8 hours), followed by annealing at 400 C. Removal of Na and Cl from the hydrolysis product was verified by energy dispersive X-ray spectrometry (EDS) (NORAN System VI, Thermo Scientific, Waltham, Mass.) in a scanning electron microscope (SEM) (TESCAN Vega II, Brno-Kohoutovice, Czech Republic).

Characterization of Titania Nanofibers

Powder X-ray diffraction (XRD) measurements were performed using a Bruker D8 Advance diffractometer irradiating Cu Ka X-rays (λ = 1.5418 Å) with an applied power of 1.5 kVA (30 kV x 50 mA). The scans were performed in continuous mode from 2 to 70 degrees (θ–2θ geometry). TiO₂ products were characterized by digital transmission electron microscopy (TEM) (Philips Tecnai 12; 120 kV). Samples were prepared for TEM measurements by dropping 5 to 10 mL of a dilute nanofiber suspension onto a Formvar/carbon-coated Cu grid (Ted Pella 200 mesh) and allowing the samples to air dry.
Preparation of Dye Solution and Optical Density (OD) Measurements

A solution of 50 μM tartrazine dye (N = 3/group) (Sigma-Aldrich) was used for evaluating the oxidation potential of the following groups: distilled water (NC), 1 M hydrogen peroxide (HP), 0.5 mg/mL TiO₂ NPs (NPs) and 0.5 mg/mL TiO₂ NFs (NFs). The absorbance was monitored with a microplate reader at 450 nm (I Mark microplate reader, Bio-Rad Lab Inc. Hercules, Calif.) over four time periods: T1 (baseline), T2 (post-30 minutes), T3 (post-90 minutes) and T4 (post-120 minutes). The solutions were stirred in glass vials while either untreated or treated with UV light irradiation at 365 nm (NC-UV, HP-UV, NPs-UV and NFs-UV) (Spectroline, Spectronics Corp., Westbury, N.Y.). At each time period, 1.5 mL was transferred to microtubes and centrifuged at 7,500 rpm for 25 min. The supernatant was plated on a 96-well plate in triplicates (150 μL per well) and absorbance read at 450 nm. The photochemical tartrazine degradation rate constant by TiO₂ (NPs or NFs) and controls (water or hydrogen peroxide) were determined from the optical densities (OD) normalized against initial OD measurements against time. Tartrazine decay follows first-order kinetics:

\[ \frac{A_t}{A_0} = \frac{C_t}{C_0} = \exp \left( -k_{app} \cdot t \right) \]  

where \( k_{app} \) is the apparent rate constant, the terms \( A_t \) and \( C_t \) are the absorbance and concentrations, respectively.24,25 Thus, it follows that the gradient of \( \ln (OD_{normalized}) \) against time provides the apparent rate constant (min⁻¹).

\[ \ln \frac{A_t}{A_0} = \ln \frac{C_t}{C_0} = -k_{app} \cdot t \]  

Descriptives on dye concentration over time by group and by light activation were collected and the Kruskal-Wallis procedure followed by multiple pairwise comparison adjusted by the Benjamini-Hochberg method performed to evaluate differences among the four UV-irradiated groups at 120 minutes. Tests were two-sided and conducted at an alpha level of 0.05 with SPSS v25. Figure 1 summarizes the experimental protocol used to evaluate the performance of TiO₂ NPs and NFs.

Results

Characterization of Titania Nanofibers

XRD analysis shows the crystalline structure of starting anatase NPs (Figure 2). After hydrolysis, anatase peaks are not present and new low-angle peaks (< 10 degrees) that have been assigned previously to numerous titanate phases including an amorphous trititanate \((\text{Na,H})_2\text{Ti}_3\text{O}_7\) are present.26 Annealing to 400 °C restored the anatase structure to the anatase phase. The annealed materials are solid nanofibers (not hollow tubes) with diameters about 10–15 nm (Figure 3). This is consistent with our previous work.19

Tartrazine Dye Solution Degradation

The physical parameters that govern titania’s photoactivity are the mass of catalyst, incident light wavelength, initial concentration of the reactant and radiant flux.

We made a direct correspondence between apparent tartrazine degradation rates with TiO₂ NPs against NPs because incident light intensity, light path, extinction coefficient and substrate concentration (= 50 mM) were the same in each experiment.
The degradation rate of tartrazine dye solution by TiO₂ with UV light activation is summarized in the Table and illustrated in Figure 4. There was no apparent degradation of tartrazine for TiO₂ NPs and TiO₂ NFs when not activated with UV light. At 120 minutes post-UV-light activation, there was a statistically significant difference in final dye concentration among the four groups (p = 0.016). After multiple pairwise comparison only the NFs-UV group showed a statistically significant difference with all other three groups (P < 0.05, in all instances). The initial tartrazine degradation rate was 0.003/min, 0.007/min, 0.007/min and 0.0147/min for NC-UV, HP-UV, NPs-UV and NFs-UV, respectively. The degradation rate of NFs-UV was approximately twice compared to NPs-UV and HP-UV.

Discussion

The physicochemical properties of TiO₂ were improved by transforming manufactured TiO₂ nanoparticles into nanofiber structures. This transformation created increased surface area and porosities to form large area films, coatings and porous membranes as well as composites with polymers, all of which would be practical in the various applications. In dentistry, TiO₂ is incorporated into bleaching agents so that UV irradiation generates reactive oxygen species by photocatalysis to produce tooth-bleaching effects. The purpose of the study was to synthesize and characterize TiO₂ nanofibers and evaluate the change in oxidation potential of TiO₂ NFs compared to commercially available TiO₂ NPs. We were able to demonstrate successfully the efficacy of changing the morphology of TiO₂ to improve its photocatalytic activity. Therefore, it is expected that replacement of TiO₂ NPs to NFs as a photocatalyst in bleaching systems could enhance the efficacy and speed of the bleaching process.

There is vast literature on TiO₂ photocatalysis. TiO₂ is a semiconductor, where energy has to be supplied in the form of thermal energy or photons for the valence electrons to become mobile generating electron (e⁻)–hole (h⁺) carriers. The mobile electrons have access to the higher quantized energy states, which in a solid material is termed the conduction band because the energy levels are very close together. The mobile electrons leave behind a vacancy called a hole in the valence orbital levels, which in a solid is termed the valence band because like the conduction band, the energy levels are very close together. The energy gap between the valence and conduction band is termed the band gap and is ~ 3.2 eV for anatase TiO₂. In the UV-vis range, the photon energy is greater than the band gap of the metal oxide, generating electron (e⁻)–hole pairs (h⁺). The fate of the e⁻/h⁺ pairs includes recombination, trapping at defect sites, initiation of reduction pathways by e⁻ and initiation of oxidative pathways by h⁺. These e⁻/h⁺ pairs react with water and oxygenated species to form hydroxyl radicals (OH) and superoxide (O₂⁻). These reactive oxygen species can further oxidize organic molecules.
To evaluate the oxidation potential of different reagents, we used a tartrazine dye solution for several reasons. First, it is not subject to photo-bleaching as was demonstrated in the negative control group that was also irradiated with UV light. Second, tartrazine dye is a Food and Drug Administration approved dye that is commonly used to color food and drinks. Therefore, consumers are exposed to tartrazine that may directly affect tooth color and have strong clinical relevance. Third, it has been widely used to induce artificial staining on extracted teeth to evaluate the efficacy of bleaching products.33

We expected that UV illumination of the tartrazine dye solution mixed with TiO2 NFs would produce hole (h+) and electron (e−) charge carriers in TiO2 resulting in increased hydroxyl surface density and sequestration of hydronium ions (H3O+) (TiO2 + H3O+ → TiO2H3O+; 2H3O+ → H3O+) These e−/h+ pairs react with water and oxygenated species to form hydroxyl radicals (OH) and superoxide (O2−). Furthermore, TiO2 degrades tartrazine under UV light,34,35 despite the fact that diffusion of e−/h+ pairs was limited to the TiO2 interfacial region and that the photocatalytic efficiency of e−/h+ pairs is low at wavelengths above 360 nm. We observed that NFs have = 2 times the degradation rate for tartrazine dye compared to NPs. This is in accordance with other studies that found photocatalytic organic dye oxidation performance is enhanced in nanofiber/nanotubular structures compared to NPs.20,36,37

It is noteworthy that our ultimate goal would be to enable electron/hole pair generation with optical photons preferable in the visible spectrum. In the case of TiO2, one drawback is the too-large band gap that restricts applications mainly with UV irradiation.22 In the future, to even enhance the yield of electron/hole pairs at the TiO2 interface, the surface could be doped with noble metals to decrease the band gap and allow excitation with light in the visible spectrum (> 360 nm).12 This may promote increased oxidizing power to degrade organic compounds such as artificial dyes. Additionally, ion exchange and intercalation of other noble metals and organic molecules may lead to optimization and functionalization of nanofibers for diverse future applications in dentistry.

Conclusion
Within the limitation of this study, we conclude that the transition of TiO2 NPs into TiO2 NFs creates optimized structural changes that yield higher oxidation potential and results in faster degradation of an artificial dye solution. ■

ACKNOWLEDGMENT
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REFERENCES
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THE CORRESPONDING AUTHOR, Christina Chi, BA, DDS, can be reached at cchi1224@gmail.com.
Clinical and Microbial Changes in Orthodontic Patients Using Clear Aligners Vs. Fixed Appliances

Joseph Mullen, BS; Melissa Agnello, PhD; Edward Viloria, DDS; Kenneth Chang Chien, BS; Emily Duong, BS; Masuma Rizvi, BDS; Pega Hajian, BS; Huiying Li, PhD; Baochen Shi, PhD; Kang Ting, DMD, DMedSc; Wenyuan Shi, PhD; Renate Lux, PhD; and Tingxi Wu, DDS, PhD

ABSTRACT This pilot study investigated the clinical and microbial changes that occur in patients undergoing orthodontic treatment using fixed appliances and clear aligners. The clear aligner group had significantly less plaque accumulation than the fixed appliances group, but no significant differences in gingival health were found. Next-generation sequencing of the 16S rRNA encoding gene revealed a shift in the oral microbiome from baseline with a unique microbial community discovered on the inner surface of clear aligners.

ORTHODONTIC TREATMENT

Joseph Mullen, BS, is a fourth-year dental student at the University of California, Los Angeles, School of Dentistry.

Melissa Agnello, PhD, received her PhD from the University of Southern California in clinical and experimental therapeutics. She is a former postdoctoral scholar in the UCLA School of Dentistry, section of oral biology, and works for uBiome in San Francisco.

Edward Viloria, DDS, is a third-year resident in the orthodontics and dentofacial orthopedics program at the UCLA School of Dentistry.

Kenneth Chang Chien, BS, is a second-year dental student at the University of California, San Francisco School of Dentistry.

Emily Duong, BS, is a first-year dental student at the UCLA School of Dentistry.

Masuma Rizvi, BDS, is a third-year dental student at the UCLA School of Dentistry.

Pega Hajian, BS, is a third-year dental student at the UCLA School of Dentistry.

Huiying Li, PhD, is an associate professor in the department of molecular and medical pharmacology at the UCLA Geffen School of Medicine.

Baochen Shi, PhD, is a project scientist working in the department of molecular and medical pharmacology at the UCLA Geffen School of Medicine.

Kang Ting, DMD, DMedSc, is a professor in the division of growth and development at the UCLA School of Dentistry.

Wenyuan Shi, PhD, is the former chairman and professor of oral biology at the UCLA School of Dentistry and serves as the chief executive officer and chief scientific officer of the Forsyth Institute in Cambridge, Mass.

Renate Lux, PhD, is a professor in the section of periodontics at the UCLA School of Dentistry.

Tingxi Wu, DDS, PhD, is the director of orthodontic and craniofacial development research and an assistant member of staff at the Forsyth Institute in Cambridge, Mass.

Conflict of Interest Disclosure for all authors: None reported.

Orthodontic tooth movement has traditionally been achieved using fixed appliances. Although this treatment modality has a long track record of success in treating malocclusion, it also has several disadvantages for patients, including poor aesthetics and a decrease in the patient’s ability to effectively brush and floss to remove oral biofilm.1–4 In the late 1990s, a computerized process of making casts with incremental changes was introduced that could be used to fabricate removable clear aligners to achieve orthodontic movement.1 With the advent of this new technology and treatment modality, orthodontic patients were then able to remove their orthodontic appliances to eat, brush and floss, thus allowing for excellent maintenance of oral hygiene.3–7
The metabolic activities of dental biofilm present on the surface of the tooth can demineralize the enamel, forming white spot lesions (WSL) that are precursors to the development of dental caries. The biofilm at the gingival margin can also lead to gingival inflammation, a precursor to periodontitis. These complications represent the two most common bacterial diseases in humans (caries and periodontal disease) and are common during orthodontic treatment with fixed appliances.6–10

Despite the increasing popularity of clear aligners, relatively few studies have investigated how this new treatment option affects patients’ plaque accumulation and degree of gingival inflammation compared to patients treated with fixed appliances. The available studies are inconclusive in their findings and often present conflicting results. Miethke and Vogt (2005) reported that the plaque index was significantly lower in the clear aligner group, but the periodontal condition in both the fixed appliance and clear aligner groups was nearly identical.4 Other studies have reported that clear aligner therapy resulted in better periodontal health over fixed appliances.6,11–13 In contrast, Chhibber et al. (2018) found no significant difference in plaque index, gingival index or papillary bleeding index between patients treated with clear aligners compared to fixed appliances.14

The development of WSL (caries) and gingival inflammation (periodontal disease) are often caused by an imbalance in the oral microbial community, which harbors one of the most diverse microbiomes in the human body.8,9 These diseases are caused by a shift from a benign, commensal microbial community toward an acidogenic community (in caries) or an inflammatory community (in periodontal disease).1,10 WSL are areas of enamel decalcification that can be carious or noncarious.5,15 Julian et al. (2013) reported that 23% of orthodontic patients developed WSL during treatment, being 2.5 times more frequent in the maxillary arch.15 Gingivitis is an inflammatory disease of the gingival tissues that is often biofilm-induced, causing erythema, swelling, bleeding and pain. Although gingivitis after orthodontic treatment is transient, WSL may require restorations to improve facial aesthetics in up to 15% of orthodontic patients.16

In addition to examining clinical outcomes of patients with fixed and removable appliances, some studies have made attempts to characterize the microbial changes in these patients. Such studies have also reported conflicting findings and many of them reported only short-term data. Karkhanichi et al. (2013) used the hydrolysis of BANA (N-benzoyl-DL-arginine-naphthylamide) by plaque samples as a semi-quantitative marker for the presence of gram-negative anaerobic bacteria strongly associated with chronic periodontitis (Treponema denticola, Porphyromonas gingivalis and Tannerella forsythia).7 They found that BANA scores were significantly greater for the fixed appliance group, which supports their other findings of decreased plaque and gingival inflammation in the clear aligner group.7 Sifakakis et al. (2018) used qPCR to investigate the change in select pathogenic bacterial species in the saliva of patients being treated with fixed appliances compared to clear aligners and found no significant changes resulting from treatment.17 Guo et al. (2018) performed comprehensive 16S rRNA gene sequencing and found that clear aligners did induce a microbial shift, but that these changes were nonpathogenic over the first three months of treatment.18 A systematic review published by Guo et al. (2017) found that although an initial increase in pathogenic bacteria was observed shortly after beginning treatment, they tended to decrease to pretreatment levels when followed for a longer period.19

### Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Appliance</th>
<th>Age</th>
<th>Gender</th>
</tr>
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<tbody>
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<td>1</td>
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<td>25</td>
<td>Male</td>
</tr>
<tr>
<td>2</td>
<td>Clear aligner</td>
<td>27</td>
<td>Female</td>
</tr>
<tr>
<td>3</td>
<td>Fixed appliances</td>
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<td>Male</td>
</tr>
<tr>
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<td>27</td>
<td>Female</td>
</tr>
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<td>5</td>
<td>Fixed appliances</td>
<td>28</td>
<td>Male</td>
</tr>
<tr>
<td>6</td>
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<td>29</td>
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<td>Fixed appliances</td>
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<td>8</td>
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<td>Clear aligner</td>
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</tr>
<tr>
<td>19</td>
<td>Clear aligner</td>
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<td>Female</td>
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</table>

### Table 2

<table>
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<tr>
<th>Patient</th>
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<th>Time point</th>
<th>TQHPI</th>
<th>GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clear aligner</td>
<td>T0</td>
<td>0.53</td>
<td>0.11</td>
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<td>1.94</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>Clear aligner</td>
<td>T2</td>
<td>1.90</td>
<td>0.40</td>
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<td>Clear aligner</td>
<td>T3</td>
<td>1.40</td>
<td>1.02</td>
</tr>
<tr>
<td>5</td>
<td>Clear aligner</td>
<td>T0</td>
<td>1.05</td>
<td>0.06</td>
</tr>
<tr>
<td>6</td>
<td>Clear aligner</td>
<td>T1</td>
<td>0.53</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>Clear aligner</td>
<td>T2</td>
<td>0.83</td>
<td>0.16</td>
</tr>
<tr>
<td>8</td>
<td>Clear aligner</td>
<td>T3</td>
<td>1.37</td>
<td>1.13</td>
</tr>
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<td>9</td>
<td>Fixed appliances</td>
<td>T0</td>
<td>0.98</td>
<td>0.53</td>
</tr>
<tr>
<td>10</td>
<td>Fixed appliances</td>
<td>T1</td>
<td>1.80</td>
<td>0.00</td>
</tr>
<tr>
<td>11</td>
<td>Fixed appliances</td>
<td>T2</td>
<td>2.65</td>
<td>1.32</td>
</tr>
<tr>
<td>12</td>
<td>Fixed appliances</td>
<td>T3</td>
<td>3.00</td>
<td>1.07</td>
</tr>
</tbody>
</table>

The limitations of the current literature include short three-month follow-up periods in analyzing the microbiome using complete 16S rRNA gene sequencing and lack of biofilm analysis present inside the clear aligners. Similar to the buildup of plaque on the surfaces of the teeth, biofilm also forms on the intaglio of the clear aligner trays. Patients are instructed to wear their clear aligners for at least 20 hours every day, meaning the biofilm present within the aligners is in contact with the tooth surfaces for a vast majority of the time during treatment. Levrini et al. (2015) and Lombardo et al. (2017) investigated the best method to remove biofilm from the inside of the trays but did not analyze the plaque’s composition, and no studies have been published to date that investigate the microbial community within the clear aligners themselves.20,21

Over the past two decades, clear aligners have become a popular orthodontic treatment option, providing an aesthetic and hygienic alternative to traditional fixed appliances. However, relatively little research has been done on how this treatment affects the oral microbiome, plaque accumulation and gingival inflammation. In this pilot study, we provide for the first time a detailed longitudinal analysis of microbial communities associated with tooth and clear aligner intaglio surfaces in patients receiving orthodontic treatment with fixed appliances compared to clear aligners, including an assessment of relevant clinical parameters.

### Materials and Methods

Study participants were recruited at the UCLA Orthodontics Clinic, and all human research protocols were approved by the UCLA Institutional Review Board (IRB # 16001258). Four patients who were preparing to start treatment with either fixed appliances or clear aligners were included. We did not specify whether the patients were treated with self-ligating or conventional brackets, as Cardoso et al. (2015) found no significant difference in plaque accumulation and gingival inflammation between patients treated with either of those modalities.22 We excluded patients with active caries, advanced periodontal disease and chronic systemic diseases, patients who currently used or had used antibiotics in the past 30 days, patients who had radiation therapy to the head and neck region. After a patient consented to participation in the study, we collected the data and samples at the pretreatment baseline (T0) and at one month (T1), three months (T2) and six months (T3). The amount of biofilm accumulation was measured using the Turesky Modified Quigley-Hein Plaque Index (TQHPI), which requires the use of disclosing solution and scores supragingival plaque formation on a numerical scale from 0 to 5.23–25 The level of gingival disease was measured using the Löe and Silness Gingival Index (GI), which focuses on two characteristic signs of inflammation: swelling and bleeding.26,27

### Clinical Parameters at Each Time Point for Fixed Appliance and Clear Aligner Groups

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Time point</th>
<th>TQHPI (mean ± SD)</th>
<th>GI (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed appliances</td>
<td>T0</td>
<td>0.69 ± 0.33</td>
<td>0.16 ± 0.25</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>1.74 ± 0.76</td>
<td>0.13 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>1.74 ± 0.24</td>
<td>0.43 ± 0.43</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>2.83 ± 0.25</td>
<td>1.20 ± 0.18</td>
</tr>
<tr>
<td>Clear aligner</td>
<td>T0</td>
<td>0.91 ± 0.27</td>
<td>0.02 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>1.10 ± 0.79</td>
<td>0.00 ± 0.00</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>0.97 ± 0.53</td>
<td>0.29 ± 0.25</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>1.70 ± 0.46</td>
<td>0.65 ± 0.69</td>
</tr>
</tbody>
</table>
on a MiSeq (Illumina, San Diego) at the UCLA microbiome core. After demultiplexing and trimming of barcodes, low-quality sequences containing bases with Phred quality values < 20 as well as sequences with > 3% uncertain basepairs were removed. The 16S rRNA sequences were clustered into operational taxonomic units at a 98% similarity level using QIIME and taxonomically assigned by comparison to the Human Oral Microbial Database (HOMD). Alpha-diversity (Shannon index), Beta-diversity (weighted UniFrac) and principal coordinate analyses were calculated in QIIME.

The power of this pilot study was calculated using the G*Power statistical analysis program. Normality of the data was then determined using the Shapiro-Wilk analysis. The results of the analysis are shown in Table 3. For the threshold \( p = 0.05 \), the calculated \( W \) value should be greater than 0.916 to indicate that the data have a normal distribution. Given the \( W \) values shown in Table 3, the TQHPI data seem to follow a normal distribution, while the GI data do not follow a normal distribution.

The implied \( \alpha \) and power of the study was then calculated using the G*Power statistical analysis program. The effect size for the TQHPI data was 0.6990 and the calculated power was 0.7264. The effect size for the GI data was 0.5061 and the calculated power was 0.6339.

The clinical data (TQHPI and GI) for each time point are outlined in Table 4. Given the normality of the TQHPI data, a two-tailed t-test was used to calculate p-values. The TQHPI scores showed an overall increase in plaque levels from T0 to T3 in both groups, with a significantly greater increase observed in the fixed appliances group (Figure 1B). The increase in TQHPI in the clear aligner group was borderline significant from T0 to T3 (\( p = 0.052 \)), but the increase in the fixed appliances group was significant at \( p < 0.01 \) (Figure 1B).
Because the GI data did not follow a normal distribution, significance was calculated using the Mann-Whitney U test. The increase in GI score for both groups is presented in Figure 2A. Similar to the TQHPI scores, the GI scores followed an upward trend from baseline throughout treatment in both groups (Figure 2B). However, none of these differences were significant at \( p < 0.05 \).

Taxa composition analysis from the 16S rRNA gene sequencing data is shown in detail in Figure 3 (view in detail at cda.org/Mullen3). Overall, each subject seems to have an individual bacterial biofilm community profile, which seems to shift upon beginning of treatment. In most patients, the anterior and posterior plaque have a similar microbial composition. However, the tray biofilm communities have a very distinct profile that is different from and less diverse than the tooth-associated oral biofilm samples.

Figure 4 highlights certain species that were significantly increased or decreased (\( p < 0.05 \) for differences in relative abundance between groups) in the tray biofilm communities compared to the tooth-associated oral biofilm samples. Three species were significantly enriched in the clear aligner trays: Streptococcus sp. oral taxon-058 (classified as Streptococcus oralis subsp. dentisanti), Gemella morbillorum oral taxon-046 and Granulicatella elegans oral taxon-596. A number of species, including Lautropia mirabilis and Corynebacterium matruchotii and different Rothia species, are greatly reduced.

Alpha-diversities were calculated for anterior and posterior biofilm samples at the various collection time points. Alpha diversity measures within-sample diversity or richness and can be measured using phylogenetic diversity, which considers phylogenetic distance or relatedness of all sequences found in a given sample. While an apparent increase was observed at the first recall visit after receiving the orthodontic appliance, none of the differences were significant (Figure 5). Next, we tested if there was a correlation between alpha-diversity and TQHPI (Figures 6). Interestingly, in patients with fixed appliances there appeared to be a correlation between these two parameters for both types of biofilm specimen collected (albeit not a very strong one). In contrast, this increase in alpha-diversity with increasing TQHPI score was completely absent in patients wearing clear aligners.

Beta-diversity is used to measure the difference or similarity between different microbial communities using
phylogenetic or nonphylogenetic metrics. Not surprisingly, analysis of beta-diversity revealed that the start of orthodontic treatment comprises a disturbance that resulted in a shift in community composition. However, the baseline samples did not cluster tightly together and the direction of the shift was not unilateral (Figure 7). Furthermore, no significant differences were noted between the anterior and posterior biofilm samples or between patients treated with clear aligners versus fixed appliances. However, the tray biofilm community was markedly different from all tooth-associated communities. This difference can be appreciated in Figure 7A, which uses principal coordinates analysis (PCoA) to demonstrate how similar each sample is to the others. PCoA is an ordination technique that summarizes the diversity present within each biofilm sample by plotting it as a single point on a two-dimensional scatterplot. The distance between each point represents the microbial disparities present between the different communities, with larger distances indicating greater difference in composition.

To explore how the communities in each individual subject changed after starting treatment, the PCoA points were highlighted by each subject’s baseline versus treatment compositions in Figures 7B and 7C. Although the directionality of the shift from baseline is arbitrary, it demonstrates the general patterns present in how each subject’s microbial communities change during orthodontic therapy. When only clear aligner subjects are plotted to observe the change from baseline, there is an appreciable migration of all samples down and toward the left relative to their baseline community (Figure 7B). The only exception to this pattern was subject 17, whose oral biofilm samples migrated toward the tray sample composition after baseline. A shift was also observed when the fixed appliance group was plotted, but no appreciable patterns were noted (Figure 7C).

Discussion

Orthodontic treatment using fixed appliances or clear aligners can cause a disruption in normal oral hygiene practices that can result in plaque accumulation and gingival inflammation. Fixed appliances introduce bonded brackets, bands and an archwire into the oral cavity, which make plaque removal and flossing more difficult. Clear aligner
treatment requires the presence of a foreign material covering the entire dentition for more than 20 hours daily and also often necessitates fixed bonded composite attachments on several teeth. Although intuitively it would seem that patients with clear aligners would be better able to maintain their oral hygiene during treatment, the current literature does not paint a definitive picture. While some studies do show that patients treated with clear aligners have improved clinical outcomes (e.g., decreased plaque and gingival inflammation), others concluded that there is no significant difference in oral hygiene between clear aligner and fixed appliance groups.\(^4,6,11–14\)

Furthermore, very few studies have been published that use next-generation 16S rRNA gene sequencing to monitor changes in the oral microbial community during clear aligner therapy, and those that are available did not compare the changes to those experienced during treatment with fixed appliances.\(^18\) The nature of plaque accumulation during clear aligner therapy is different than in treatment with fixed appliances, because with clear aligners the oral biofilms are frequently disturbed throughout the day when patients remove them to eat and perform oral hygiene practices. Given the increasing popularity of clear aligner treatment, a more thorough understanding of how this therapy affects the oral environment both clinically and microbially is warranted. Through this pilot study, we were able to provide a glimpse into how clear aligners and fixed appliances affect the oral microbiome and clinical parameters of oral health as well as present a first look into the community present within the clear aligner trays themselves.

**FIGURE 7A.** Beta-diversity analysis for all samples using PCoA. Note that the tray biofilm samples (green) tend to cluster closely together separate from the oral biofilm samples.

**FIGURE 7B.** Beta-diversity analysis for the clear aligner group. The samples taken during treatment (circled) tend to shift in a relatively consistent pattern from the baseline composition.

**FIGURE 7C.** Beta-diversity analysis for the fixed appliances group. The samples taken during treatment (circled) tend to shift from the baseline composition, but no consistent pattern is identified.
The fixed appliances group experienced a significant mean increase in TQHPI score of 2.14 over the first six months of treatment, compared to the clear aligner mean increase of 0.79, which was borderline statistically significant (Figure 1B). None of the increases in GI score were found to be statistically significant, although the fixed appliances group showed a higher mean increase in GI score compared to the clear aligner group (+1.04 versus +0.63, Figure 2A). Thus, this pilot study concludes that clear aligner therapy results in less plaque buildup on teeth compared to treatment with fixed appliances. This observed lower level of plaque could be due to decreased plaque accumulation, greater ease of plaque removal or a combination of the two. However, the increased plaque levels in the fixed appliances group did not seem to affect gingival inflammation because the groups had similar GI scores. Even though patients treated with fixed appliances had increased levels of plaque, this did not seem to have a major influence on the oral microbial community itself. Although an overall microbial shift was observed in the biofilm composition from baseline, there was noted variability from patient to patient in how much the community changed (Figure 3). Given the small sample size in this limited pilot study, no clear or definitive pattern of how the oral community changes with these therapies was identified. The bacterial species that was most enriched in the clear aligner tray communities was Streptococcus sp_oral_taxon-058 (recently named Streptococcus oralis subsp. dentisanti), which is associated with caries-free individuals (Figure 4). Gemella morbillorum oral taxon-046, a member of the normal oral microbiota, was also significantly enriched. The third species that was increased in the clear aligner trays is Granulicatella elegans oral taxon-596, which is found in increased numbers in patients with active caries. This represents a mixture of benign and pathogenic bacteria, making it difficult at this time to draw any conclusions on whether the tray community should be considered pathogenic.

Alpha-diversity analysis showed an apparent increase in microbial diversity over the first month, which then seemed to plateau or slightly decrease back toward pretreatment levels (Figure 5). This finding was surprising because decreased biofilm diversity tends to be associated with periodontal disease and increased diversity is generally a sign of periodontal health. However, this seemingly increased diversity may help explain in part the lack of a significant increase in GI scores in both groups.

Beta-diversity and taxa composition analysis revealed that the microbial makeup of the tray biofilm was significantly different from the oral biofilm communities (Figure 7A). The microbiome present in the inner surface of the clear aligners was less diverse, which tends to be associated with periodontal disease. Because patients are instructed to wear the clear aligners for at least 20 hours per day, the biofilm present in the clear aligners is in contact with the teeth and gingival margin for a majority of the time during orthodontic treatment. As a whole, the tray biofilm did not seem to significantly alter the composition of the oral biofilms during the six-month treatment time period of this pilot study. However, in subject 17 the oral biofilm samples did show a shift in their composition toward the tray biofilm (Figure 7B). The small sample size of this pilot study makes it difficult to determine whether this shift was an incidental finding or if such a shift may be observed more widely in the general patient population. A potential reason for this shift could be explained by the nature of plaque accumulation in clear aligner patients. For example, after receiving a professional dental cleaning (prophylaxis), patients place the same clear aligner into the mouth without cleaning it, which introduces the potential for reinoculating the tooth surface with the tray community's composition.

A potential future direction for the research could be to explore whether cleaning/sterilizing clear aligner trays before reinsertion after prophylaxis affects that subject's tooth-associated biofilm microbial composition. Further studies with a more robust sample size would provide greater insight to how the tray biofilm may affect the oral microbial community.
Conclusion
This study concludes that patients treated with clear aligners experience significantly less plaque accumulation (measured by the TQHP-I) on the surfaces of the teeth compared to patients treated with fixed appliances over the first six months of orthodontic therapy. There is no significant difference in the microbial communities found in biofilm collected from central incisors compared to first premolars. Orthodontic treatment with clear aligners and fixed appliances caused a shift in the oral microbial community from baseline, although the nature of this shift seems to be largely patient specific. The inner surfaces of clear aligners harbor a unique microbial community that is less diverse compared to the communities found in tooth-associated biofilms. Further studies with a larger sample size are needed to better understand the clinical and microbial changes that are induced by fixed appliances and clear aligner therapy.

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REFERENCES
25. Faul, F; Erdfelder E; Lang A; Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. 2007 May;39(2):175–91.

The corresponding authors: Tingxi Wu, DMD, DM/EdSc, and Renate Lux, PhD, can be reached at twu@dentistry.ucla.edu and rlux@dentistry.ucla.edu.
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10-Year Institutional Retrospective Case-Control Study of Medication-Related Osteonecrosis of the Jaw

Pardis Barati Mahvar, BSc; Amna Imran, DDS, MPhil, BDS; Reyes Enciso, PhD; Andrew Sanapanya, BS; Mohammad Khalifeh, DDS, MS; Parish P. Sedghizadeh, DDS, MS; and Laurel Henderson, DDS, MS

ABSTRACT The connection between antiresorptive therapy (ART) and medication-related osteonecrosis of the jaw (MRONJ) has been studied extensively in the literature but limited by methodological challenges. This retrospective case-control study evaluates the connection between ART and MRONJ over a 10-year period. We identified 223 MRONJ patients and compared them to 615 non-MRONJ patients taking ART. Observational population studies can help inform dental practitioners of risk assessment and aid in preventing morbidity in the dental setting.

Bisphosphonate (BP) and denosumab (Dmab) medications are used as antiresorptive therapy (ART) to treat specific bone conditions including osteoporosis, metastatic bony lesions and multiple myeloma. Prescriptions for ART, specifically oral BPs, have increased steadily since 1988. According to a 2004 review of medical office visits for osteoporosis, out of 6.3 million office visits, nearly 73% included a prescription written for BP. Long-term use of ART is associated with several potential adverse effects including medication-related osteonecrosis of the jaw (MRONJ), atrial fibrillation, esophageal cancer, musculoskeletal pain and atypical femoral fractures without clear causal relationship.

MRONJ is a condition defined as exposed or unexposed necrotic bone in the
maxillofacial region without healing after six to eight weeks in patients with no history of radiation exposure to the jawbone and with a history of ART. A clinically impressive characteristic of MRONJ is sequestering bone in the oral cavity.

A task force of the American Society for Bone and Mineral Research, after broad research on the topic, stated that MRONJ risk related to oral BP use appears to be very low. Nevertheless, they recommended that continuous research and observation is needed for better understanding considering the rapidly evolving incidence of MRONJ. It has been posited that the development of MRONJ is linked to malignancy, chemotherapy and local infection. MRONJ is more prevalent in cancer patients receiving cumulative doses of intravenous BP as compared to the noncancer population, and studies support that cancer patients who receive intravenous BP are at higher risk for development of MRONJ. MRONJ risk in noncancer osteoporosis populations varies, with some studies indicating little to no significant association.

In recent years, various attempts have been made to investigate the epidemiological features and risk factors for MRONJ, but these investigations have been limited by methodological challenges. One challenge is temporal; accepted diagnostic criteria were not available initially and there was no specific diagnosis code for MRONJ in the International Classification of Diseases until several years after the condition was first reported. The prevalence of MRONJ can vary depending on case definition and the target population. In 2014, the American Association of Oral and Maxillofacial Surgeons (AAOMS) proposed this case definition of MRONJ based on current literature and clinical observations: Current or previous treatment with ART or antiangiogenic agents, exposed bone or bone that can be probed through an intraoral or extraoral fistula in the maxillofacial region that has persisted for longer than eight weeks and no history of radiation therapy to the jaws or obvious metastatic disease to the jaws.

The aim of this institutional study was to evaluate a few clinically relevant parameters such as the use and type of ART, the duration of drug treatment, the presence or absence of MRONJ, the presence or absence of cancer and the type of cancer associated with ART and MRONJ in an ethnically diverse and robust patient population at a major dental school in Los Angeles. Dental practitioners frequently treat patients who have taken ART, and thus population studies are important for better understanding MRONJ risk.

Methods

Data Sources

The Herman Ostrow School of Dentistry of USC electronic health record (EHR axUms; ExanSoftware, Henry Schein Co., British Columbia) was queried for patients of record for a 10-year period between 2007 and 2017 and data were collected via Oracle database management software by an information technology data analyst (AS) for this study. Institutional review board (IRB) approval was obtained for this study (USC protocol #UP-17-00870).

Study Population and Design

Inclusion criteria for this retrospective case-control study comprised patients with a history of ART use of any gender, age, ethnicity, department of care or duration of treatment from 2007 to 2017. Exclusion criteria comprised any patients who did not have a record of ART use or who had osteoradionecrosis. Patient information was deidentified and compiled in a Microsoft Excel spreadsheet (AS). The patient population from the years 2007–2017 (n = 142,352) was queried for the words related to osteonecrosis/MRONJ and ART resulting in 1,023 records with age, gender and ethnicity. These 1,023 records were divided among three researchers (LH, Al and PB) between January and April 2018 for analysis. The researchers then manually entered parameters including use and type of ART, the duration of drug treatment, the presence or absence of MRONJ, the presence or absence of cancer and the type of cancer when available, and thus population studies are important for better understanding MRONJ risk.
MRONJ Case Selection

Patients with any history of previous or current clinical signs and symptoms (radiographically present or clinically present nonhealing lytic and exposed bony lesions in the maxillofacial region with a history of ART therapy in accordance with AAOMS case definition) of MRONJ in their dental records were included in this study. The data were acquired by searching all dental records for the terms ONJ, MRONJ, BRONJ, BONJ, DRONJ and osteonecrosis and common misspellings of these terms. The International Classification of Diseases (ICD-10) code for MRONJ (M87.180) was also queried. Any dental records with positive findings were reviewed to verify a past or current lesion in the health history. Controls were identified as any patient who had a history of ART but did not have past or current lesions of MRONJ.

Exposure to ART

A history of ART was identified via annual medical history and digital dental records. The ARTs included in this study were pamidronate, alendronate, risedronate, clodronate, ibandronate, zoledronate and denosumab. All routes and dosages were included. Patients were categorized into mutually exclusive categories of ART user and nonuser. A nonuser was defined as having no records of an ART prescription at any time during or prior to 2007 and 2017. A patient who took at least one prescription during or prior to the observational period was considered an ART user. For every patient with a positive history of ART, the duration of treatment was investigated. The duration of treatment was determined based upon the details of the medical history and the dental records. The date that therapy was initiated and discontinued was used to determine the length of treatment. The duration of treatment was coded in terms of years and subdivisions of years (e.g., 18 months of treatment was coded as 1.5). If a patient had only one exposure to ART, the dosage of that treatment was taken into consideration (e.g., one exposure to alendronate 70 mg/wk was coded as one week out of a year or 0.192). If the patient did not provide a discontinuation date of the drug or the date was not recorded, the date of data collection was used as the end date, indicating use up to the study period.

Statistical Analysis

Descriptive statistics were presented for the study sample, mean and standard deviation for continuous variables and frequency for categorical variables. To investigate the relationship between the presence of MRONJ and ethnicity, the type of ART, the history of cancer and type of cancer, Chi-square tests were conducted. To investigate the differences in the duration of ART treatment in years between the groups with and without presence of MRONJ, we used an independent samples t-test. To investigate the relationship between the presence of MRONJ and the duration of ART over time, a Chi-square test was
conducted. The statistical significance was set at a p-value ≤ 0.05. Statistical tests were conducted with IBM SPSS Statistics version 25 (IBM, New York).

**Results**

Of our dental patients of record between 2007 and 2017 (n = 142,352), we confirmed 838 patients (0.6% of the total patient population) with a history of ART use. The ART patient population was comprised of 160 men, 675 women and three of unknown gender. For those 838 patients, we could determine the presence or absence of MRONJ in all. A subset of these patients had at least one MRONJ lesion (n = 223) for comparison to non-MRONJ patients (n = 615).

**Race/Ethnicity**

The frequency of patients for each self-reported race/ethnicity is presented in Figure 1 with a majority of Hispanic (40.6%) patients, followed by Asian (17.1%), African American (9.5%) and Caucasian (5.7%) with 11.6% choosing “other race” and 15.4% undeclared. The number of patients with the presence of MRONJ for each ethnicity/race is shown in Figure 2. A statistically significant association was identified between the presence of MRONJ and ethnicity (n = 838; Chi-square: p < 0.001). Overall, Asians had the highest occurrence of MRONJ as compared to any other race/ethnicity.

**Type of ART**

Alendronate was the most commonly used drug (prescribed to postmenopausal women to treat osteoporosis) with 61.0% of this sample having a positive history (oral route). The second most common was successive ART/combination therapy (up to three drugs), the third most common was risedronate (7.4%) and zoledronic acid was the fourth most common (Figure 3, n = 838).

**ART Treatment Duration and MRONJ**

Patients diagnosed with MRONJ received on average ART for 5.64 years ± 4.94 months compared to non-MRONJ patients who received ART for an average of 4.15 years ± 3.86 months (n = 677). A total of 161 patients had an unknown duration of therapy. The duration of ART therapy and the presence of MRONJ were statistically significantly positively correlated (n = 677; Spearman coefficient R = 0.155; p < 0.001). The odds of developing MRONJ in this sample of 677 patients for people who received ART for 5.64 years or more was 70.7% higher than people using ART for less time (OR = 1.707; 95% CI = 1.178 to 2.474; p = 0.005).

**ART Type and MRONJ**

A statistically significant association was identified between the presence of MRONJ and the type of ART taken (Chi-square: p < 0.001; n = 838). Figure 4 represents the number of patients with and without MRONJ for each type of ART. Patients taking only alendronate (n = 511) had 66% lower odds to develop MRONJ (OR = 0.34; 95% CI = 0.25 to 0.46; p < 0.001) than patients taking another ART (n = 327). By comparison, patients taking more than one BP (n = 85) had a 77.7% higher likelihood of developing MRONJ than patients taking one BP (OR = 1.78; 95% CI 1.11 to 2.84; p = 0.016). In this sample, patients taking zoledronate (n = 58) had 3.26 times greater likelihood of developing MRONJ than patients taking another ART (n = 780); patients taking risedronate (n = 62) had about the same likelihood of developing MRONJ than patients taking another ART (n = 776) with an OR = 0.956 (p = 0.882). Patients taking ibandronate (n = 41) had about a 30% greater likelihood of developing MRONJ than patients taking another ART (n = 797). Patients taking denosumab (n = 13) had about a 50% higher likelihood than patients taking another ART (n = 784).

**History of Cancer**

A history of cancer was also statistically significantly associated with MRONJ in this sample (n = 838; Chi-square: p < 0.001). Patients with a history of cancer who received ART were more than twice as likely to develop MRONJ (OR = 2.22; 95% CI = 1.58 to 3.11; p < 0.001) compared to patients with no history of cancer (e.g., for osteoporosis). There was a statistically significant difference in the occurrence of MRONJ depending on the type of cancer (N = 838; Chi-square: p < 0.001). The most common cancers in this sample were breast cancer (n = 83), prostate cancer (n = 27) and multiple myeloma (n = 26).
ART Therapy and History of Cancer

The frequency of patients with the presence of MRONJ for each type of ART is shown in Figure 5 for patients with a history of cancer and in Figure 6 for patients with no cancer history.

Discussion

Herein we evaluated a robust dental patient population at the University of Southern California with a history of ART for osteoporosis or cancer. We identified important demographic, pharmacologic and clinicopathologic factors associated with MRONJ as compared to patients without MRONJ. The incidence of MRONJ has been reported to range between 0.7% to 6.7% for cancer patients receiving intravenous zoledronate and at most 0.1% for osteoporosis patients taking oral BPs, which increased to 0.21% in patients with longer than four years of oral BP exposure. As a dental school, we are more likely to see MRONJ than in a medical setting or private practice dental setting, especially due to management expertise and referral biases. Therefore, our sample population does not represent the general dental population but provides the opportunity to conduct observational studies with larger sample sizes.

Importantly, case-control study designs such as this do not provide incidence or prevalence of a disease in their true sense. These study data are retrospective and based on tertiary care clinics and not data collected across a general population and thus are not meant to provide information on incidence or prevalence. Prospective population studies would better define true incidence or prevalence, and the multifactorial nature of MRONJ requires that consideration be given to independent risk factors that can impact incidence, such as duration of drug use and comorbidities to name a few.

Consistent with previous findings, the type of ART and the duration of use plays an important role in MRONJ risk. As found in a recent systematic review and meta-analysis of 13 studies, alendronate was the oral drug most commonly taken by the patients (72.2% for other authors and 61.0% for our study). This is expected as alendronate is one of the most frequently prescribed drugs and osteoporosis is a relatively common condition. Alendronate was also the drug with the lowest odds to develop MRONJ compared to other reported ARTs. In the cancer setting in this study, zoledronate was the most commonly used ART in patients who developed MRONJ. Again, this makes sense clinically as zoledronate is used frequently for the treatment of cancer patients and has significantly greater potency and pharmacokinetic bioavailability to the skeletal compartment than oral alendronate, which has hundredfold lower potency and less than 1% bioavailability following gastrointestinal absorption as compared to intravenous zoledronate.

The duration of treatment was also studied, and our patients taking ART for at least 5.6 years were more likely to have MRONJ lesions than those taking ART for a shorter duration of time. Other studies have found the important exposure duration to be three years prior for MRONJ development. With exposure to BPs, for example, it is postulated that with more temporal exposure to ART more drug is accumulated in the hard tissues of the mouth and thus the risk for MRONJ is higher. Theoretically, the more accumulated drug, the greater the changes in bone biology and the more difficult it is for the body to heal when infection due to invasive dental procedures is present.
This study found an association between the use of ART for cancer therapy and MRONJ lesions. Cancer has been shown to be an independent risk factor for MRONJ. This connection could be due to the immunocompromised state associated with cancer, which makes resisting oral infections and maintaining ideal oral hygiene a challenge. Our study found that breast cancer, prostate cancer, and multiple myeloma were the types of cancers most commonly presenting at our university dental school.

A significant limitation of this study, like many retrospective studies, is the heterogeneity of the reporting of the data by clinical practitioners. There were a number of patient records with no specific cancer name or no duration of treatment entered in the chart. Also, we are a major referral center for MRONJ cases in the Los Angeles area, thus we have sampling and referral bias. This makes for inflated values of MRONJ occurrence that are not generalizable to other populations. Further, certain Asian populations have greater risk for MRONJ for yet unknown reasons that may include genetic factors or ART overtreatment. Accordingly, we have a large Asian population in Los Angeles and in our study, thus further inflating MRONJ occurrence. Overall, our MRONJ occurrence and target population may not be representative of the overall occurrence in different populations at large and so our results should not be generalized to other populations. Finally, not all patients taking ART will report this in a health or dental record. This will lead to underestimated numbers of controls, again relatively inflating the number of disease cases. There are many reasons for this, including patients not remembering that they are taking one of these medications given the weekly or monthly dosing, for example, in the osteoporosis setting. In other cases, patients do not know what a BP or ART is even if they are taking it, particularly with the different ethnicities and languages represented here, and thus they do not always self-report taking such a medication. Additionally, the duration of therapy varied from 0.3 to 10 years, explaining the large standard deviation of our results in this context.

In this study, we did not report the average age of patients because we found these values to be higher than previous reports due to the nature of our study query and our electronic health record, axiUm. This increased age variable could intrinsically make sense, as those of more advanced age could have greater cumulative exposure to ART and thus potentially more adverse effects associated with therapy. Unfortunately, this variable is inaccurate in our study due to a common confounding factor associated with retrospective studies utilizing databases like axiUm. The axiUm software keeps patient records that are not updated with the vitality of the patient; thus, there are likely some patients who are deceased who have been included in this study but their death date is not included in axiUm charting, creating a bias for older age. This type of variable and discrepancy could be overcome if medical records are merged with dental records. Finally, retrospective studies such as this naturally suffer some degree of observational bias and confounders given the multifactorial nature of MRONJ development. These aforementioned factors highlight study limitations, some of which are relatively common and inherent to MRONJ investigations in this context.

Conclusions

The findings in this study characterize some of the factors associated with MRONJ in our patient population at the Herman Ostrow School of Dentistry of USC. Those at highest risk are onologic as compared to osteoporotic patients and Asians, and long-term use increases risk for MRONJ in the ART population. The data are important for clinicians in order for them to better understand what factors are associated with MRONJ development in this patient population and also to identify which patients could benefit from risk reduction and prevention protocols prior to invasive oral surgical procedures, as one example.

REFERENCES


THE CORRESPONDING AUTHORS, Fardis Barati Mahvar, BS, and Laurel Henderson, DDS, MS, can be reached at baratima@usc.edu and laurrethe@usc.edu.
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Circadian Behaviors of Oral and Skin Fibroblasts

John Ngo, BS; Hodaka Sasaki, DDS, PhD; and Ichiro Nishimura, DDS, DMSc, DMD

ABSTRACT One of the key factors in oral and skin wound healing is fibroblast behaviors. This study reports fibroblasts derived from mouse palatal mucosa and dorsal skin. Oral fibroblasts exhibited robust expression of core clock genes as compared to skin fibroblasts and a clear circadian pattern in the cell migration and floating collagen gel contraction in vitro. Our study suggests that oral wound healing involving fibroblast repopulation and contraction may follow a diurnal cycle.

AUTHORS

John Ngo, BS, a third-year dental student at the University of California, Los Angeles, School of Dentistry. He received his undergraduate degree in biological sciences from UC Irvine. His research in the Nishimura Lab at the Weintraub Center for Reconstructive Biotechnology focuses on the circadian rhythm and its effect on wound healing.

Conflict of Interest Disclosure: None reported.

Hodaka Sasaki, DDS, PhD, is a lecturer in the department of oral and maxillofacial implantology at Tokyo Dental College. He previously performed research as a visiting assistant project scientist in the Nishimura Lab at the Weintraub Center for Reconstructive Biotechnology.

Conflict of Interest Disclosure: None reported.

Ichiro Nishimura, DDS, DMSc, DMD, is a professor of dentistry and bioengineering at the University of California, Los Angeles, and the founding director of the Weintraub Center for Reconstructive Biotechnology at the UCLA School of Dentistry.

Conflict of Interest Disclosure: None reported.

The skin and oral barriers in humans are comprised of an overlying epithelial layer and an underlying connective tissue. In response to injury, however, oral mucosa presents better wound healing than skin, resulting in minimal or practically no scarring.1,2 One of the key differentiating factors in the environment that account for the accelerated healing observed in the oral mucosa is the presence of saliva. Saliva contains multiple key growth factors and cytokines, including epidermal growth factor (EGF) and transforming growth factor (TGF-a).3,4 Cell migration and proliferation of oral epithelial cells are increased in the presence of EGF-containing saliva and are decreased upon exposure to EGF-inhibiting factors.3 Moisture balance provided by saliva is also a critical facilitator of the wound healing process.5 While environmental factors of the oral cavity contribute to better wound healing, it must be noted that skin transplanted into the oral cavity retains its original behaviors such as keratin production and proliferation patterns.6 Therefore, intrinsic factors of oral barrier tissue and, in particular, oral fibroblasts may affect wound healing.

We propose that the intrinsic factors regulating oral fibroblast behavior may include the molecular clock mechanism, which has been shown to control wound healing.7,8 The central circadian rhythm is maintained in the suprachiasmatic nucleus (SCN), a region in the hypothalamus responsible for regulating physiological homeostasis.9 The molecular clock mechanism consists of a transcriptional/translational feedback loop orchestrated by clock genes10 (Figure 1). Circadian Locomotor Output Cycles Kaput (Clock) and Brain and Muscle Arnt-Like protein-1 (Bmal1) perform as positive feedback signals. The heterodimeric transcriptional factors CLOCK and BMAL1 activate transcription of Period (Per) and Cryptochrome (Cry) genes,11,12 Their protein products form PER-CRY heterodimers, which in turn inhibit the transcriptional activation by CLOCK and BMAL1,13 These circadian rhythm genes...
are not only expressed in the SCN but also have been observed in various peripheral tissues, such as heart and vascular tissues,14,15 skeletal tissue,16,17 fibroblasts18–20 and dento-craniofacial tissues.21,22

By analyzing the International Burn Injury Database (iBID), Hoyle et al. found that skin burn injuries that occurred during the day healed significantly faster than the nighttime burn injuries.8 This peculiar wound healing dichotomy was explained by the molecular clock regulation of skin fibroblast behaviors such as migration to the wound site.8 We recently reported that skin fibroblast behaviors such as migration to the wound site.8 We recently reported that skin fibroblasts, such as oral fibroblasts, exhibit more pronounced circadian behaviors in oral and skin tissues,14,15 skeletal tissue,16,17 fibroblasts18–20 and dento-craniofacial tissues.21,22

The objective of this study was to characterize clock gene expression and circadian behaviors in oral and skin fibroblasts. We report that oral fibroblasts exhibited more pronounced clock gene expression profiles than skin fibroblasts. Unlike skin fibroblasts, oral fibroblasts demonstrated the circadian pattern of in vitro migration and gel contraction. Our data suggest that the fibroblast-specific molecular clock mechanism may contribute to the unique behavior of oral wound healing. This study investigated the genes associated with the circadian rhythm, including Npas2, Per1, Per2, Per3, Bmal1, Cry2 and Clock. An Npas2 knockout (homozygous deletion for Npas2) mouse model was used to examine the specific effect of Npas2 on fibroblast behaviors. The study identifies circadian genes that may be potential therapeutic targets to increase wound healing, which may improve the outcome of various surgical procedures in dentistry.

Materials and Methods

Animal Ethics Statement

Oral and skin fibroblasts from C57Bl/6J female mice were used in this experiment. Human and animal studies showed that gender differences in the circadian rhythm are very small.27 To date, no sex differences were observed on the expression of circadian clock period and phase of cells.28 The effect of sex as a biological variable using peripheral cells such as oral and skin fibroblasts was considered limited for the cellular-base circadian rhythm expression; in our project, we used oral and skin fibroblasts harvested only from female mice. All of the experimental protocols using animals were reviewed and approved by the UCLA animal research committee (ARC No. 2003-009) and followed the Public Health Service Policy for the Humane Care and Use of Laboratory Animals and the UCLA Animal Care and Use Training Manual guidelines. All of the animals had free access to food and water and were maintained in regular housing with a 12-hour light/dark cycle at the Division of Laboratory Animal Medicine, UCLA.

Oral and Skin Fibroblast Cell Cultures

Primary fibroblasts from female mice (10–20 weeks old) dorsal skin and from the palatal oral mucosa were cultured in Dulbeco’s Modified Eagle’s Medium (DMEM) with 10% fetal bovine serum and 100 U penicillin/0.1 mg/mL streptomycin at 37°C, 5% CO2 in a humidified incubator. In a separate experiment, palatal oral mucosa fibroblasts were harvested from female mice carrying Npas2 knockout mutations.20,24,26

Fibroblasts of passages 3 ~ 5 were used in this study. A WST-1 assay was performed to monitor cell proliferation activity.
Circadian Gene Expression in Skin and Oral Fibroblasts

Messenger RNA expression of seven circadian genes in oral and skin fibroblasts, as well as in Npas2 KO oral fibroblasts, was determined by quantitative real-time polymerase chain reaction (RT-PCR) using TaqMan MGB probes (Thermo Fisher Scientific Inc., Waltham, Mass.). Fibroblasts were cultured in 24-well plates and synchronized at 80% confluence via addition of 100 nM dexamethasone to the medium and incubated for two hours, followed by washing with DMEM. Dexamethasone is known to exert a synchronizing effect on circadian rhythms. Total RNA was extracted (RNasey kit, Qiagen, Valencia, Calif.) every six hours for 48 hours (n = 4 per time point) after the synchronization. After quantity and quality of the RNA were examined, RT-PCR was performed to quantify RNA expression using commercially available RNA primers for each gene. Glyceraldehyde 3-phosphate dehydrogenase (GAPDH) was used as the housekeeping control. The circadian expression pattern of clock genes was compared between skin and oral fibroblasts by two-way analysis of variance (ANOVA). The interaction between time and fibroblast origin was used to assess the circadian expression pattern of core clock genes. P-values < 0.01 were considered statistically significant.

In Vitro Wound Healing Scratch Plate Assay

Fibroblasts were seeded into a 6-well plate and synchronized as described above. After two hours, scratch lines were created with a plastic pipette and wells were washed with medium (n = 5 per group). These scratched areas were examined by photomicrography every hour from zero to 24 hours. The number of cells that migrated into the scratched area was counted at three, six, nine, 12, 15, 18 and 24 hours. The increased number of cells from the previous time point (CN) determined the cell migration rate (Rmag) that was standardized by the total cells in the scratch area at 24 hours.

\[ R_{mag} = \frac{CN_{t} - CN_{t-3}}{|CN_{t24} - CN_{t0}|} \]

The cell migration rate of oral and skin fibroblasts was compared by two-way ANOVA. P-values < 0.01 were considered statistically significant. When the significance by two-way ANOVA was reached, a Student’s t-test was performed for each time point.

Floating Collagen Gel Contraction Assay

The floating collagen gel contraction assay was performed following the published protocol. A 500 μL collagen type 1 gel mixture containing 50,000 oral or skin fibroblasts was placed in a 24-well plate (n = 5 in each group) and incubated at room temperature for 20 minutes. In a separate experiment, oral fibroblasts isolated from palatal gingiva of Npas2+/− and Npas2−/− mutant mice were used. The solidified gels were transferred to a 100 mm diameter dish and cultured (37 °C, 5% CO₂ in a humidified incubator). The gel images were scanned by a desktop scanner at zero, six, 12, 18, 24 and 48 hours. The area of each gel (GA_{t}) was determined in the scanned images. The gel contraction percent (Rgel) was determined by the gel area difference between the time point of interest and the initial time point standardized by the gel contraction rate at 48 hours.

\[ R_{gel} = \frac{GA_{t} - GA_{t0}}{|GA_{e88} - GA_{t0}|} \]

Two-way ANOVA was performed and p-values < 0.01 were considered statistically significant. When the significance by two-way ANOVA was reached, a Student’s t-test was performed for each time point.

Results

Circadian Clock Gene Expression in Oral and Skin Fibroblasts

Oral and skin fibroblasts were successfully synchronized in their circadian rhythms and harvested. A WST-1 assay was used to evaluate cell proliferation and indicated that there was no significant difference in proliferation activity between oral fibroblasts and skin fibroblasts (data not shown). RT-PCR was performed after synchronization in order to examine the peak time points when the fibroblasts expressed the highest amount of the assayed RNA. RT-PCR of the oral and skin fibroblasts depicted cyclical pattern of the circadian rhythm gene expression (Figure 2). Over the 48-hour period, the circadian expression patterns of Per1, Bmal1 and Npas2 were found more prominent in oral fibroblasts, indicating clearer diurnal peaks than those of skin fibroblasts (two-way ANOVA, p < 0.01). The circadian expression timing of Per3 and Cry2 differed significantly between oral and skin fibroblasts. These experiments revealed that the clock gene expression pattern of fibroblasts was tissue-source specific.

Different Circadian Pattern of Oral and Skin Fibroblast Migration

Scratch tests were performed in order to quantify the rate of fibroblast migration. Time-lapse photomicrographic recording of the in vitro wound healing scratch test demonstrated that oral and skin fibroblasts migrated into the created void area (Figure 3A). The total number of oral fibroblasts that migrated into the created void area was less than that of skin fibroblasts at 24 hours. There was no observable difference in fibroblast migration at the 48-hour mark. Interestingly, the rate of oral fibroblast migration was minimal at the early time period. The oral fibroblast migration
FIGURE 2. Core clock gene expression in oral and skin fibroblasts. RT-PCR expression of seven messenger RNA strands after fibroblast circadian rhythm synchronization with dexamethasone over a period of 48 hours. Circadian rhythm of both the oral mucosa (OM) fibroblasts and skin (SK) fibroblasts was confirmed. Oral mucosa circadian rhythm expression was generally more robust than skin fibroblast expression.
increased between six hours and nine hours and peaked at 12 hours followed by a slow migration period (FIGURE 3B). By contrast, skin fibroblasts migrated immediately during the zero to three-hour period followed by the slower migration activity. The migration patterns of oral and skin fibroblasts were statistically significant (two-way ANOVA, p < 0.01). This study suggested that the cell migration activity of oral and skin fibroblasts within the 24-hour period was significantly different.

**Different Floating Collagen Gel Contraction Pattern of Oral and Skin Fibroblasts**

Collagen gel contraction was used to assess in vitro fibroblast behaviors. Increased gel contraction in vitro has been used as a surrogate measurement to demonstrate increased wound closure and healing. At 48 hours, oral fibroblasts displayed greater gel contraction than skin fibroblasts (FIGURE 4), which was consistent with published observations. This study further demonstrated that oral fibroblasts were slow to start the gel contraction during the first 12 hours, followed by the increased gel contraction (FIGURE 4). By contrast, skin fibroblasts induced rapid gel contraction during the first 12-hour period followed by the relative inactivity. The contraction pattern between oral and skin fibroblasts was significantly different (p value < 0.01).
Because the peak expression timing of a core circadian gene, \textit{Npas2}, in oral fibroblasts appeared to coincide with the peak activities of cell migration and floating collagen gel contraction, we examined the potential role of \textit{Npas2} in the distinct behavior of oral fibroblasts. The floating collagen gel contraction assay depicted the early contraction activity in \textit{Npas2}^{+/–} (heterozygous knockout) and \textit{Npas2}^{–/–} (homozygous knockout) oral fibroblasts (\textbf{Figure 5A}). While \textit{Npas2}^{+/–} oral fibroblasts still retained the gel contraction activity at 12 hours, \textit{Npas2}^{–/–} oral fibroblasts

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5a.png}
\caption{Npas2 Knockout Mutation in Oral Fibroblasts Attenuated Circadian Pattern of Floating Collagen Gel Contraction}
\end{figure}

Npas2 knockout oral fibroblasts have significantly less Npas2 expression (\(p < 0.001\)). Relative gene expression of the other circadian rhythm proteins in wild type, \textit{Npas2} heterozygotes and \textit{Npas2} homozygotes (\textbf{Figure 5C}). The other six genes had no significantly altered RNA expression in response to knocking out Npas2. Npas2 knockouts had significantly less Npas2 expression (\(p < 0.001\)).
appeared to have lost the contraction activity during this period, resulting in a plateau in the gel contraction (Figure 5B). As a result, the gel contraction behavior of \(Npas2^{-/-}\) oral fibroblasts, resembling skin fibroblasts, was statistically different from that of wild type oral fibroblasts. The \(Npas2\) knockout mutation did not affect the expression of other clock genes although \(Per2\) and \(Per3\) expressions were slightly decreased (Figure 5C).

**Discussion**

Connective tissue fibroblasts present a wide range of phenotypic diversities.\(^{36}\) A large number of studies have reported that oral fibroblasts increase the floating collagen gel contraction in vitro\(^{37-39}\) and synthesize growth factors,\(^{37,40}\) collagens and remodeling enzymes.\(^{36,41,42}\) Overall, oral fibroblasts are proposed to contribute to faster oral wound healing and less scarring than their dermal counterparts.\(^{32,41}\) The present study further revealed that oral and skin fibroblasts significantly differ in their circadian behaviors.

The role of the molecular clock mechanism during dento-cranial tissue embryogenesis and development has been researched. For example, Lacruz et al. reported circadian expression of \(Per1\), \(Per2\) and \(Bmal1\) in ameloblast-like LS8 cells.\(^{44}\) Zheng et al. also reported circadian expression of core clock genes in an ameloblast cell line.\(^{45}\) These studies further demonstrated the circadian expression of amelogenin (\(Amelx\)), a critical enamel-specific protein,\(^{44,45}\) suggesting that enamel development is regulated by a circadian clock mechanism. In fact, the enamel rods show transverse lines called cross-striations, and enamel development has been suggested to have a circadian pattern.\(^{46}\)

In order to regenerate lost tissue, wound healing reiterates, at least in part, tissue-specific embryogenesis and development processes. It has been suggested that the circadian clock genes regulate cell migration of mesenchymal stromal cells,\(^{47}\) hematopoietic immune progenitor cells,\(^{48,49}\) and fibroblasts,\(^{5,20}\) all of which participate in wound healing. Oral fibroblasts were able to complete the wound healing process faster than their skin counterparts with minimal scarring in the oral cavity. The expression of circadian clock genes (\(Per1\), \(Cry1\), \(Bmal1\) and \(Clock\)) has been postulated to be responsible for physiological variations in cell proliferation of human oral mucosa.\(^{50}\) Therefore, this study investigated the tissue-specific molecular clock mechanism and circadian behavior of oral fibroblasts.

The scratch test (Figure 3) and the floating collagen gel contraction assay (Figure 4) revealed that oral fibroblasts behaved differently from skin fibroblasts and the peak oral mucosa fibroblast activity is observed to occur at 12 hours. However, skin fibroblasts are observed to contract the gels slowly, with no further substantial contraction after six hours. Furthermore, both cell migration and the collagen gel contraction assays indicated that oral fibroblast behavior was most substantial at the same time point when \(Npas2\) expression in oral mucosa fibroblasts peaked (Figure 2). An experiment involving \(Npas2\) knockdown in human colorectal cancer cells demonstrated an increased cell migration and cell proliferation activities.\(^{51}\) Therefore, we examined if a complete \(Npas2\) knockout mutation affected their behavior. The \(Npas2\) knockout mutation in oral fibroblasts significantly decreased the midday activity of collagen gel contraction (Figure 5), and thus, \(Npas2^{-/-}\) oral fibroblasts mimicked the skin fibroblast behavior (Figures 4 and 5). In conclusion, our observations suggest that \(Npas2\) gene expression plays an essential role in oral wound healing. An increase in \(Npas2\) gene expression would increase the speed of oral mucosal wound healing by promoting fibroblast behavior. \(Npas2\) knockout fibroblasts display fibroblast behaviors that are similar to skin fibroblasts. Furthermore, increased \(Npas2\) expression has been linked with enhanced osseointegration with rough surface implants.\(^{24}\) These findings suggest that \(Npas2\) expression may become a future therapeutic target to hasten implant and implant-supported crown delivery time.

Recently, Janjic and Agis proposed “chronodentistry,”\(^{22}\) in which therapeutic application in dentistry might consider circadian rhythm for more effective outcome. For example, swelling after oral surgery does not reduce progressively but follows a circaseptan (approximately seven days) rhythm.\(^{52,53}\) Furthermore, environmentally induced “jet lag” in mice affects the corneal epithelium renewal and repair.\(^{54}\) These studies, in addition to the findings presented here, highlight the potential role molecular clock genes could play in wound healing. For this reason, clock genes...
could be a potential therapeutic target. It is possible that manipulation of these genes could decrease healing times following surgical procedures in dentistry, including implants, apicectomies, free gingival grafts and crown-lengthening procedures, which would all benefit from a decreased recovery time. The exact process of wound healing is currently unknown; however, the outcome of this study suggests that further investigation of circadian clock gene regulation may provide an important clue in accelerating oral mucosa wound healing following dental surgical procedures.

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REFERENCES
23. Sukotjo C, et al. Oral fibroblast expression of wound-inducible transcript 3.0 (wit3.0) accelerates the...

THE CORRESPONDING AUTHOR, Ichiro Nishimura, DDS, DMSc, DMD, can be reached at inishimura@dentistry.ucla.edu.
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ORANGE COUNTY


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Reduce Risk, Increase Productivity With Cellphone Policies

TDIC Risk Management Staff

There is little doubt that cellphones have dramatically changed our lives. In fact, “phone” is a bit of a misnomer, as it does so much more than make and receive calls. These mobile devices are now computers, cameras, media players, e-readers and GPS trackers all rolled into one.

It’s not surprising then that few of us can go a day without our cellphone by our side. They have become ubiquitous, accompanying us in the car, in meetings, in restaurants and in the workplace. But this puts employers in a difficult spot. Not only does cellphone use bring up questions of productivity and professionalism, it also brings up questions of privacy when used in a dental office setting.

According to a survey conducted by CareerBuilder, more than half the respondents identified cellphone use as the biggest productivity killer in the workplace. The consequences of lost productivity are direct and indirect, causing reduced employee morale, strain on employer-employee relationships, a lower quality of work and negative impact on client interactions.

The Dentists Insurance Company reminds dentists that cellphone use during work hours can send the message that patients are not the practice’s priority. It can also lead to distractions, which can result in errors in documentation and lack of attention to detail, opening the practice to a liability claim.

The Dentists Insurance Company’s Risk Management Advice Line has received several calls regarding cellphone use in the office. In one case, a practice owner called about a dental assistant who was repeatedly on her phone. At a performance review six months prior, she was instructed to put her phone away during the workday. After that time, her restroom breaks increased, suggesting she was using her phone in the restroom.

The Risk Management analyst informed the dentist that it is within an employer’s right to require employees to keep their phones in a drawer and to limit their use to designated break periods. The analyst suggested the office create a universal cellphone-use policy and distribute it to all employees. Violation of this policy would be grounds for disciplinary action, including termination.

In another situation, a dentist reported that her head assistant, who had been with the practice for 14 years, was “addicted” to her phone. The employee would read (and send) text messages during morning huddles and would have her phone in her hand while greeting patients. She would even leave her phone out during treatments. The employee manual stated that cellphone use was not allowed during work hours and was only allowed during breaks and lunch periods. The dentist relied on this employee heavily and didn’t want to lose her.

The Risk Management analyst guided the dentist to apply policies consistently with all employees. She advised the dentist that in addition to addressing the matter with the employee directly, to hold an office meeting to remind staff of the office’s cellphone policy.

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and to make it clear that they could be subject to termination if they are caught violating the policy repeatedly.

Written policies are an employer’s best protection against excessive cellphone use during work hours. While banning cellphone use entirely isn’t feasible, it is appropriate to limit when employees can use phones, such as during meal and rest periods. It is also recommended that cellphones be kept with an employee’s personal belongings or in a drawer to avoid distraction.

It’s not enough to simply have a policy. Following through with disciplinary action demonstrates that you are committed to breaking cellphone rules if they know that the policy is more than an empty threat.

Other cellphone-use considerations include:

- Restricting locations where cellphone use is permitted. For example, it is reasonable to prohibit their use in operatories, in the front office or in the presence of patients.
- Outlining what type of use is allowed. For example, texts and brief phone calls are fine, but downloading music or videos is not.
- Minimizing disruptions. Employers can request that ringers are set to silent or vibrate, calls are kept brief and free from offensive language and employees speak quietly when on the phone.
- Protecting privacy. Policies should prohibit taking photos or videos within the practice to protect patient privacy, unless preapproved by the dentist.
- Employee safety. Employees should not use a cellphone while driving on company business or when engaged in physical activities such as carrying an instrument tray.

- Infectious disease control. Cellphones are believed to harbor as much as 10 times the bacteria as toilet seats. But unlike toilets, people rarely disinfect their phones. A 2014 study showed cellphones are frequent contributors to hospital-acquired infections in the dental setting.
- TDIC’s Risk Management team also warns dentists of the inherent risks of texting patients with regards to protecting privacy. It is recommended that dental practices avoid texting patients altogether, but if you must text a patient, be sure to avoid sending any protected health information and make sure the communication is documented in the patient’s chart. Text messaging is only considered HIPAA compliant under certain circumstances. If your practice intends to text patients regularly, seek a secure, HIPAA-compliant third-party vendor that offers the needed encryption.

It is also recommended that dental practices develop a policy regarding communication expectations between employees and their employer. For example, it is a best practice to call in sick, rather than send a text. If an employee is unable to report to work, it is advised they speak to the dentist or office manager directly by phone.

In a case reported to the Risk Management Advice Line, a dentist stated he received a text from an employee at 4 a.m. on a Saturday that conveyed she would not be able to make it to work that day. The dentist called the employee back immediately after receiving the text. When the employee answered, the dentist heard “what sounded like Vegas in the background.” He later found photos of a bridal shower at a local casino posted on the employee’s Facebook page. Had the employee called in, it would have been clear that she was not, in fact, sick. But the office did not have such a policy in place at the time.

The issue in the above case was the informality of the communication. Texting reduces an employee’s accountability as well as the likelihood that these interactions will be documented in the employee’s file. Additionally, there are often cases in which an employee is texting nonmanagement staff members rather than those to whom they should be reporting. This should not be allowed. Following up with a phone call is not intended to catch employees doing something they shouldn’t be doing; rather, it is to have a conversation about the behavior and to inquire whether the employee has available sick time or PTO.

Cellphone-use policies should be documented in writing, signed by the employee and kept within the employee file. It’s important to note that dentists should model acceptable cellphone use in the office. Setting the tone means avoiding the impression of being distracted by a call and limiting phone use to appropriate times that do not interfere with patient care.

Cellphones are an integral part of our daily lives. It’s hard to imagine a time when we weren’t reachable every moment of every day or when we didn’t have access to information at our fingertips. In the workplace, smart cellphone policies as part of a comprehensive employee manual can help your office maintain productivity, increase professionalism and ensure patient privacy is protected.

TDIC’s Risk Management Advice Line is a benefit of CDA membership. If you need to schedule a no-cost consultation with an experienced risk management analyst, visit ticinsurance.com/RMconsult or call 800.733.0633.
4381 SOUTH SAN FRANCISCO GP  Retiring dentist offering 23 year practice close to Kaiser Hospital. 4 op facility with new & recently upgraded equipment. Asking price to be determined.

4359 SANTA CRUZ GP  offering 30+ years of goodwill within walking distance to the beach! Located in a well-established, attractive, single story professional building complex with ample parking, good visibility and easy access. 2 doctor days/week, 2 hygiene days/week, 380 active patients with approx. 10 new patients/mo. 3 fully equipped ops in 850 sq. ft. Average GR $250K with Average adj net of $135K. Asking price $150K.

4368 SANTA CLARA GP  25 year practice in community retail center near Levi Stadium. Nice fully-equipped 700 sq. ft. facility with 5 ops. Average Gross Receipts based on 3 years is $583K. Asking $350K.

4380 SAN MATEO GP  Unique opportunity to own a San Mateo GP. This location generates significant foot traffic. 1,498 square foot facility with 4 ops, reception area, business office, private office, staff lounge, lab area, sterilization area, bathroom, storage & dedicated parking spaces. Current Gross Receipts annualizing at $431K with an adjusted net of $192K. Seller will help for smooth transition. Asking $292K.

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4370 SAN JOSE PROSTHODONTIC PRACTICE  Cosmetic and prosthodontic practice established 40+ years. Located in a busy commercial/residential area of San Jose, close to several amenities, referral sources. 4 fully equipped ops in 1,074 sq. ft. facility. Lots of on-site parking and EZ freeway access. 3 yr. average GR $554K+ with average adjusted net of $180K. Approx 700 active patients, all completely fee-for-service (Seller is not contracted with any insurance companies or Delta). 2 days of hygiene/week. Owner transitioning into retirement, will help for smooth transition. Asking $299K.

4338 PENINSULA PROSTHODONTIC PRACTICE  Preeminent 45 year Prosthodontic practice located in mid peninsula neighborhood. State-of-the-art 1,242 square foot facility with 5 operatories. Seller willing to help in the transition. Outstanding referral sources. Average Gross Receipts $1.3M with 4 doctor-days per week. Asking $884K.

4382 MONTEREY COUNTY GP  Gorgeous practice in scenic Monterey Bay peninsula in ample seller owned building with state-of-the-art equipment. $900K+ average annual gross receipts with 4 doctor days. Asking $678K.

4343 CAPITOLA GP  Gorgeous, state-of-the-art practice offering 33+ years of goodwill. Beautifully appointed office environment and building, located within minutes of charming downtown Capitola, known for its colorful, seaside shops and restaurants tucked into a hillside along Soquel Creek. Must see this office to appreciate its splendor. Asking $643K for practice. Seller owns building; it is available for purchase, or to lease.

4366 SONOMA COUNTY GP  Fabulous practice and location within one of the North Bay’s gems of a town. Classically beautiful and well appointed office with 4 ops in 1,425 sq. ft. Fantastic storefront location on a well traveled road, walking distance to the pedestrian-friendly center of downtown. 900+ active patients, all fee-for-service. No Delta Dental Patients. 4 doctor days/week and 4 hygiene days/week. Last two years average GR $866K with average adj. net of $407K. Seller will help for smooth transition. Asking $650K.

4375 LOS GATOS FACILITY  Seller offering fully equipped, state-of-the-art, modern, 2 operatory facility including furniture, fixtures and leasehold assets in medical office building adjacent to Los Gatos Community Hospital. Asking $250K.

4362 MARIN COUNTY GP  Seller owned 1,550 square foot facility with 5 fully-equipped ops. Owner/Doctor transitioning into retirement and offering 36 years of goodwill in desirable area. Located on a well traveled road in a charming town with temperate weather, easy, outdoor living and natural beauty. Enjoy California living at its best. No Delta Premier patients. Excellent reputation and word-of-mouth referrals. Seller will help for smooth transition. Average Gross Receipts last 2 yrs is $450K. Asking $248K for the practice. Blvd condo is available for purchase.

4355 SAN FRANCISCO ENDO  Endodontic practice in signature building with wealth of referral sources. State-of-the-Art, modern, 1,027 square foot office with 2 fully equipped ops. Well established, seller with sterling reputation willing to help for smooth transition.

4216 SIERRA NEVADA FOOTHILLS  23 year practice located in the heart of the Sierra Nevada foothills in modern building close to downtown area. 1,024 square foot office with 4 fully-equipped ops., upgraded major equipment and digital radiography. Average Gross Receipts $890K+ with 56% average overhead. Asking price for practice $604K.

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When it comes to managing your practice, you’re not alone. Our smart analysts have dentistry-focused expertise in leadership, ownership, patient management, practice systems and transitions. Tap into one-on-one guidance by phone or explore an online library of tools and guides.
Aspects of the Health Insurance Portability and Accountability Act (HIPAA), which became law in 1996, continue to be misinterpreted by health care providers who are covered entities. Dentists who do not understand basic elements of the law risk paying more for compliance efforts and can fail to meet the law's standards. This article explains common misunderstandings heard by CDA Practice Support staff from dentists and their staff.

Every health care provider must comply with HIPAA rules.

Only health care providers that conduct certain transactions electronically are required to comply with HIPAA.1 The covered transactions include but are not limited to:

- Submitting a claim for payment (even if it is submitted on paper to a claims clearinghouse that electronically submits the claims to the payer).
- Checking patient eligibility for benefits and coverage under a plan.
- Requesting authorization for treatment.
- Requesting status of a claim.

These health care providers, along with claims clearinghouses and health plans, are generally referred to as HIPAA-covered entities.

Therefore, it is possible for a dental practice to maintain patient information electronically and to not have to comply with HIPAA because the practice does not conduct the covered transactions electronically. Regardless of HIPAA, all state health care providers must comply with California’s Confidentiality of Medical Information Act that is similar to HIPAA and is in some aspects more stringent.

HIPAA requires a written patient authorization in order to share patient information with family and friends. Not in every situation. The law permits a HIPAA-covered entity to infer, based on professional judgment, that a patient does not object to the entity sharing information with family or individuals involved in the care of the patient.2 For example, a dental practice with a family as long-time patients may not need written authorization to share an adult child’s treatment information with a parent because the practice knows the parent coordinates every family member’s treatment. An example of when a dental practice may want to obtain written authorization is when a patient moves out of the area, a dental practice may require a patient’s written authorization to confirm the patient’s desire to share information with a new dentist.

Providing patient information to another health care provider requires patient authorization.

This type of disclosure for the purpose of treating the patient is permitted without patient authorization, for example, when a general dentist forwards patient information to a specialist to whom they are referring a patient. In other circumstances, such as when a patient moves out of the area, a dental practice may require a patient's written authorization to confirm the patient's desire to share information with a new dentist.

It is a legal requirement to provide annual HIPAA training to employees.

HIPAA requires covered entities to train their workforce but its occurrence is not calendar dependent. Training at a small dental practice could be as simple as providing employees with the practice’s privacy and security policies and documenting their review.1 After initial training, employees should be trained again after a material change in office policy or in the law. An employee who has failed to follow the dental practice’s policies and procedure should be retrained.
The designated privacy officer and security officer should have a higher level of training because they are ultimately responsible for inventorying where the dental practice’s patient information is stored and how it moves, assessing risks to that information, implementing a risk management plan that includes required safeguards and developing the dental practice’s written policies and procedures. They are responsible for documenting the practice’s compliance efforts.

Patient information cannot be taken out of the facility.

Patient information can be taken out of the facility as long as there is a legitimate need to do so and the dental practice has taken reasonable safeguards to protect the information. For example, an associate dentist may need to follow up with patients in the evening after treatment. The practice should have a policy that describes the business reasons for which patient information may be taken out of the facility and that the information should be limited to the minimum necessary to accomplish the task. The policy can include details and options such as electronic communication of patient information and destruction or return of information after use.

Sharing treatment details without patient identifiers with a study club does not require patient authorization.

Has everything shared with a study club been stripped of patient identifiers? Does the context of the presentation provide clues about the patient? Just because information is not visible to the eye does not mean a digital image cannot be linked to an individual. Digital images have metadata that can be linked to an individual if the image is posted online. It is best to obtain patient authorization to use their information for nontreatment purposes.

A covered entity must ensure electronic patient information is received securely.

A covered entity is responsible for the secure communication of patient information unless the patient has given informed consent to receiving the information via unsecure email. A covered entity should verify the recipient’s email address is correct but is not required to verify the recipient’s email inbox is secure. If the recipient is a HIPAA-covered entity, then the recipient is required to ensure stored electronic patient information is secure.

The Notice of Privacy Practices and business associate agreements are the only HIPAA documents required.

A covered entity investigated by the U.S. Department of Health and Human Services Office for Civil Rights for a patient complaint or security incident will be requested to produce myriad documentation. A description of required documents will be the subject of this column in January 2020.

REFERENCES
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6169 VACAVILLE  Long established Delta PPO practice. 5-days of hygiene. 2019 trending $700,000+ with Available Profits of $280,000. Great north side location. Full Price $300,000.

6168 SACRAMENTO'S CAMPUS COMMONS  “Bread & butter” Delta PPO practice averages $480,000 in collections per year. Well liked Dentist. 10+ weeks off a year. 4-days of Hygiene. 3-D Cone Beam. Great implant upside as retirees in area require this service. Full Price $200,000.

6167 NORTH SANTA CLARA COUNTY  -  “OUT-OF-NETWORK”  Perfect for Skilled Dentist who seeks strong patient relationships and wants to be insurance independent! 2019 trending $840,000+ on Owner’s 3-day week. Office has been upgraded and charting is paperless.


6165 ROSEVILLE ORTHO  – “OUT-OF-NETWORK”  Stanford Ranch. Great satellite office. $455,000 invested in build-out, furnishings, computers and equipment. 3-chair Bay. Digital Pan with Ceph. 51 active patients and averages 3 New Patients per month. Full Price $150,000.

6164 SAN FRANCISCO BAY AREA  -  “OUT-OF-NETWORK”  Highly regarded as evidenced by 25+ new patients per month. Collections have topped $2 Million in each of the last 3-years with Profits averaging $1 Million. Paperless. 3D Cone Beam. Great location. Seller shall work back to affect orderly transition. Rare opportunity for Dentist seeking Superior Platform to practice their craft at highest level.

6163 LAKEPORT  Attractive option to practicing in ultra-competitive settings in expensive housing markets. Appeal of practicing here is ability live a less hectic life. Decompress, have more time for yourself. Beautiful 6-op facility with high-end technology and completely networked. 2018 collected $956,000 with Profits of $360,000. 2019 trending $1.1+ Million in collections. Building optional purchase. Full Price $240,000.

6158 FORTUNA  Relaxed lifestyle in Humboldt County’s Banana Belt. Adjacent to Ferndale. Perfect for Dentist seeking small town living. 2018 Collected $395,000 with $156,000 in Profits. 2019 trending $400,000+, 6-weeks off. Lots of work referred. Full Price $75,000.

6157 SACRAMENTO'S ELK GROVE AREA  -  “SOLD”  2018 collected $909,000 on Owner’s 3-day week. Successor can increase to 4-days as practice is rich in patients. 25+ new patients per month. 5-ops, Digital Pan, strong Recall, great staff.

6152 SAN RAFAEL  -  “SOLD”  2018 collected $520,000. Stand-alone building optional purchase. Nearby DDS who desires their own building should relocate their practice and have instant 1 Million practice in superior location.

6147 SAN FRANCISCO BAY AREA  -  “OUT-OF-NETWORK”  - “SOLD”  2018 collected $2.2 Million. Hygiene produced $1+ Million. $700,000+ in profits. Seller available for long transition.

4003 PEDO CHINESE / HISPANIC  3,000+ Charts. Move to your office. Full Price $150,000.

4006 ALTA LOMA High identity Center. Absentee. Grossing $700,000. 5-ops, 3 equipped.

4009 IRVINE  Lady DDS Grossing $1 Million. 5-ops. Partnership.

4011 DIAMOND BAR  This is a Dream Million Dollar location to be. 5-ops. Several Restaurants bring in droves of customers on a daily basis, FP $150,000.

4013 ORANGE COUNTY BEACH CITY  Grossed $70,000 last month. 4-ops with room for more. Full Price $800,000.

4015 HEMET  Easy way to Gross $500,000. Grossing $240,000 on 1-day per week. Full Price $110,000.

4019 $1 MILLION NET PROFIT  Opportunity of a lifetime.

APPLE VALLEY  Grosses $500,000 to $600,000. 3 ops. Low overhead.

BAKERSFIELD AREA  Grossing $40,000/month on 2 day week.

DIAMOND BAR  5-ops with digital Pan. Very busy future here. Full Price $150,000.

IRVINE  Lady DDS grossing $1 Million. Will share office.

LA HABRA  Huge Shopping Center. Well maintained. PT Seller will stay.

LADERA RANCH  4-ops. Grossing $500,000. High Growth area.

LAGUNA WOODS  Grossed $800,000 during Renovation. Renovation done. Should gross $1 Million.

LOS ALAMITOS  Established 4-ops with real estate.

MIRACLE MILE NEAR FAIRFAX  Beautiful corner suite with Wilshire view. 3-ops recently remodeled.

ORANGE  Grossing $1.2 Million. State-of-art beautiful!

ORANGE COUNTY  High profile shopping center. Grossing $1.5 Million.

ORANGE COUNTY  Near Chapman / Tustin Streets. Gross $400,000. Merge or grow.

ORANGE COUNTY BEACH  5-ops. Gross $1 Million first year. Area growing.

ORANGE COUNTY BEACH CITY  Absentee. Grossing $900,000+. 4-ops, room for 5th. Hands-on Owner will do $1 Million first year.

ORANGE COUNTY BEACH CITY  Grossing $800,000 part-time. Valuable Real Estate may be available.

PALM SPRINGS AREA  Grossing $1.5 Million. 8-ops.

REDLANDS  5-ops. Grossing $500,000. Low overhead. Part Time Seller. Full Price $450,000.

RIVERSIDE  Lady DDS grossing $300,000. 3-ops. Full Price $250,000.

SAN JUAN CAPISTRANO BEACH  Grossing $200,000 on 16 hour week.

SANTA CLARITA  70,000 Autos pass daily. Tremendous upside. Full Price $250,000.

SOUTH ORANGE COUNTY  Crown Valley Shopping Center. 4 ops. Grossing near $800,000. Lots of new home development.

UNION PRACTICE - INLAND EMPIRE  Grossing $650,000 on 2.5 day week. Nets close to $400,000.

UPLAND  3-ops, low overhead. Seller will transition. Full Price $360,000.

WANTED: IRVINE - NEWPORT BEACH - COSTA MESA - TUSTIN  “High Fee-for-Service” Dentist lost lease. Seller will merge his 40-year practice doing $800,000 into yours.

WEST LOS ANGELES  Prestigious Medical Building. Grossing $800,000.

WESTMINSTER  Starter in busy strip center. One side Hispanic, other side Vietnamese. Full Price $85,000.
The call came from another office in town just before Christmas asking if we could see one of their patients because their dentists were gone for the holidays. I must admit I was surprised at how upset the patient was at his dentist and how willing he was to share the tale. Seems he broke a cusp on tooth No. 31 a few weeks prior. Other than a sharp edge, the tooth was without any symptoms. He was informed by his dentist that he needed a crown on No. 31. And because tooth No. 30 had a large previously placed amalgam and the patient hadn’t used his calendar maximum, his dentist also recommended preventing future fracture by placing a crown on No. 30 at the same time. This sounded reasonable, so the patient agreed. As soon as the anesthetic wore off after the procedure, the patient’s lower right side was very painful and extremely cold sensitive. To make matters worse, the temporaries came off within a week and the sensitivity got much more intense. They were recemented and promptly came off again. The next time they came off was when I got the call. I made custom temporaries to get him through the holidays with the hopes the sensitivity would lessen. The patient returned a couple of days later and happily told me the temporaries were doing just fine. He asked if he should keep his appointment with his previous dentist to have the final restorations cemented. I told him there is a world of difference between temporaries and permanent crowns and that he absolutely should keep that appointment.

A few weeks later the patient returned mad as a hornet. Since the crowns were cemented, the teeth had been hurting. From his description of the discomfort, it didn’t sound like irreversible pulpitis, just severe pulpal inflammation. I checked the occlusion, which was OK. The PA showed no evident apical pathology, but the BW had significant mesial and distal open margins on Nos. 30 and 31. I informed the patient of the open margins and that they needed to be redone. The CDA Code of Ethics supports informing patients of the status of their oral health if the comments are justifiable and not based on opinion (section 1F, Obligation to Inform). The patient said he felt something wasn’t quite right when he could put his fingernail under the crowns on the facial. I tried to get him to agree to return to his dentist and said I would gladly forward the films to their office. He adamantly refused to consider this. I then told him of a wonderful program that CDA has called Peer Review and how fair and impartial it is. His comment was that he’s been in constant pain for months, except during the time he was wearing my temps, and that he wanted this fixed now. He then asked if I would call his dentist. As I prepared myself to make the call, I couldn’t help but reflect on a call I had received many years ago from a dentist who informed me that one of my previous patients, who I had done a deep composite restoration on, was having severe pain in the tooth. He told me that on his films, which he emailed to me, there appeared to be decay that was not completely removed. Other than the fact that it was a heart-stopping experience, I remember clearly the kind and compassionate way he delivered the bad news. Therefore, when I called this dentist, I not only told him of the open margins and the patient’s refusal to return or consider peer review, I also said that from my many years of peer review I had learned that even in the hands of the finest dentist, not everything turns out as we would hope. Crowns that don’t fully seat happen. I also said the patient was very angry and that I feared there might be a potential lawsuit. The dentist’s office manager called back within the hour and asked if we would replace the crowns, which we did. I believe that, being human, we all make mistakes. What matters is what we learn from them and what we do about it when mistakes happen. I believe the dentist made a wise decision and avoided a potential nightmare.

This type of situation is not easy to handle and brings up the ethical principles of veracity (being truthful) and professionalism. If done well, a hostile situation can be defused and respect for the profession enhanced.

Henrik Hansen, DDS, is a general dentist practicing in Fairfield, Calif. He currently serves on the CDA Judicial Council and is a past chair of the Council on Peer Review as well as a past member of the ADA Council on Dental Benefit Programs.

Have an ethical question you’d like to have addressed by the Judicial Council? Email lori.alvi@cda.org.
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Your Life’s Work Comes Down To This Decision

BAY AREA

AC-989 SAN FRANCISCO (Facility): Busy Retail Shopping Plaza w/ major anchor tenants! 3 ops $125k
AC-1059 DALY CITY: Amazing practice w/ seasoned staff in highly desirable neighborhood. 1500 sf w/ 4 ops $345k
AC-1072 DALY CITY: Seller to work back until May 2022! 1045 sf w/ 3 ops. Plumb for 1 add’l! $450k
AG-871 SAN FRANCISCO: Seller Motivated! ~800 sf w/ 2 ops Price Reduced $65k
AG-944 SAN FRANCISCO: An opportunity like this does not come along very often! ~998 sf w/ 3 ops
Reduced $540k
AG-945 SOUTH SAN FRANCISCO: ~1800 sf w/ 4 ops $1495k
AG-993 WEST PORTAL AREA: Desirable area w/ easy commute to downtown San Francisco. ~1000sf w/ 3 ops Reduced Price: $395k
BC-741 DANVILLE (Facility): ~ 1600 sf w/ 3 ops. PRICED TO SELL! $10k
BC-949 ALBANY: Desirable commercial/residential area. Medical Prof Bldg w/ good frontage. 3200sf w/ 4 ops $695k Real Estate: $1.8
BC-1010 ANTIOCH: Health Prof. Complex 2118 sf w/ 2 equipped ops + 3 add’l $250k
BC-1022 OAKLAND: “Pill Hill” Area near hospital! 1064 sf & 2 ops. Plumb for 1 add’l! $150k
BC-1056 SAN RAMON (Facility): Move-in ready facility in well maintained professional complex. 1698 sf w/ 4 ops $80k
BG-1025 WALNUT CREEK: You won’t find a more outstanding opportunity than this extraordinary practice! ~2138 sf w/ 6 ops. $750k Real Estate: $995k
BN-952 BERKELEY: Don’t hesitate on this incredible opportunity! ~835 sf w/ 3 Ops. Seller Motivated $200k
BN-1023 RICHMOND: This is a rich opportunity for the astute dentist! 1450sf w/2 ops + 2 add’l! $50k/Real Estate $750k
BN-1038 BERKELEY: A perfect opportunity to own a practice in one the Bay Area’s most popular cities! 1000sf w/ 3Ops. $385k
BN-1060 LAFAYETTE: Imagine living, practicing & raising your family here in this community! 1400sf w/ 3op. Seller Motivated $225k
CC-846 SAN RAFAEL: Prof/Retail Building Complex. 3 ops 640 sf Collections $433k in 2017 $275k
CC-927 SAN RAFAEL: Build the practice of your dreams by increasing this 2-day work week! 800 sf w/ 3 ops $175k

BAY AREA CONTINUED

CC-979 NOVATO: Seller Retiring. 803 sf w/ 3 ops near downtown and Old Town Novato. $195k (Real Estate $215k)
CC-1030 SANTA ROSA: Condo office in modern bldg w/ ample parking & adjoining Ortho practice! 1683 sf w/ 5 ops $325k
CC-1049 SANTA ROSA: Fully Remodeled, Amazing Location. 2000 sf w/ 5 ops $685k Real Estate Also Available
CC-1074 SANTA ROSA: Unbelievable Buildouts! 1200 sf 3 ops $300k
CG-616 NAPA COUNTY: State-of-the-Art office! ~850 sf w/ 2 Ops. $250k
CG-995 VALLEJO: Live, play and practice here where your lifestyle can’t be beat! ~2035sf w/ 7 ops $1.175M
CG-1048 SONOMA: This highly successful family-oriented practice has it ALL! ~1500 sf w/ 4 ops Reduced $630k
CN-911 SANTA ROSA: Want a change in lifestyle? This fabulous practice is the heart of the Wine Country! 2250 sf w/ 4 ops + 1add’l. $499k
DG-862 MID-PENINSULA: Rare gem with up to 7 operatories in the Bay Area! ~2274 sf w/ 6ops + 1add’l. $475k
DG-988 CAMPBELL: The ideal opportunity to practice in this community! ~988 sf w/ 3 ops $288k
DG-1006 MONTEREY AREA: This practice is one which every dentist aspires to! ~3400 sf w/ 8 ops Reduced $1.325M
DG-1009 CARMEL: Amazing fee-for-service practice w/ no contracts! ~1150 sf w/ 4 ops $625k
DG-1014 MONTEREY: Don’t miss your opportunity to live and practice in beautiful Monterey! ~1125 sf w/ 4 Ops. Reduced $750k
DG-1034 BELMONT: Med Prof Bldg on bustling commercial corridor. ~2000 sf w/ 5 ops $425k
DG-1035 LOS GATOS: Over 40 years Goodwill in this charming community! ~1010 sf w/ 4 ops. $790k
DG-1042 MOUNTAIN VIEW: Amazing opportunity providing quality, high-end dentistry! ~ 890 sf w/ 3 Ops $895k
DG-1078 SARATOGA Ortho: One-of-a-kind, modern, high-tech orthodontic boutique practice! ~ 1400 sf w/ 5 Ops $980k
DN-1031 CUPERTINO: This remarkable practice awaits only your talent and skill! 1500sf w 3 ops + 1 add’l. $1.25M
**BAY AREA CONTINUED**

**DN-1032 PLEASANTON Facility:** The perfect place to live, practice & raise a family! 1400sf w/4ops. **Includes CT Scan! $185k**

**DN-1041 SAN JOSE:** This stunning practice is an excellent opportunity for new grads! ~1207sf w/ 3ops + 1 add'l. **Reduced! $175k**

**DN-1003 PLEASANTON Facility:** This is an excellent opportunity for a graduate or a dentist seeking a Satellite location. 1000sf w/ 3ops. **$68k**

**DN-1046 SANTA CRUZ AREA:** Opportunities like this does not come along, except once in a lifetime! Office 2050 sf w/ 5 ops. Total sq ft 3880. $595k / Real Estate: $1.1mil

**DN-1067 CASTRO VALLEY:** Conservative treatment & compassionate philosophy delivered in a warm environment. 1498sf w/ 5ops. **$650k / Real Estate: $675k**

**NORTHERN CALIFORNIA**

**EC-1018 WEST SACRAMENTO:** All new leaseholds & top of the line PC EQ in 5 ops! 6 ops currently in use. 10 ops total available! **$795k**

**EG-910 MIDTOWN SACRAMENTO:** A thriving practice does not come along very often! ~1107 sf w/ 2 + 1 add'l. **Reduced $210k**

**EG-968 SACRAMENTO:** Desirable, mid-town neighborhood, w/ ample parking in garage! ~1527 sf w/ 5 Ops. **Reduced $480k**

**EG-972 ELK GROVE:** Prime location! Real Estate available to purchase in the future! ~ 3500 sf w/ 8 ops+. **Reduced $495k**

**EG-1012 EAST SACRAMENTO:** A practice like this one does not come available very often! ~ 2900 sf w/ 8 ops. **$2.5M**

**EG-1016 LINCOLN:** Look no further than this growing community to springboard into your success! ~1800 sf w/ 4 Ops **Reduced $560k**

**EG-1039 EL DORADO HILLS VICINITY:** The ideal opportunity to practice in this community! ~1100 sf w/ 4 Ops. **$350k**

**EG-1061 SOUTH AUBURN VICINITY:** Come live, play and practice in the heart of this pristine town! ~1100 sf w/ 4 Ops. **$350k**

**EN-1051 SACRAMENTO:** Location, Accessibility and Quality Relationships! 1,671sf w/5ops. **$395k**

**EN-1052 EAST SACRAMENTO:** Remarkable, long-established opportunity, loaded w/ goodwill! 1100 sf w/ 4 ops. **$950k**

**EN-1055 ROCKLIN Facility:** Build your own success here in this family-oriented community! 1650 sf w/ 4ops +1 add'l. **$95k**

**EN-1077 DAVIS:** Imagine living and practicing here! Hesitate and you may miss out on your dream! 1100sf. w/ 5 ops. **$575k**

**FC-650 FORT BRAGG:** Family-oriented practice. 5 ops in 2000 sf **$350k** for the Practice & **$40k** for the Real Estate

**FG-841 ARCATA:** Great demographics w/ very little competition! ~1114 sf w/3ops **Reduced Price: $200k / Real Estate Available**

**FN-961 EUREKA:** Where the quality of life can’t be beat! 1400sf w/ 4 ops. Practice Reduced: $395k / Real Estate Available **$395k!**

**FN-855 NO. HUMBOLDT:** Seller relocating! Long-established, 100% FFS practice! 1600 sf w/ 3ops + 1 add'l. **$190k / Real Estate Available**

**GN-953 CHICO:** Established for 34 years and the seller is passing their goodwill on to you! 1067sf w/ 3ops. **Now Only $220k!**

**GN-1071 REDDING:** Streamlined policies & loyal patient base, this quality practice is your springboard to success! 2264sf w/ 4 ops. **$525k**

**NORTHERN CALIFORNIA CONTINUED**

**HG-1053 GRASS VALLEY:** Well-established practice of 40+ years, known for its quality dentistry! ~1200 sf w/ 3 ops **$420k**

**HG-1068 LAKE TAHOE AREA:** ~2500 sf w/ 3 Ops. **Reduced $315k / Real Estate Available**

**HG-815 TRUCKEE AREA:** Amazingly priced at 50% of Collections! ~1000 sf w/ 3 ops **$165k / Real Estate Available**

**HG-983 GRASS VALLEY:** Newly remodeled office in highly desirable neighborhood! ~1250 sf w/ 3 ops. **Reduced Price $195k / Real Estate Available**

**HG-987 LAKE TAHOE AREA:** State-of-the-Art Practice located in picturesque mountain setting! ~ 3,400 sf w/ 6 Ops **$785k**

**HN-879 SONORA:** Great Cash-Flow for Only 3 Days a Week! 2950 sf w/ 3 ops **Reduced Price: $265k**

**HG-934 GRASS VALLEY:** Underworked PT base should support larger production numbers! ~1200 sf w/ 3 Ops **Reduced $168,750 / Real Estate Available**

**HN-999 CALAVARAS Co. (Facility / Real Estate):** 1,500 sf w/ 2 equipped Ops + 1 fully plumbed & 3 partially plumbed. **$500k**

**HN-991 PLACERVILLE:** Quality, conservative and compassionate practice! Will consider work back. 1,654 + 473 sf w 5 ops. **$675k**

**CENTRAL VALLEY**

**IG-881 TURLOCK:** Long established has unsurpassed quality care. ~3500 sf w/ 10 Ops (shared). **Reduced: $295k**

**IG-1007 GREATER MODESTO AREA:** Combines a quality learning environment with relaxed rural living. ~3000sf w/ 6 ops. **$545k**

**IG-1009 TRACY:** This opportunity is waiting for you to sink your roots down and invest your future here! ~1200sf w/ 4 ops. **$745k**

**IN-1069 STOCKTON:** Well-established & fully equipped w/ modern equipment, this is an excellent opportunity! 1450sf w/ 3ops +1 add'l. **$260k**

**JC-811 FRESNO COUNTY:** Seller willing to consider Associateship for qualified DDS w. intention to Buy In! Considerable Goodwill in Community! 3,000 sf w/ 6 ops **$350k**

**JC-823 LOS BANOS:** Heavy emphasis on hygiene. 1000 sf w/ 3 ops **$80k**

**JC-1054 VISALIA:** Practice AND REAL ESTATE! Prof Bldg on major thoroughfare. 2,260 sf w/ 6 ops **$275k / Real Estate $517k**

**SPECIALTY PRACTICES**

**BC-784 CENTRAL CONTRA COSTA CO Perio:** Seasoned Staff. 3 ops **$295k**

**BG-843 WALNUT CREEK Perio:** Priced at 50% of collections! 4 ops **$390k**

**BG-1024 WALNUT CREEK Prosth:** ~2138 sf w/ 6 ops. **$750k Real Estate: $995k**

**BN-998 WALNUT CREEK/SAN RAMON AREA Ortho:** Looking for your dream Orthodontic practice! 1450 sf w/ 5 Open bays/Chairs. **$1.15M**

**DN-1044 FOSTER CITY Perio:** Shared Space Situation. Conveniently located within walking distance of major corporations. 830sf w/ 3 ops. **$195k**

**GG-940 NORTH OF SACRAMENTO Perio:** Practice is on track to collect more than $1,000,000 in revenues this year! ~4300 sf w/ 5 ops. **Reduced $555k**

**JG-757 VISALIA Perio:** Incredible Giveaway at this price! Collections over $800k! ~2000 sf w/ 5 ops **Steal at $150k**

“ASK THE BROKER” can now be found at **WWW.WESTERNPRACTICE SALES.COM**
Face Scan – Blendshapes (Free, niels jansson)

Facial scanning technology has become commonplace, so much so that most modern cellphones have this capability integrated. Orthodontic, implant and aesthetic dental software makers have capitalized on this explosion by allowing users to accept topographical scans from any source into their applications. In the mobile device realm, exporting a scan requires an app because this capability is not currently supported in Android or iOS. Face Scan is one such application that is optimized to “capture approximate scans of human faces” and, if the capability is purchased in-app, allows users to export this scan in FBX format. Face Scan was reviewed on an iPhone X running iOS 13.1.2. Face Scan has a simple interface, which consists of four buttons: Add Texture, Export, Clear Textures and Settings. Opening the app activates the mobile phone’s scanning capabilities and a topographical scan of the user’s face is displayed. This scan has no color, automatically removes the user’s eyes and teeth and only detects the face up to the most anterior aspect of the ears (the remainder of the head and neck are cropped). When the “Add Texture” button is pressed, a photo of the user’s current expression is taken and overlaid on the scan. This scan – photo texture and topography – can be exported for use in other 3D applications like Autodesk’s Maya, Lightwave 3D or Blender. Unfortunately, Face Scan falls short in terms of accuracy: Measurements vary wildly from real life, sometimes as much as 2 inches in extremely poor scans, but consistently over- or under-reporting true size by 5 mm to 10 mm when displayed in Blender. This is not a fault of Face Scan, as it clearly states its purpose of “approximate scans of human faces.” The app appears to have been intended for entertainment use and for that purpose is admirable and inexpensive. For clinical use, dentists would be better served looking into another application like Bellus3D.

– Alexander Lee, DMD

Station (Free)

Busy people stay productive through the help of many desktop applications on their computers. More recently, a major shift to cloud computing has resulted in many of those desktop applications having their own counterparts accessible through a web browser. The many advantages to using web applications include not requiring users to install and maintain desktop software on their client computers. One major disadvantage to web applications is that users must be consistently connected to the internet in order to access them. Using many web applications in multiple windows and tabs within a web browser can be difficult to organize. Station is a browser for busy people. With more than 660 web applications available, users can simplify their productivity to a central location and stay focused.

Station is free for personal use and requires users either to sign up for an account with their email address or sign in with their Google account. Once credentials are entered and verified, users can choose any number of apps to add to their dock, which is a sidebar that contains all installed web applications. Clicking on any dock item brings users to the respective sites for them to log in to their productivity web applications. Because all application interfaces are web-based, users can opt to stay logged in and the app will maintain their credentials for their next visit. Multiple open windows or pages within a dock app, such as Microsoft Word documents, are grouped to help maintain a clean interface. Users can switch quickly between multiple applications such as Gmail and Dropbox and also search across pages using a simple keyboard shortcut. More than 30 other keyboard shortcuts are available to help users to quickly switch between applications or perform tasks within their work. Users can also set custom silence notifications for each application in the dock, allowing productivity without being interrupted. This concept of having a central interface to access all web applications is refreshing, as it replaces the need for bookmarks and tabs in multiple open web browser windows, but does require some time and effort to set up.

– Hubert Chan, DDS

Would you like to write about technology?

Dentists interested in contributing to this section should contact Andrea LaMattina, CDE, at andrea.lamattina@cda.org.
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