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DEPARTMENTS

FEATURES

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Endings and Beginnings

KERRY K. CARNEY, DDS

I told Jack Conley I wanted to do a brief review of the last six editors of the *Journal of the California Dental Association*. Jack corrected me and said that they were not the last but the first six editors. Before unification in 1973, the state had two associations, the California Dental Association (composed of the northern regions) and the Southern California Dental Association. Each state association had its own *Journal* and newsletters. Unification brought an end to the old publications and a beginning for the new *Journal*.

Dr. Steve Yuen of southern Alameda County served from July 1973 to June 1975. He was the first editor to head the *Journal of the California Dental Association* we know today. He was followed by Drs. Jack Saroyan (July 1975 to April 1977), Keith Blair (July 1977 to June 1980), Robert Sachs (July 1980 to January 1983), Jack Conley (July 1983 to November 2004), and Alan Felsenfeld (December 2004 to November 2008).

I was able to reach some of the editors and asked about changes they witnessed in CDA and in the *Journal* itself during their tenures. Each of their first editorials provided a snapshot of the period and/or the direction they wanted to take the *Journal*.

Those first issues must have been an adventure. Not just a composite of the old journals but something new to reflect the beginning of a new united association of California dentists. Dr. Yuen described his encompassing vision of the *Journal* in his first editorial, "these pages are open to all of you ... We encourage thorough and fair examination of the varied texture of our professional fabric ... We look forward to the future ... with you."

Endings and beginnings in the succession of the editor are really no more than transitions.

Dr. Saroyan, a native of San Francisco, wrote in his first editorial "A good professional publication has to reflect the vested interests of the membership as well as inform the members of current events in their profession." He proposed the inclusion of self-scoring quizzes and human-interest stories of members.

The third editor, Dr. Blair, hailed from San Diego. Thirty-one years ago, his first editorial was titled, "*Political Action: The Alternative to Wringing Our Hands*." He described a turbulent time when the FTC was taking legal action against the ADA for purported restriction of trade. He also provided a prescient warning of the dangers of attempting to address *access to care* issues with *midlevel provider* scenarios before those labels had became commonplace. He appealed for grass roots political action and encouraged dentists to become more involved in the decision-making process.

Dr. Sachs, an oral surgeon from San Francisco, wrote his first editorial in July 1980. His direction for the *Journal* emphasized a shift toward greater scientific content. "A significant attempt will be made to introduce more quality scientific articles, primarily ones of clinical interest." He also reminded me he had published the first of "Dr. Bob" Horseman's features.

Dr. Conley, of Los Angeles, became editor just before the CDA headquarters was moved from Los Angeles to Sacramento in 1983. His first editorial described a tide of change at CDA and in the insurance environment. During his 22-year tenure, the family of CDA publications changed and grew. The *Update* was added and became the medium of association news, departmental reports, and member profiles. The current scientific orientation and the creation of theme-based issues was part of his editorial legacy. Jack also reminded me that Bob Horseman became a regular contributing editor shortly after he assumed the helm.

Dr. Felsenfeld, an oral maxillofacial surgeon from Los Angeles, took up the daunting task of following Dr. Conley's 22-year term. His first editorial recounted the selection process for the position of editor (which remained the same this

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It is my goal to work with staff, contributors, and volunteers to perpetuate and enhance the legacy of excellence the *Journal* embodies.

time). He also described the editor's duties above and beyond those associated with the publication. As a member of the executive committee (ex-com) he was gratified to see changes in CDA that came as a result of research on the wants and needs of our members. It gave focus of purpose and made CDA a much more member-driven organization. As far as changes in the *Journal*, Dr. Felsenfeld increased its content with regard to basic science and traditional research.

Endings and beginnings in the succession of the editor are really no more than transitions. Like another thread in the fabric, the whole cloth is what is important. The *Journal* will change not in a revolutionary manner but will evolve in a manner that best serves its members. The *Journal* is accessed in many different ways. Some peruse the entire issue. Some readers skim the abstracts, some read the current topics, (some even read the editorial), but after this review and consulting with others, it is clear to me that the most consistently enjoyed feature is "Dr. Bob."

It is my goal to work with staff, contributors, and volunteers to perpetuate and enhance the legacy of excellence the *Journal* embodies. ■■■■

Address comments, letters, and questions to the editor at kerry.carney@cda.org.

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Deborah Zemke

Too Much of a Good Thing But Worth the Work

When it comes to knowing about the microbes that call our mouths home, scientists have more than enough information; it's the gathering all of the integral pieces of information into one place when designing experiments is the labor-intensive job.

Fortunately, grantees of the National Institutes of Health of Dental and Craniofacial Research, part of the National Institutes of Health, and their worldwide colleagues intend to find a solution with the launching of the pioneering comprehensive database of the oral microbiome, otherwise known as the estimated 600 distinct mouth-dwelling microorganisms.

"The HOMD fills a critical research need," said Lawrence Tabak, DDS, PhD, NIDCR director. "The oral microbiome is extremely rich in data and HOMD

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Lights Out and Save Money

It's easy to be green while lowering business expenses at the same time. Liz Reyna, an official with Tara Energy, a retail electricity provider in Texas, writing in the July 2008 issue of the *Texas Dental Journal*, provides her dentist readers with a number of tips on saving energy — and therefore money — by following certain guidelines and adopting certain technologies in their practices.

According to Reyna, heating and cooling contribute the most to an office's electricity costs, so understanding how to more efficiently cool and heat the workplace can go a long way toward reducing monthly bills. Programmable thermostats help control heating and cooling schedules. Optimal temperatures are 68 degrees for heating and 78 degrees for cooling. Also, offices should adhere to a maintenance schedule, replacing air filters, inspecting fan belts, lubricating motors, and checking for refrigerant leaks regularly.

Lighting is the second key contributor to electricity costs. The lessons learned in childhood (turn off the lights when a room is not in use) is still a good idea. Commercial properties should install light timers to control when and how long exterior as well as interior lights are on.

Most utility companies offer free advice on saving energy. Dentists would be wise to take a few moments to make sure their practices are efficient.

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Safeguarding Consumer Privacy, E-prescribing Cited for Health Care Reform in the United States

A distinguished group of bipartisan health policy and technical experts released a report recently calling for accelerating adoption and use of health information technology and electronic health information exchange to streamline improvements in the U.S. health care system.

In their inaugural report, "Accelerating Progress: Using Health Information Technology and Electronic Health Information Exchange to Improve Care," the State Alliance for e-Health (State Alliance), a consensus-based, executive-level body composed of governors, state legislators, attorney generals and state commissioners, examined the challenges states face in implementing health information technology and health information exchange, including provider concerns about implementation costs, variations in technical standards for interoperability and consumer concerns about data privacy and security. The report is meant to spur continued innovation in states to make the vision of an interconnected, efficient, quality-based health care system — and ultimately a healthier American public — a reality.

The State Alliance specifically highlights e-prescribing and consumer privacy as critical to advancing e-Health in America and encourages states to be proactive in creating and implementing policies that advance these and other e-health initiatives. E-prescribing is cited as a landmark gateway to stimulating other advances in e-health.

"We must harness our American ingenuity to bring about a technological revolution in America's health care system," said Vermont Gov. Jim Douglas, co-chair of the State Alliance. "HIT and electronic HIE are essential tools in states' efforts to control costs and improve health care in the United States."

For more information on the State Alliance, please visit www.nga.org/center/ehealth.

Novel Technique Addresses Soft Tissue Complications of Block Grafting

A study published recently in the *Journal of Oral Implantology* describes a new tunnel technique that was successfully applied in two dental implant cases.

Successful autogenous bone grafting, the gold standard for bone augmentation procedures, depends, in large part, on good soft tissue coverage. This new method involves the use of acellular dermal matrix allograft as a way to ensure proper soft tissue augmentation and, thus, improve the chances of satisfactory dental implant placement, according to a press release.

Modifications have been made to the tunnel technique in the years since it was first described 22 years ago. However, this new approach differs from others in terms of incision location, dissection method, and suturing method. The application of the technique before block graft surgery and the particular way in which the graft is slid under the tunnel are also unique.

In this study, two patients with very thin soft tissue underwent augmentation to reduce the risk of monocortical block graft failure due to wound dehiscence and premature exposure, according to a press release. There were no complications in either case, and the soft tissue thickened.

Advantages of the new tunnel technique include its simplicity and predictability, as well as its short average duration of a half-hour to 45 minutes. This method plays an important role in the treatment plan of dental implant placement.

To read the entire study, go to http://www.allenpress.com/pdf/orim_34.5_Final.pdf.

Taste Change Associated With a Dental Procedure

Taste loss or dysfunction are conditions that have a number of causes, one of which can be invasive dental procedures. According to Gary Klasser, DMD; Robert Utsman, DDS; and Joel Epstein, DDS, writing in the July issue of the *Canadian Dental Journal*, damage to oral nerves caused by surgery or needles delivering anesthesia can cause loss of taste in patients. Damage to nerves due to neurotoxicity of the anesthesia itself is also a possibility, the authors said.

Klasser, Utsman, and Epstein described the case of a 66-year-old man who suffered from taste loss following oral surgery. They noted that although there is no curative therapy for trauma-induced taste change, "studies have shown that zinc supplementation, sialogogues, and surgical procedures have been useful in treating taste disorders."

Hypnosis: An Alternative to Needles and Novocain

Is it possible the soothing voice of the dentist can transport a patient into a state of mind that allows the dental professional to complete a procedure whether that be a simple cleaning or a complex procedure that involves oral surgery? Perhaps.

Wendy J.N. Lee listened to the words of Peter Stone, DDS, associate professor at the University of Southern California School of Dentistry, as her body slipped into a more comfortable position during a recent visit to the dental school. A USC cinema graduate student, Lee filmed Stone's hypnosis techniques for "Say Aah," a documentary about her fear of dentistry.

Hypnosis has some roots in dentistry. It was first reported in Egypt more than 3,000 years ago. This practice ended with Horace Wells in the 19th century, who initiated the use of nitrous oxide and ether during procedures.

In the years that followed, chemicals and general anesthesia became common practice, and hypnosis became a sleepy alternative to sedation.

Today, the USC School of Dentistry is the only dental school in the United States offering formal training for dental professionals in the use of hypnosis.

Stone, who works in the division of health promotion, disease prevention and epidemiology, teaches "Modern Hypnosis for the 21st Century Dentist." He has taught the techniques and applications of hypnosis since 1981 for the Southern California Society of Clinical Hypnosis.

"The time spent learning hypnosis not only makes a visit to the dentist more pleasant for the patient, but it also enhances a practitioner's productivity, providing a stress-free environment for all," said Stone. "Working with nervous patients makes it difficult to carry out our job. Dentists by nature don't like to hurt people. We're trained to bring them relief from pain. When a patient is relaxed and calm, the procedure goes more smoothly and more quickly."

Additionally, it may be a less expensive alternative to conscious or general sedation, which can cost hundreds of dollars.

"In the average patient, we can teach them to relax and control their fears 90 percent of the time. In a small group of patients, hypnosis allows them to control pain, bleeding or salivation during a procedure, or speed up recovery time," said Stone.

Stone shared his experience with one patient during oral surgery. "I remember telling my assistant, 'If only John would stop bleeding, I could finish this procedure quicker and remove the root tip causing his pain.' Instantly my patient stopped bleeding."

The technique is also used to control gagging, bruxism, or breathing problems. Hypnosis can enhance memory of a pleasant visit to the dentist.

Dentists each year from across the country and Canada travel to Los Angeles for a two-day hypnosis course taught by Stone at the USC School of Dentistry. The workshop provides dentists with the tools and skills needed to use hypnosis comfortably in their dental practice.

Hala Al-Tarifi, DDS, South Pasadena, Calif., shared her experience, "I started implementing hypnosis in my office, and one of my patients slept through a crown prep."

For more information, go to The American Society of Clinical Hypnosis at www.asch.net or the Southern California Society of Clinical Hypnosis at www.scsch.camp7.org.

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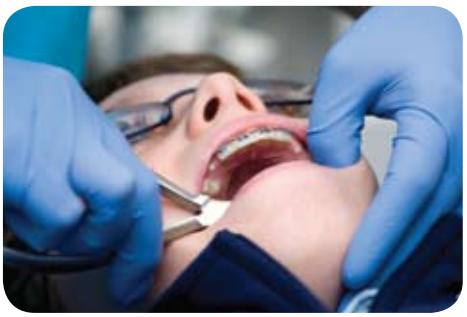

Orthodontic Association Takes Education Crisis Head On

The American Association of Orthodontists has been seeking long-term, sustainable solutions to the crisis in orthodontic education. Through its Task Force on Recruitment and Retention of Faculty, progress is being made.

"We are beginning to realize our goal of putting realistic and lasting solutions in place to address orthodontic faculty recruitment and retention, a crisis we share with dentistry as a whole. We know many are called to teach, and we are laying the groundwork to help these important educators answer that call," said Donald R. Joondeph, DDS, MS, task force chair and AAO past president.

"We cannot expect the government or those outside of the profession to solve the crisis for us. This is a multifaceted problem which requires continued study and commitment of resources. We encourage others to examine our initiatives," commented Raymond George, Sr., DMD, AAO president.

The task force disbursed $2 million to augment salaries of full-time faculty at accredited postdoctoral orthodontic programs in the U.S. and Canada. One-time awards of up to $30,000 were distributed to 142 orthodontic faculty members in recognition of their contributions to the specialty and as an incentive to remain in orthodontic education.

AAO efforts during its 2007-08 fiscal year secured commitments for more than 60 years of teaching through a new initiative: full-time faculty teaching fellowships. Eleven faculty members received two- or three-year fellowships.

Addressing the Impact of Poverty

An estimated 1 in 8 Americans live in poverty, including more than 13 million children. The National Governors Association Center for Best Practices, in an effort to improve the economic outcomes of disadvantaged families, awarded $12,000 grants to Arizona, Delaware, Illinois, Maine, Michigan, Ohio, Vermont, Virginia, Virgin Islands, and Wisconsin to convene *Governors Summits on Poverty and Economic Opportunity.*

The summits will provide governors and legislators in those states a springboard for spurring state and local action to reduce poverty.

"Many states already have taken action to reduce poverty," said John Thomasian, director of the NGA Center. "Our hope is these summits help governors in their efforts to advance innovative strategies that increase economic opportunities and reduce the devastating effects of poverty on their citizens."

The states were chosen because their proposals demonstrated how their summit will connect to and build upon existing efforts to reduce poverty; involve key state and local leaders, such as cabinet members, business leaders, legislators, foundation representatives, mayors and other stakeholders; and advance a robust state-wide agenda designed to promote economic opportunity and reduce poverty.

Poverty and economic hardship can result in long-term social and economic costs for children, families, communities and states, but the overall affect can be felt by the economy at large. Poverty has large costs for states and the nation, with childhood poverty estimated to cost the U.S. economy approximately $500 billion annually.

UPCOMING MEETINGS

2009

May 14-17	*CDA Presents The Art and Science of Dentistry*, Anaheim, 800-CDA-SMILE (232-7645), cda.org.
Sept. 11-13	*CDA Presents The Art and Science of Dentistry*, San Francisco, 800-CDA-SMILE (232-7645), cda.org.
Sept. 30-Oct.-4	American Dental Association 150th Annual Session, Honolulu, Hawaii, ada.org.
Nov. 8-14	United States Dental Tennis Association fall meeting, Scottsdale, Ariz., dentaltennis.org.

To have an event included on this list of nonprofit association continuing education meetings, please send the information to Upcoming Meetings, CDA Journal, 1201 K St., 16th Floor, Sacramento, CA 95814 or fax the information to 916-554-5962.

MICROBES, CONTINUED FROM 913

becomes the essential search engine for scientists to view and retrieve this information, generate novel hypotheses, make computational discoveries, and ultimately develop more biologically sound therapies to control oral diseases."

The online compendium, the Human Oral Microbiome Database, can be accessed free of charge at www.homd.org and is overseen by Forsyth Institute scientists in Boston and King's College London, England. The Web site states the HOMD is an ongoing project and that taxon description pages will not be completed until late next year. The database, referred to as the digital equivalent of the Oxford dictionary of oral microorganisms, provides detailed biological entries for each species and an extensive catalogue of the thousands of genes these microbes express.

Floyd Dewhirst, DDS, PhD, a leader of the project and a scientist at the Forsyth Institute, said the HOMD also introduces the first comprehensive nomenclature system to bring order to the naming of uncultured or previously unnamed oral microbes. Additionally, the standardized numbering system aids in eliminating the confusing names and irrelevant database designations that have aggravated scientists or placed obstacles to research.

"We've already assembled a great deal of useful information for the research community, but we will continue to expand and refine the database for the next several years," Dewhirst said. "I can see the Human Oral Microbiome Database serving as a valuable model for other microbiome databases now and in the years to come."

The database also categorizes each microbe by its 16S rNA sequence, a distinctive fingerprint of genetic information that scientists have used for the past 20 years to identify microorganisms, according to a news release. This sequence information allows the microbes to be placed in a family tree that shows how they are related to each other. For organisms whose DNA has been sequenced, HOMD provides online tools to analyze and view all their proteins and genes. Each category of information in the database is interlinked, easily searchable, annotated properly and will be frequently updated to say current.

Informally called "biology's next revolution," according to a press release, microbiome studies have opened a window in the complex microbial communities occupying most parts of the human anatomy. These studies will define how microbes contribute to sustaining health and when community dynamics are

perturbed, play a role in common chronic disease, i.e., tooth decay and perio disease.

Last December, NIH launched the Human Microbiome Project that initially will sequence all of the genes or genomes of 600 representative microorganisms sampled form microbial communities in the skin, digestive tract, mouth, female urogenital tract, and nose, said researchers. More studies and under way or under development.

"The oral microbiome is currently better understood than those of other sites in the body, such as the intestine, said Bruce Paster, PhD, another project scientist also at the Forsyth Institute. "Since oral microorganisms appear in infections throughout the human body, the HOMD database certainly will be useful to physicians. Likewise, microbiologists in the industry will find HOMD helpful because oral microbes sometimes contaminate food or the drug manufacturing process."

For more information about the NIH and its programs, go to www.nih.gov.

Most of Nation Receiving Fluoridated Water

In response to the Centers for Disease Control and Prevention's announcement that 70 percent of the country's population is receiving optimally fluoridated water, Mark J. Feldman, DMD, past president of the American Dental Association, was buoyant.

"We welcome this very encouraging news from the Centers for Disease Control and Prevention about the increase in the number of Americans receiving optimally fluoridated water. We know from years of experience and scientific study that community water fluoridation benefits everyone," Feldman said.

"The ADA has long advocated water fluoridation as the single most effective public health measure to prevent tooth decay. Our members are committed working with federal, state, and municipal governments to increase even further the number of Americans who benefit from it."

Differentiating Cleft Palate from Cleft Lip, Links to Other Congenital Anomalies

What are the associations between cleft lip and/or cleft palate and other congenital anomalies, such as clubfoot, ear defects, anencephaly, or coronary heart disease? Do these patterns indicate that cleft lips and palates result from different mechanisms altogether? Or are they variable severities of the same phenomenon?

In a new study in *The Cleft Palate – Craniofacial Journal*, researchers analyzed more than 1,000 cases of newborns with multiple anomalies to differentiate between cleft lip and/or cleft palate and to determine their associations with other congenital anomalies.

Anencephaly had the greatest association with all cleft types, which probably reflects its disruptive character. Spina bifida and VATER (vertebral, ano-rectal, tracheo-esophageal, and renal) complex showed the most strongly negative associations with clefts of all types. Six defects were found to be associated with cleft lip only. Three defects were associated with cleft palate only, including ear canal atresia and clubfoot. The negative association between clefts and neural tube defects invited further investigation.

Coronary heart disease was the anomaly most often found in association with clefts.

Cleft lip and palate is more likely to be associated with birth defects than cleft lip alone, which lends support to the notion that cleft lip and palate is a more severe presentation of the same anomaly; however, the patterns of specific defects associated with each condition indicate that different mechanisms and distinct pathways may be involved.

Honors

The National Dental Association's Legend Award for 2007 has been given to **Clifton O. Dummett, DDS**, distinguished professor emeritus of the University of Southern California School of Dentistry. He was recognized for his "ongoing service in the interest of the profession, service to the community, and as a historian of the NDA legacy."

Clifton O. Dummett, DDS

Deborah Horlak, RDH, BA, MA

John D. B. Featherstone, PhD

Deborah Horlak, RDH, BA, MA, Stockton, Calif., has been named director of the Dental Hygiene program at the Arthur A. Dugoni School of Dentistry.

The University of California, San Francisco, has named **John D. B. Featherstone, PhD,** as dean of the UCSF School of Dentistry. The appointment, approved last week by the UC Board of Regents and is retroactive to Sept. 1, 2008.

Featherstone has served as interim dean since the retirement of the previous dean, **Charles Bertolami, DDS, DMedSc,** in August 2007. He has been a member of the school's faculty for 13 years and served as chair of the school's Department of Preventive and Restorative Dental Sciences from 1996 to 2005.

Larry J. Moore, DDS, MS, Altadena, Calif., has been elected vice president of the American Association of Oral and Maxillofacial Surgeons.

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Dental Occlusion and Periodontal Disease: What Is the Real Relationship?

MONISH BHOLA, DDS, MSD; LEYVEE CABANILLA, DDS, MSD; AND SHILPA KOLHATKAR, DDS, MDS

ABSTRACT The role of occlusion in periodontal disease has always been a challenging topic. A good understanding of the current status of the relationship of occlusion and periodontitis is of paramount importance in order for dental clinicians to provide adequate and comprehensive periodontal treatment in patients presenting with traumatic occlusion. This article reviews the literature regarding the relationship between occlusion and periodontitis and presents recommendations for clinical practice based on available evidence. Clinical cases illustrating the complexity of this relationship and their management are presented.

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The relationship between occlusal forces and periodontal disease has been studied extensively. Some of the research, conducted in 1930s implicated trauma from occlusion as the etiology of periodontitis.[1,2] Early experiments conducted on sheep and monkeys supported the role of trauma from occlusion as an etiologic factor in periodontal disease.[2,3] These earlier reports were primarily based on individual observations and opinions and their validity was questioned as they lacked proper controls. Furthermore, the design of the studies did not justify the conclusions drawn.

During the course of the next few decades, the role of microorganisms in the development of periodontitis became clear, and emphasis switched to the role of trauma from occlusion as a possible cofactor in the development of periodontitis. This was primarily based on Glickman's work who proposed that a traumatogenic occlusion could alter and accelerate the progression of periodontitis, and direct the inflammatory process into the periodontal ligament and eventually bone.[4,5]

He proposed the pathway of gingival inflammation could be changed if forces of abnormal magnitude were acting on these teeth. As a result of further studies, he concluded that instead of an even destruction of the periodontium and alveolar bone, sites that are exposed to abnormal occlusal forces, develop angular bony defects and

FIGURE 1. Schematic diagram based on Glickman's theory of codestruction. The solid black arrow indicates the path taken by inflammation in the presence of occlusal trauma that would result in an angular pattern of bone loss. The gray arrow represents the path taken in the absence of occlusal trauma.

infrabony pockets.[6,7] This has been called the codestruction theory. **FIGURE 1** is a schematic diagram illustrating this concept.

As investigators studied the effects of subgingival plaque on attachment loss and bone loss, an important study by Waerhaug associated the location and the severity of attachment loss with the location of the "plaque front" on the tooth.[8,9] He examined autopsy specimens similar to Glickman's work, but in addition, measured the distance between the subgingival plaque and the inflammatory cell infiltrate in the gingiva and the surface of the alveolar bone. He concluded that angular bone defects and infrabony pockets occurred just as often on teeth that were not affected by trauma from occlusion, as compared to teeth with occlusal trauma. According to Waerhaug, loss of connective tissue attachment and resorption of bone around teeth was exclusively the result of inflammation associated with subgingival plaque. According to him, angular bone defects result due to a difference in the apical migration of subgingival plaque on adjacent teeth.

A majority of these early papers relied on autopsy material to develop the theories that linked traumatic occlusion to periodontitis. Although examination of autopsy material provides valuable information about the patterns of attachment loss and bone destruction, it has limited value in establishing a "cause-effect" relationship between occlusal trauma and the progression of periodontitis. Thus, although Waerhaug's investigation did not support Glickman's findings, it paved the way for further research on this subject.

Animal Studies

Some of the more prominent studies of the 1970s and 1980s were published by Lindhe, Ericsson, and Nyman, using the beagle dog animal model, and by Polson and Zander who used the squirrel monkey model for their studies.[10-25] Using these animal models, researchers could artificially induce experimental periodontitis by using silk ligatures or by letting the animals accumulate plaque and calculus over a variable period of time (usually six months). They could then superimpose traumatic occlusion by using cap splints, and evaluate its effect on bone loss and attachment loss.

Studies by Ericsson and Lindhe's group using beagles indicated that heavy occlusal forces, when combined with plaque-induced periodontitis led to accelerated attachment loss. Furthermore, in the absence of periodontitis, heavy occlusal forces led to increased tooth mobility and bone loss. Bone loss was primarily present in the form of widened periodontal ligament spaces, and, in a few cases, horizontal loss of crestal bone height.

Studies by Polson and Zander, using the squirrel monkey model, demonstrated that trauma from occlusion caused increased loss of alveolar bone, but failed to produce loss of connective tissue attachment. The authors also reported that elimination of traumatic forces in the presence of continuing periodontitis did not lead to bone regeneration or a reduction in mobility.

Based on animal studies, trauma from occlusion in the presence of inflammation may accelerate periodontal disease progression. Without plaque-induced inflammation, trauma from occlusion alone will not result in connective tissue loss but can lead to widening of the periodontal ligament space, bone loss, and increased mobility. **FIGURES 2-4** are radiographic examples of some patterns of bone loss associated with trauma from occlusion.

Human Studies

Pihlstrom et al. evaluated the association between occlusal trauma and periodontitis by examining a series of clinical and radiographic parameters of maxillary first molars.[26] They concluded that teeth with occlusal contacts in working, balancing, and nonworking positions had no greater severity of periodontitis than teeth without these contacts. Of the teeth examined, those that demonstrated signs of traumatic occlusion (mobility, widened periodontal ligament space), had greater probing depths, loss of attachment, less bone support, and higher gingival and calculus indices.

Groups of individuals interpret this data differently. Although teeth that demonstrated signs of traumatic occlusion had greater periodontal destruction, this could be related to the increased presence of local factors, such as plaque and calculus around these teeth. Thus, it is hard to establish whether the various signs of traumatic occlusion were the result of trauma from occlusion or developed secondary to loss of periodontal support due to plaque-related periodontal destruction when trying to establish a "cause and effect" relationship from this data.

Tooth No. 30 (**FIGURE 5**) presents a diagnostic challenge. It shows evidence of recent pulpectomy and vertical bone loss. The bone loss seen on the distal aspect may be associated with heavy occlusal forces or due to the presence of calculus and/or pulpal involvement.

Initial periodontal therapy consisted of scaling and root planning. Guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier was

FIGURE 2. Vertical bone defect on the mesial and distal of No. 20, possibly associated with heavy occlusal load as a result of the absence of molar occlusion. (Radiograph courtesy of Dr. Shaziya Haque.)

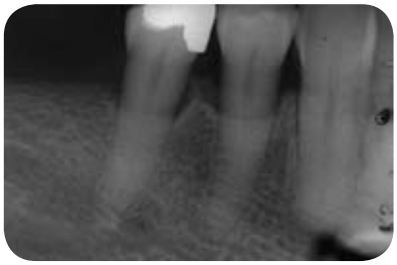

FIGURE 3. Circumferential defect and widening of the periodontal ligament spaces on Nos. 28 and 29. (Radiograph courtesy of Dr. Donald Sherman.)

FIGURE 4. Large defect on the distal of No. 18, which tested vital. Open flap debridement ruled out the presence of root fracture. Heavy centric and eccentric contacts noted.

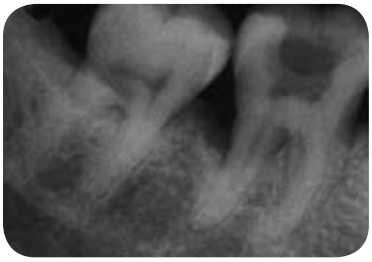

FIGURE 5. Tooth No. 30 presents a diagnostic challenge. It shows evidence of recent pulpectomy and vertical bone loss. The bone loss seen on the distal aspect may be associated with heavy occlusal forces or due to the presence of calculus and/or pulpal involvement.

FIGURE 6. Radiograph after 16 weeks.

performed. Endodontic treatment was completed and the tooth was provisionally restored with very "light" occlusion. Radiograph taken 16 weeks later (**FIGURE 6**) revealed resolution of vertical defect.

Burgett et al. conducted a randomized controlled trial where all patients received initial periodontal therapy and were divided into two groups: those who received occlusal adjustment, or those who received no occlusal adjustment prior to definitive periodontal therapy.[27]

Periodontal therapy consisted of both nonsurgical and surgical (modified Widman flap) treatment. After two years, patients who received occlusal adjustments had a statistically significant mean probing attachment gain when compared to the patients who did not receive occlusal adjustments. There was no significant effect of occlusal adjustment on the reduction in probing depths, and, surprisingly, they did not find any significant difference in reduction of tooth mobility between the adjusted and the nonadjusted groups. A retrospective study by Jin and Cao concluded there were no significant differences in probing depth, clinical attachment levels, or the loss of alveolar bone height, when comparing teeth with and without abnormal occlusal contacts.[28]

Therefore, the study conducted by Jin and Cao supported some of the earlier observations of Burgett when teeth with and without abnormal occlusal contacts were evaluated using human subjects.[27,28]

Researchers have also examined the effect of trauma on the healing of periodontal tissues. Rosling et al. compared the healing of periodontal structures around mobile teeth associated with angular bone defects, and firm teeth, after periodontal surgery.[29] They concluded that infrabony pockets associated with hypermobile teeth exhibited the same degree of healing as those adjacent to firm teeth. Felszar et al. conducted another eight-year longitudinal study that examined the relationships between tooth mobility and periodontal therapy, and occlusal adjustment. They concluded that, although clinically mobile teeth were successfully treated and maintained, they did not respond as well to treatment as firm teeth with comparable initial periodontal disease.[30] Their findings contradicted the results of Rosling's study.

Findings have been published by numerous authors in the form of case reports or case series. Although these case reports provide important information and valuable insight, a certain course of treatment which is successful for a patient, may not transfer to a larger group of patients.[31]

It is quite promising that within the past 10 years, a number of human studies have been conducted in an attempt to gain more insight to the very challenging topic regarding the role of occlusion in periodontal disease initiation and progression. Recently, Bernhardt et al. investigated the potential associations between dynamic occlusal interferences and signs of periodontal disease in posterior teeth.[32] Their findings were based on a cross-sectional epidemiologic study titled "Study of Health in Pomerania." The data in their study was derived from posterior teeth of 2,980 dentate subjects and was statistically analyzed using a mixed linear model that allowed them to get correlations between measurements on multiple teeth within each subject. They demonstrated a weak relationship between nonworking side contacts and increased probing depth and attachment loss.

Another recent study looked into the effect of occlusal contact during mastication on the status of the periodontal tissues.[33] This study was conducted under the assumption that forces generated during

mastication are potentially traumatic to the periodontium. It was demonstrated that chewing movements deviating from normal increased the mobility of specific types of teeth. The authors suggested that occlusal evaluation with border and tapping movements might be insufficient when trying to assess the effect of occlusal forces on the periodontium. They further stated that differences in the manner by which occlusal forces and discrepancies are evaluated may contribute to the conflicting findings seen in several human studies. This should be taken into consideration when interpreting results from various clinical studies.

A majority of previous investigations compared patients with occlusal discrepancies versus patients without occlusal discrepancies. Since changes in clinical parameters such as probing depths and attachment levels studied using this approach are generally reported as patient mean, it is very possible that progression in more active sites within a patient may be masked. Taking this into consideration, a group of investigators studied the effects of occlusal discrepancy using the individual tooth as the experimental unit.[34-36]

The progression or deterioration of the individual tooth instead of the patient mean was followed over time. The authors retrospectively analyzed records of patients from private practice, and reported that teeth with occlusal discrepancies presented with deeper pocket depths and worse prognosis than those who did not have occlusal discrepancies. In addition, when followed over time, there was a significant increase in probing depths in teeth with occlusal discrepancies, and when left untreated were associated with progression of periodontal disease. Furthermore, occlusal treatment seems to reduce the progression of periodontal disease over time. Thus, based on these recent human studies, occlusal discrepancies appear to be a risk factor in the progression of periodontal disease.

To summarize results based on human studies, there is some evidence of association between trauma from occlusion and periodontal disease, but none proves a cause and effect relationship. Data is still inconclusive regarding the effect of trauma from occlusion on the response to periodontal therapy.

PERI-IMPLANT BONE, has been shown to possess mechanoreceptors that allow sensory feedback rom loaded implants.[4]

Impact of Occlusal Forces on the Peri-implant Structures

Implants have become an integral part of the field of dentistry, therefore it is worthwhile to briefly comment on the current evidence regarding the effect of occlusal forces on the peri-implant structures. Unlike natural teeth, which are suspended in the alveolus by the periodontal ligament (PDL), osseointegrated implants are more rigidly attached to bone. It has been demonstrated that implants can only be displaced 3-5 µm vertically and 10-50 µm laterally compared to 25-100 µm vertically and 56-108 µm buccolingually in natural teeth.[39] Thus, implants are unable to adapt like teeth.

When overloaded, teeth can respond by widening the PDL to accommodate excessive forces. This adaptive phenomenon is not seen in implants. Peri-implant bone, has been shown to possess mechanoreceptors that allow sensory feedback from loaded implants.[40] It is plausible that bone around the implant is able to respond to occlusal forces through these mechanoreceptors. When the load is excessive, peri-implant bone loss can occur.[41]

Readers are referred to recent articles for a more comprehensive review of available evidence regarding the relationship between occlusal forces and peri-implant structures.[42,43] The following statements represent current theories:

1. Mechanical stress below a certain threshold (6600 microstrain) may lead to bone apposition, but stresses above this threshold may lead to bone loss or complete loss of implant osseointegration.[44]
2. Occlusal overload can result in marginal bone loss around oral implants with no inflammation in the peri-implant tissues.[45]
3. Occlusal overload can result in complete loss of osseointegration.[46]
4. Occlusal overload in the presence of peri-implantitis could result in increased bone loss.[45]

Due to lack of randomized controlled or prospective cohort studies, a causative relationship between occlusal overload and bone loss or loss of osseointegration cannot be established at this time.

Discussion

While some studies found a relationship between increased attachment loss and tooth mobility, others found no relationship between attachment loss and abnormal occlusal contacts. Tooth mobility can be a result of a variety of factors including loss of alveolar bone, attachment loss, and inflammation within the periodontal ligament or any other process, which may affect the supporting periodontal structures. Therefore, any relationship found between tooth mobility and progressing periodontitis does not necessarily implicate or defend occlusion as a cofactor in the progression of periodontal disease.[37]

Despite numerous studies that ad-

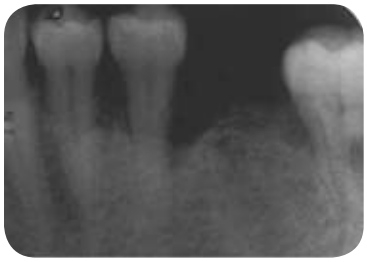

FIGURE 7. Vertical defect on distal of No. 20.

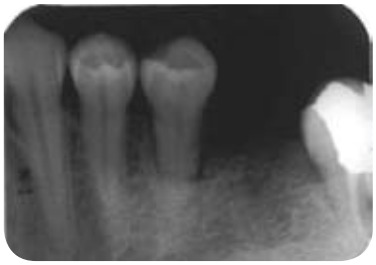

FIGURE 8. Three-month postoccclusal adjustment.

FIGURE 9. Periapical radiograph taken of No. 29 in a 84-year-old African American female patient. The tooth had slight mobility with heavy centric and eccentric contacts. Splinting of the tooth was performed after occlusal adjustment. Surgical therapy consisted of guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier.

dress the theory of occlusion, there have been very few that can help answer the question "Does occlusal trauma modify the progression of attachment loss due to inflammatory periodontal disease?" In reviewing the literature, it is clear from the numerous experiments carried out both in animals and humans, that:[38]

1. Trauma from occlusion does not initiate gingivitis or periodontitis.
2. Occlusion may be a risk factor in the progression of periodontitis.
3. Healing following surgical treatment of periodontal disease may be more advantageous in nonmobile than in mobile teeth.

Based on the literature, it appears there is no clear answer to the role of occlusion in periodontal disease. Rather, this is a gray area and one has to examine each case on an individual basis, while keeping some evidence-based findings in mind. A clinician's decision to use occlusal adjustment as part of periodontal therapy should be based on a number of factors, such as the type of periodontal therapy (surgical versus nonsurgical), goal of periodontal therapy, and establishing a dentition that the patient can maintain in health and function. A treatment directed toward removing occlusal trauma alone, such as occlusal adjustment or splinting, may reduce the mobility of the teeth, but will not prevent further progression of plaque-related periodontal disease or help regain the lost periodontium. Although longitudinal studies in humans are needed to provide a better understanding of this relationship, they are difficult to perform, given the nature of this subject and for ethical reasons.

Conclusions

While occlusal forces do not initiate periodontitis, trauma from occlusion can result in resorption of alveolar crestal bone, leading to increased tooth mobility, which may be temporary or permanent. This bone resorption with increased tooth mobility should be regarded as a physiologic adaptation of the periodontium to the traumatic occlusal forces.

Periodontal health can be maintained without occlusal adjustment and although some studies showed a statistically significant gain in clinical attachment with occlusal adjustment, whether this is of any clinical significance and benefit to patients, is uncertain.[27] Once periodontal health is established, occlusal therapy can be performed if indicated, to help reduce mobility.

Occlusal adjustment is an effective therapy against increased tooth mobility when such mobility is associated with an increased width of the periodontal ligament. Increased tooth mobility as a result of reduced height of the alveolar bone can be accepted, provided the occlusion is stable (there is no further tooth migration or increasing mobility), and does not hinder the patient's chewing ability or comfort. Tooth mobility is not synonymous with occlusal trauma, and may be related to a number of inflammatory conditions around the teeth.

Recommendations for Clinical Practice

Any form of treatment should be geared at removing the inflammation in the periodontium first. This may include both nonsurgical and surgical periodontal therapy. Any potential occlusal factors should be evaluated subsequent to this, and addressed if necessary. An exception to this course of treatment would be a situation where the occlusal factors interfere with the patient's ability to masticate and function properly or for patient comfort. An example of such a situation would be a long-standing chronic periodontal condition, where the extent of bone loss results in excessive and/or progressive mobility of teeth.

In such cases it is advisable to address the occlusal component of the treatment plan, concurrently with periodontal therapy.

The following cases demonstrate the complexity of addressing trauma from occlusion in the presence of periodontal disease.

Case 1. Reduction of probing depth and mobility following occlusal adjustment and scaling and root planning.

FIGURE 7 illustrates an angular bone defect on the distal aspect of tooth No. 20 with clinical probing depth of 8 mm. Buccolingual displacement of 2 mm was detected. Open contact between Nos. 20 and 21 was present. Heavy centric and eccentric occlusal contacts were noted on No. 20.

Occlusal adjustment on No. 20 and scaling and root planning were performed. At the three-month re-evaluation appointment, reduction in mobility and probing depth were seen. A radiograph taken at that appointment (**FIGURE 8**) revealed

FIGURE 10. The same area after 2½ years. Marked reduction in the mesial defect is noted along with complete resolution of the distal defect. The patient was functioning comfortably and reported no discomfort on chewing.

slight improvement in bone topography. Surgical periodontal therapy is required to address the residual vertical defect.

Case 2. Surgical therapy combined with splinting of teeth and occlusal adjustment to treat vertical defect on No. 29.

FIGURE 9 shows periapical radiograph taken of No. 29 in a 84-year-old African American female patient. The tooth had slight mobility with heavy centric and eccentric contacts. Splinting of the tooth was performed after occlusal adjustment. Surgical therapy consisted of guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier.

FIGURE 10 shows the same area after 2½ years. Marked reduction in the mesial defect is noted along with complete resolution of the distal defect. The patient was functioning comfortably and reported no discomfort on chewing. ■■■■

REFERENCES

1. Stillman PR, The management of pyorrhea. *Dental Cosmos* 59:405-14, 1917.
2. Box HK, Experimental traumatogenic occlusion in sheep. *Oral Health* 29:9-15,1935.
3. Stones HH, An experimental investigation into the association of traumatic occlusion with periodontal disease. *Proceedings of the Royal Society of Medicine* 31: 79-95, 1938.
4. Glickman I, Smulow JB, Alterations in the pathway of gingival inflammation into the underlying tissues induced by excessive occlusal forces. *J Periodontol* 33:7-13,1962.
5. Glickman I, Smulow JB, Effect of excessive occlusal forces upon the pathway of gingival inflammation in humans. *J Periodontol* 36:141-7, 1965.
6. Glickman I, Smulow JB, Further observations on the effects of trauma from occlusion. *J Periodontol* 38:280-93, 1967.
7. Glickman I, Smulow JB, Adaptive alterations in the periodontium of the rhesus monkey in chronic trauma from occlusion. *J Periodontol* 39:101-5, 1968.
8. Waerhaug J, The infrabony pocket and its relationship to trauma from occlusion and subgingival plaque. *J Periodontol* 50:355-65, 1979.
9. Waerhaug J, The angular bone defect and its relationship to trauma from occlusion and down growth of subgingival plaque. *J Clin Periodontol* 6:61-82, 1979.
10. Lindhe J, Svanberg G, Influence of trauma from occlusion on progressive experimental periodontitis in the beagle dog. *J Clin Periodontol* 1:3-14, 1974.
11. Lindhe J, Ericsson I, Influence of trauma from occlusion on reduced but healthy periodontal tissues in dogs. *J Clin Periodontol* 3:110-22, 1976.
12. Ericsson I, Lindhe J, Effect of longstanding jiggling on experimental periodontitis in the beagle dog. *J Clin Periodontol* 9:497-503, 1982.
13. Lindhe J, Ericsson I, The effect of elimination of jiggling forces on periodontally exposed teeth in the dog. *J Periodontol* 53:562-7, 1982.
14. Ericsson I, Lindhe J, Effect of longstanding jiggling on experimental marginal periodontitis in the beagle dog. *J Clin Periodontol* 9:497-503,1982.
15. Ericsson I, Lindhe J, Lack of significance of increased tooth mobility in experimental periodontitis. *J Periodontol* 55:447-52, 1983.
16. Nyman S, Lindhe J, Ericsson I, The effect of progressive tooth mobility on destructive periodontitis in the dog. *J Clin Periodontol* 5:213-25, 1978.
17. Polson AM, Meitner SW, Zander HA, Trauma and progression of marginal periodontitis in squirrel monkeys. III. Adaptation of interproximal alveolar bone to repetitive injury. *J Periodontal Res* 11:279-89, 1976.
18. Polson A, The relative importance of plaque and occlusion in periodontal disease. *J Clin Periodontol* 13:923-7, 1986.
19. Polson AM, Kantor ME, Zander HE, Periodontal repair after reduction of inflammation. *J Periodontal Res* 14:520-5, 1979.
20. Polson AM, Meitner SW, Zander HA, Trauma and progression of marginal periodontitis in squirrel monkeys. IV. Reversibility of bone loss due to trauma alone and trauma superimposed upon periodontitis. *J Periodontal Res* 11:290-7, 1976.
21. Kantor M, Poison AM, Zander HA, Alveolar bone regeneration after the removal of inflammatory traumatic factors. *J Periodontol* 7:687-95, 1976(A).
22. Perrier M, Polson A, The effect of progressive and increasing tooth hypermobility on reduced but healthy periodontal supporting tissues. *J Periodontol* 53:152-7, 1982.
23. Polson AM, Zander HA, Effect of periodontal trauma upon intrabony pockets. *J Periodontol* 54:586-92,1983.
24. Polson AM, Adams RA, Zander HA, Osseous repair in the presence of active tooth hypermobility. *J Clin Periodontol* 10:370-9, 1983.
25. Polson AM, Trauma and progression of marginal periodontitis in squirrel monkeys. II. Co-destructive factors of periodontitis and mechanically produced injury. *J Periodontal Res* 9:146-52, 1974.
26. Pihlstrom B, Anderson KA, et al, Association between signs of trauma from occlusion and periodontitis. *J Periodontol* 57:1-6, 1986.
27. Burgett FG, Ramford SP, et al, A randomized trial of occlusal adjustment in the treatment of periodontitis patients. *J Clin Periodontol* 19:381-7, 1992.
28. Jin L, Cao C, Clinical diagnosis of trauma from occlusion and its relation with severity of periodontitis. *J Clin Periodontol* 19:92-7, 1992.
29. Rosling B, Nyman S, Lindhe J, The effect of systematic plaque control on bone regeneration in infrabony pockets. *J Clin Periodontol* 3:38-53, 1976.
30. Fleszar TJ, Knowles JW, et al, Tooth mobility and periodontal therapy. *J Clin Periodontol* 7:495-505, 1980.
31. Gher ME, Nonsurgical pocket therapy: dental occlusion. *Ann Periodontol* 1(1):567-80, 1996.
32. Bernhardt O, Gesch D, et al, The influence of dynamic occlusal interferences on probing depth and attachment level: results of the Study of Health in Pomerania (SHIP). *J Periodontol* 77(3):506-16, 2006.
33. Ishigaki S, Kurozumi T, et al, Occlusal interference during mastication can cause pathological tooth mobility. *J Periodontal Res* 41:189-92, 2006.
34. Harrel S, Nunn M, Longitudinal comparison of the periodontal status of patients with moderate to severe periodontal disease receiving no treatment, non-surgical treatment and surgical treatment utilizing individual sites for analysis. *J Periodontol* 72:1509-19, 2001.
35. Nunn M, Harrel SK, The effect of occlusal discrepancies on treated and untreated periodontitis. I. Relationship of initial occlusal discrepancies to initial clinical parameters. *J Periodontol* 72:485-94, 2001.
36. Harrel SK, Nunn M, The effect of occlusal discrepancies on treated and untreated periodontitis. II. Relationship of occlusal treatment to the progression of periodontal disease. *J Periodontol* 72:495-505, 2001.
37. Gher ME, Changing concepts. The effects of occlusion on periodontitis. *Dent Clin North Am* 42(2):285-99,1998.
38. Periodontal Literature Reviews: a summary of current knowledge. *Am Acad Periodontol* 1996.
39. Kim Y, Oh T-J, Misch CE, Wang H-L, Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res* 16:26-35, 2005.
40. Wada S, Kojo T, et al, Effect of loading on the development of nerve fibers around oral implants in the dog mandible. *Clin Oral Implants Res* 12:219-24, 2001.
41. Isidor F, Histological evaluation of peri-implant bone at implants subjected to occlusal overload or plaque accumulation. *Clin Oral Implants Res* 8:1-9,1997.
42. Isidor F. Influence of forces on peri-implant bone. *Clin Oral Impl Res* 17(s2):8-18, 2006.
43. Gross MD, Occlusion in implant dentistry. A review of the literature of prosthetic determinants and current concepts. *Australian Dent J* 53(s1):S60-8, 2008.
44. Melsen B, Lang NP, Biological reactions of alveolar bone to orthodontic loading of oral implants. *Clin Oral Implants Res* 12:144-52, 2001.
45. Miyata T, Kobayashi Y , et al. The influence of controlled occlusal overload on peri-implant tissue. Part 3: a histologic study in monkeys. *Int J Oral Maxillofacial Implants* 15:425-31, 2000.
46. Isidor F, Mobility assessment with the Periotest system in relation to histologic findings of oral implants. *Int J Oral Maxillofacial Implants* 13:377-378, 1998.

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Increasing Dental Care for Very Young Children: What Can Training Accomplish?

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ABSTRACT Too few dental providers feel comfortable or are keen on seeing young children in their practices, and training in oral health has generally ignored the dental component of early childhood. Evaluation of California's $7 million First Smiles showed increased knowledge and skills among 3,369 dental professionals trained. Positive practice changes included increasing willingness to see more 1-5 aged children, including special needs; seeing children for a first visit by age 1; and conferring with a pregnant patient's medical provider.

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Dental caries is the most prevalent chronic disease of children, especially among low-income families, despite the fact that tooth decay is largely preventable through regular dental checkups, the use of fluoride and sealants, and appropriate diet and oral health care.[1] While research is ongoing, periodontal infection has also been associated with adverse pregnancy outcome and maternal oral flora is one of the greatest predictors of the oral flora of her offspring.[2]

Children with compromised immunity or cognitive or other developmental and physical conditions, with limited ability to cooperate with preventive oral health practices, may be especially vulnerable to the effects of oral diseases and at higher risk for complications.[3]

Severe dental caries is a particular problem in young children because of the difficulty in managing them in a dental office, or requiring expensive treatment in an operating room, and the multiple visits necessary to treat them.

Despite a recommendation by the American Academy of Pediatrics, American Dental Association, and the American Academy of Pediatric Dentists that children receive a first oral health visit by age 1, in California, in 2005, more than one-third (34.3 percent) of children age 5 and under had never had a dental visit. (The figure rises to 37.2 percent for those between 100 percent to 200 percent of the poverty level.[4])

Child health professionals can play a significant role in reducing the burden of this disease if they have adequate training and support to do so.

However, training in oral health of young children continues to be an important need for both medical and dental pro-

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viders, and, has, with a few exceptions, generally ignored the dental component of early childhood.[5] Further, U.S. dental schools may not be adequately addressing the prenatal to 5-year old age group in the didactic and clinical portions of their curricula.

This study examined the impact of California's $7 million "First Smiles" training program conducted statewide by the California Dental Association Foundation (CDAF) and Dental Health Foundation (DHF) in 2004-2008. The goal of the program was to increase access to quality oral health education and preventive services for children aged newborn to 5, particularly low-income and children with disabilities and other special health care needs, by expanding the number of dental and medical providers willing to provide services to this population; and to increase the capability of community-based organizations that typically serve families with the highest risk for oral disease, such as Head Start, to provide anticipatory oral health guidance to parents. This paper focuses primarily on the results of the training for dental professionals.

Background

First 5 California, a state program to serve children aged newborn to 5 funded from a voter-approved tax on the sale of tobacco products, launched an Early Childhood Oral Health Initiative in 2004 of which First Smiles was the major component. The initiative was based on recognition of the link between a child's oral health and their overall health, and the critical gap in access to services for many low-income families related to providers' knowledge, attitudes, and involvement.

A multidisciplinary Scientific Advisory Committee, SAC, of 15 experts in children's oral health was convened and guided the project. To standardize the training, key messages the SAC reached consensus on were piloted among a group of 300 dentists in May 2004 as the curriculum was being developed. The curriculum was tailored as necessary for both medical and dental professionals and field tested and revised before implementation.

TABLE 1

Project Goals for Reaching Providers With Education and Training

	Dental Professionals	Medical Professionals	
	Dentists, dental hygienists, and dental assistants	Primary care providers (pediatricians, family practice, OB-GYNs, pediatric nurse practitioners)	Medical residents
Education	75% (34,097)	50% (7,174)	50% (1,238)
Training	30% (13,683) (92% reached as of February 2008)	20% (2,900) (100% reached as of December 2007)	50% (495) (100% reached as of December 2007)

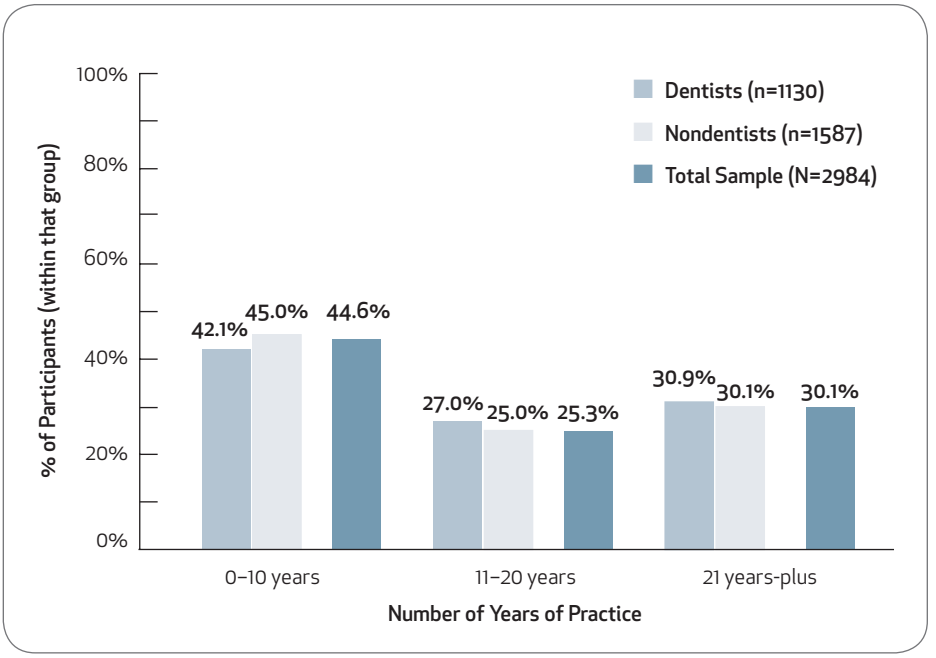

FIGURE 1. Dental professionals' years in practice.

Program Goals

First Smiles was expected to reach 75 percent of California's dental providers and 50 percent of the state's primary care providers with education; and 30 percent of the dental and 20 percent of the medical providers with training as shown in **TABLE 1**.

The expected program outcomes included provider knowledge gain, increased skills concerning oral health of children aged newborn to 5, and adoption of desired practice changes, such as willingness to see children at younger ages, and longer-term system changes.

Training Strategies

Education and training for the dental professionals were offered in a variety of formats, including two-hour (e.g., at local dental society dinners) and four-

hour (e.g., at major meetings and conferences) in-person trainings, two-hour Web cast training sessions, and modules for distance learning. In some cases, joint training was offered for dental and medical providers. Educational strategies included dissemination of journal articles, some commissioned by this project, policy briefs, and newsletters. The project also served as a resource for disseminating new and emerging research by posting the latest scientific information on its Web site.

TABLE 2

Pediatric Patient Mix in the Dental Practices

Survey Question	M	SD	n
Regarding all the children ages 0 – 18 in your practice, approximately what percentage is made up of the following children?			
a) Children ages 0 to 5	21.1%	24.40	2,599
b) Children receiving Medi-Cal, Healthy Families, Healthy Kids or other public program benefits	20.8%	31.88	2,557
c) Children from families who are agricultural/farmworkers	10.0%	19.40	2,424
d) Children with disabilities or other special health care needs	5.3%	9.89	2,550

Method

Data Sources

The data for the study came primarily from about 14 evaluation instruments uniquely created for this project. These included participants' initial and follow-up surveys with the course post-test imbedded; a trainer feedback survey about the ease of use and effectiveness of the curriculum and course materials for participant learning; a local dental society survey to assess awareness about the program and perceptions about its usefulness; and a local First 5 commission survey to determine familiarity with the project and involvement in funding of local oral health strategies. Post-training telephone interviews with a representative sample of dentists and parent focus groups were also used to inform the evaluation.

The five California dental schools responded to a curricula survey in baseline 2004-05 and follow-up in 2007-08 academic years concerning the age newborn to 5 curriculum content. A representative sample of U.S. dental schools was analyzed during the same periods for comparison. The U.S. sample was selected systematically from the 47 non-California dental schools in sequences separated by an interval of one with the following other considerations: additional schools selected based on previous contact with this project; familiarity of the evaluator with the school; and availability of complete contact information on Web site. Names of schools were drawn until a sample size of half (23) of the non-California schools was selected. A total of 21 (91 percent) completed surveys were received, representing 45 percent of the U.S. dental schools outside of California. The 21 dental schools in the initial survey sample were sent the follow-up survey in November 2007 and 20 (95 percent) responded.

Data Collection And Analysis

The training participants, dental and medical providers, completed the survey/post-test ("survey") immediately after participating in a training session (referred to as "the initial survey"). They completed a similar survey/post-test approximately six months later (called the "follow-up survey.") The initial survey was completed onsite immediately after the training session and collected by program trainers according to the authors' instructions, and mailed to them in self-addressed, prepaid mailers. The authors faxed or emailed the follow-up survey to participants who supplied the required contact information on their initial survey. (While dentists were the most likely to supply such information, a fax number, about one-third of all surveys were missing the information and no follow-up was possible). When e-mailing proved far less effective, the authors sent the follow-up survey only by fax.

Detailed coding schemes and Excel spreadsheets were created for the surveys and data entry staff were trained in their use. Standard data security measures were taken. The written provider surveys were logged in as they arrived and the data were entered into the spreadsheets for analysis. The data were cleaned and statistical analysis performed using SPSS Version 15.0. To avoid alpha level inflation in sets of related analyses, a Bonferroni correction was made. Summaries of findings from the telephone interviews and other qualitative data sources were prepared in structured formats from written notes, coded, and analyzed for content.

Study Limitations

The study used a post-test-only design to demonstrate knowledge gain (as opposed to knowledge increase), a suitable design when there is no available comparison group and no pretest data. The design requires identification of items on a post-test that were included in the curriculum, which this study met. Pretests can add to project expense and cost valuable instructional time. Trainers and the SAC were concerned that taking additional time away from delivering the course (especially the shorter course) to require participants to complete a pretest was impractical and would have limited

TABLE 3

Initial Post-test Results of Dental Providers, Total Sample

Survey Question	% Correct on Initial Survey		
	In-Person 2-Hour (n=1410*)	In-Person 4-Hour (n=1258*)	Online (n=123*)
TRUE / FALSE			
a) Age for infant's first dental visit	91.4	93.1	91.9
b) Behavioral issues in treating children with special needs	42.1	44.9	39.0
c) Medi-Cal/Healthy Families reimbursement	80.2	82.8	84.6
d) Role of xylitol gum	92.6	92.5	95.9
e) Remineralization with fluoride varnish	96.2	94.6	95.9
Total average score for true/false	80.5	81.6	81.5
Average # of true/false items correct	4.0	4.1	4.1
MULTIPLE-CHOICE			
1. Risk factors associated with early childhood caries	77.9	80.2	86.9
2. Pathological factors in caries balance equation	75.7	81.1	81.3
3. Protective factors in caries balance equation	68.1	76.6	70.7
4. Most prevalent unmet need in children with special needs	92.3	95.2	97.6
Total average score for multiple choice	78.5	83.3	84.2
Average # of multiple choice items correct	3.1	3.3	3.4
Total test score (all items combined)	79.6	82.3	82.7

*Sample size is after excluding those cases with eight or more blank post-test responses on the initial survey.

value-added information about knowledge gain that wasn't already intuitively known. State First 5 staff agreed that the course post-test results would be the indicator for knowledge gain, and six months later used as the indicator for knowledge retention.

Findings

Program Reach

During the course of the four-year program, First Smiles provided training to 15,230 healthcare professionals (75 percent as dental providers), and 883 staff from participating community agencies, meeting close to 100 percent of the target training goal. The dataset for this study consisted of the 3,369 dental professionals who attended one of the training courses and completed an initial survey between January 2005 and October 2007. Approximately 10 percent of these providers also returned a follow-up survey that could be matched to their initial survey.

The Study Sample

Of those who specified their profession (13 percent did not do so), dentists comprised about 35 percent of the sample and allied dental professionals (hygienists and assistants) represented 44 percent. Dental residents and dental office staff made up the remaining 8 percent. Seven of 10 course participants were women, which would be expected with such a high percentage of allied dental participants.

First Smiles drew a diverse participation of dentists ethnically and racially (probably reflecting the wide reach the program attempted to achieve). While somewhat the same proportion of black dentists attended a training as practice in California, there were nearly twice the proportion of Hispanic and more than twice the proportion of Asian dentist participants than represented among the state's dentist population. (Compared to the physician respondents, dentists were much more likely to identify their gender and race/ethnicity.)

A broad range of years (less than 1 year to 56 years) of practice was represented in the sample, with those professionals practicing for relatively fewer years outnumbering those who had been in practice for relatively more years. Close to half (44.6

percent) of the dental respondents were in practice for 10 years or less, with the remainder about equally divided between 11-20 years, and more than 21 years in practice. The number of years practicing their profession was substantially the same for dentists and allied staff (**FIGURE 1**).

Pediatric Patient Profile

The authors asked about certain characteristics of the pediatric patient mix in these dental offices. The average percentage of respondents' practices devoted to children aged newborn to 5 and to children receiving some form of public benefits were each approximately 21 percent. On average, only 10 percent of their practice was made up of children from farmworker families (a population of special interest to the project funder) and only about 5 percent of children with disabilities or other special needs (**TABLE 2**).

Knowledge Gain and Retention

All of the training participants exhibited a great deal of knowledge in most areas of the curriculum content (80 percent average correct post-test scores). Dental providers, as well as medical providers, did least well in understanding that there is no general difference in the behavioral issues of children aged newborn to 5 with special needs versus all children of that age group. They also did slightly less well in identifying the protective factors in the caries balance equation (**TABLE 3**). With all of the post-test items combined, those who took the four-hour and online course performed significantly better ($p=<.005$) than the two-hour group.

As expected, there was a general trend for course participants to lose some information over the six-month follow-up period, regardless of the length of course. The different dental professions differed significantly on total test performance; hygienists and dentists did not differ from each other but they performed significantly better than dental assistants as shown in **FIGURE 2**.

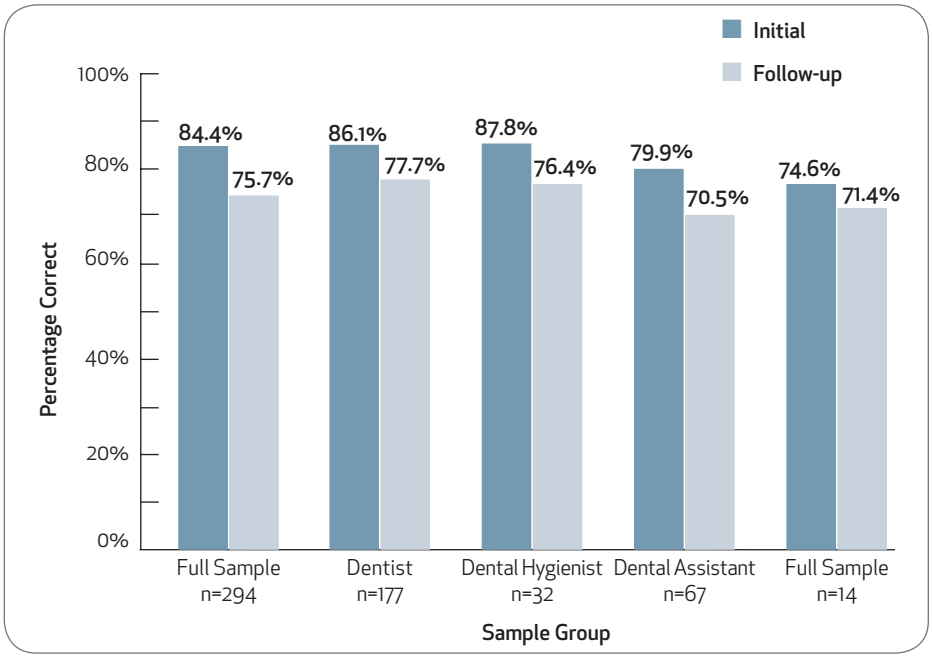

FIGURE 2. Dental post-test questions correct, initially and at six months.

Satisfaction with the Training

Overall, the dental participants were very satisfied with the course. They reported being very likely to recommend the course to colleagues (six months later more than half, 56.5 percent, had done so) and anticipated being able to apply information they learned in their practices. They also expected to use the course materials. The follow-up telephone interviews with general dentists also affirmed the value of the training as shown in **TABLE 4**.

Dental professionals who took the training made use of a variety of resources to stay current on issues related to young children's oral health. The most common methods utilized were reading journal articles (74 percent of the respondents) and attending conferences and workshops on the topics (**TABLE 5**).

Self-perceived Skill Improvement

Overall, the dental providers agreed that the course increased their skills after training (**TABLE 6**). The highest degree of perceived increase was in learning how to communicate with parents, followed by performing a knee-to-knee exam; the lowest increase reported was in learning how to bill and get reimbursed for procedures.

To examine possible gender differences in the ability to handle very young children after taking the course, this skill (item "d" in **TABLE 6**) was analyzed separately. Based on responses from the initial surveys, female and male general dentists did not differ significantly in the skill of managing the behavior of young children in a dental practice.

Except for the skill in knowing when to treat and when to refer an oral health problem (item "b" in **TABLE 6**), an analysis of variance revealed that dental participants perceived significantly less skill change due to taking the course when they were asked about this again six months later.

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TABLE 4

Dentists' Feedback About the Training Six Months Later

- "The course helped me a lot with technique."
- "I've implemented the fluoride varnish procedure described at the training."
- "I was already seeing young kids but the course definitely improved the quality of care I provide."
- "I feel so much more comfortable with being able to see younger children."
- "I learned that kids need to come in at a younger age than I previously thought."
- "The information about disabilities and special needs made me more comfortable with being able to see these children."
- "Now I can explain to parents why it's important to bring them in early."
- "I don't see any new children in my older practice but I opened a new practice where I accept children 0-5."

TABLE 5

Type of Resources Utilized by Dental Providers Since Training

Survey Question	n
What resources have you utilized in the last six months to stay updated on oral health issues related to children 0–5?	
Read professional journals on the topic	226
Attend conference or workshop on the topic	124
First Smiles (this project's) Web site	96
Other Web-based educational sites and materials	74
Other (what?)	22
Discussion/consults with other dentists	5
By training or being in residency training	4
Los Angeles POHAP (Pediatric Oral Health Assessment Project)	2
Unable to determine	2

Note. Because survey questions allowed for the respondent to check more than one choice, no percentages were computed).

Practice Behavior Changes

Age at First Visit

Although one-third of the total sample of general dentists reported they typically started seeing children at age 3 (with female general dentists significantly more likely than their male colleagues to see children at younger ages), only 14.5 percent saw them as early as the first birthday as recommended by the American Dental Association and American Academy of Pediatrics. Six months after taking the course, however, all general dentists, without regard to gender, whose initial and follow-up surveys could be matched appeared to be seeing children at younger ages.

At the time of follow-up, 28.4 percent, up from 22.8 percent initially, indicated that they saw children for a first appointment at age 1, a 24.6 percent change (TABLE 7).

Years in practice, a proxy measure for dentists' age, and gender were examined at the time of training to see if there was a relationship with when children were first seen. Analysis of variance revealed that female dentists reported typically starting to see children at a significantly younger age than their male colleagues (TABLE 8). General dentists who had been in practice longer was correlated to seeing children at older ages at their first visit (r=.101, p<.01), suggesting that younger dentists were more likely to take patients at younger ages.

Frequency of Performing Procedures and Role Delegation

There was considerable variation in the frequency with which preventive procedures were performed by the dental providers for children newborn to 5, and pregnant women/new mothers. The procedures that tended to be performed quite frequently, as reported by the total sample, were discussion of infant feeding and nutrition counseling. Six months after the training, there were statistically significant (p<.006) increases in four procedures: for children newborn to 5, participants more frequently applied fluoride varnish and discussed an infant's bottle or breast feeding practices. For pregnant patients, dentists discussed breast feeding practices and recommended xylitol gum more often (TABLE 9). The gender differences were not significant when examined to see whether female and male general dentists might serve pregnant patients differently relative to the frequency of coordinating their care or consulting with their obstetrical provider.

Six months after receiving the training, 8.3 percent of the dental providers whose offices placed sealants and 8.7 percent of those who applied topical fluoride reported increasing delegation of these procedures as a result of what they learned at the course, thereby allowing the dentists to see more patients. Other role changes

TABLE 6

Increase in Self-perceived Skill Level Among Dental Providers, Initial and Six Months

Survey Question	Initial Survey				Follow-up Survey			
	M	SD	n*	Already Had Skill n**	M	SD	n*	Already Had Skill n**
Specifically with regard to children 0-5, to what extent did this course increase your skills in:								
a) Performing a knee-to-knee exam	2.48	.62	209	61 (20.7%)	2.21	.70	209	62 (20.4%)
b) Knowing when to treat and when to refer an oral health problem	2.35	.67	196	61 (20.7%)	2.25	.64	196	65 (21.5%)
c) Knowing how to treat a problem I identify	2.31	.66	208	46 (15.6%)	2.13	.64	208	62 (20.5%)
d) Managing behavior of very young children	2.26	.70	210	55 (18.6%)	2.10	.67	210	54 (17.8%)
e) Providing education and other anticipatory guidance to parents	2.49	.58	221	42 (14.5%)	2.36	.66	221	44 (14.5%)
f) Learning how to bill and get reimbursed for procedures	2.12	.76	223	33 (11.6%)	1.71	.69	223	36 (12.0%)
g) Organizing the dental office for success	2.16	.71	212	39 (13.8%)	1.90	.64	212	40 (13.6%)

Note. Item mean scores reflect the following response choices: 1 = *very little*, 2 = *some*, and 3 = *a great deal.* * The total number of participants providing follow-up surveys that could be matched to the initial survey was 311. However, the sample size for valid (nonmissing) responses varied from question to question. **Those who indicated "*very little because I already had this skill*" were withheld from the computation.

that occurred with less frequency were delegation of doing *Streptococcus mutans* testing and performing coronal polishing.

Willingness to See Young Patients

One of the key goals for this program was an increase in workforce capacity for seeing more children age newborn to 5, and identifying what it would take to facilitate this. Approximately half of the general and pediatric dentists indicated they were likely or very likely to increase the number of very young children in their practice as a result of taking the course.

Six months after the training, 16 percent (25 of 156) of the general dentists reported they were seeing more children aged newborn to 5 specifically due to taking the course, an important increase but not at the level they anticipated right after attending a training. Six (5.9 percent) of the 102 dentists interviewed after training reported they had increased the number of children age newborn to 5 in their practice specifically due to taking the course. An additional 63 (62 percent)

TABLE 7

Age of Child Accepted by General Dentists, Initial and Follow-up

Survey Question	Matched Surveys (n = 169)				
	Initial		Follow-up		% Change
	n	%	n	%	
At what age do you typically start to see young children in your practice?					
1	37	22.8	48	28.4	+24.6
2	35	20.7	33	19.5	-5.8
3	55	32.5	54	32.0	-1.5
4	20	11.8	15	8.9	-24.6
5	10	5.9	9	5.3	-10.2
6	4	2.4	2	1.2	-50.0
No Response	7	4.1	7	4.1	0.0

TABLE 8

Gender Differences for General Dentists for Age of First Visit (N=1,124)

Question	Female			Male		
	M	SD	n	M	SD	n
At what age do you typically start to see young children in your practice?						
From 1 year of age to 8 years of age	2.69[a]	1.26	591	3.11[a]	1.57	533

[a] $F(1, 1123) = 25.91$, $p < .05$.

TABLE 9

Frequency of Performing Procedures at Time of Training and Follow-up

Survey Question	Initial Survey			Follow-up Survey		
	Never or Almost Never	Occasionally	Always or Almost Always	Never or Almost Never	Occasionally	Always or Almost Always
How frequently do you or another member of the dental team ordinarily perform the following in your practice?						
For children 0 to 5						
a) Apply fluoride varnish	106 37.9%	87 31.1%	87 31.1%	55 19.4%	106 37.3%	123 43.3%
b) Provide nutrition counseling to parent / caregiver	26 9.3%	112 39.9%	143 50.9%	22 7.6%	91 31.3%	178 61.2%
c) Discuss an infant's bottle or breastfeeding practices	36 13.0%	96 34.8%	144 52.2%	24 8.3%	80 27.6%	186 64.1%
d) Coordinate care or consult with a child's medical provider	104 37.4%	121 43.5%	53 19.1%	104 36.1%	144 50.0%	40 13.9%
e) Inquire about the oral health of the child's mother or caregiver	68 24.2%	115 40.9%	98 34.9%	44 15.3%	126 43.9%	117 40.8%
For pregnant women / new mothers						
f) Perform saliva testing	263 94.3%	13 4.7%	3 1.1%	262 92.6%	15 5.3%	6 2.1%
g) Discuss breastfeeding practices	157 56.3%	76 27.2%	46 16.5%	124 43.5%	97 34.0%	64 22.5%
h) Coordinate care or consult with a pregnant patient's medical provider	162 58.1%	92 33.0%	25 9.0%	162 57.0%	94 33.1%	28 9.9%
i) Recommend xylitol gum	143 51.8%	78 28.3%	55 19.9%	75 26.3%	126 44.2%	84 29.5%

Note. The total sample size for the matched initial and the follow-up surveys was 311. However, the number of valid responses ranged from 276 to 291.

dentists reported there had been a slight increase in the number of these children in their practice but not necessarily due to the course; they described general pediatric practice-building activities or usual patient attrition as the reasons, not a change in the overall ratio of young children to other patients in the practice. Three (2.9 percent) of the interviewed dentists reported increasing the number of children age newborn to 5 with disabilities or other special needs as a direct result of taking the course, describing increased confidence and comfort level with such children.

Female general dentists were significantly ($F(1, 1120)=18.89$, $p<.05$) more likely than males to say they were would see more children age newborn to 5; dentists in practice for longer periods of time (and presumably older) indicated they were *likely* to not increase the number of children this age in their practices. However, six months later there were no significant differences in either gender or years in practice when it came to intended and *actual* experience.

The barriers to taking more very young children were fairly evenly divided among three reasons shown in FIGURE 3. Personal life issues were described as nearing retirement, cutting back hours, coming back from/about to go on maternity leave and so forth. "Other" comments were of two types: parent resistance to bringing in children so young and the dentist preferring an adult population ("my patients are growing old with me").

What it Takes for Dentists to See More Newborns to Age 5 Children

More than half of the dentists said more training for staff, primarily in providing parent education and managing children's behavior, would make a difference in their willingness to see very young children (a dentist stated, "Take 25 years off my age and maybe I'd do it") (TABLE 10). More training needed regarding clinical skills included the knee-to-knee exam, oral sedation, sealants, and fluoride varnish. Examples of "other" training needs included risk assessment, oral health instruction for parents/caregivers and motivational training for the dentist to want to see young children. About 41 percent said having higher reimbursement for procedures (including those not currently covered)

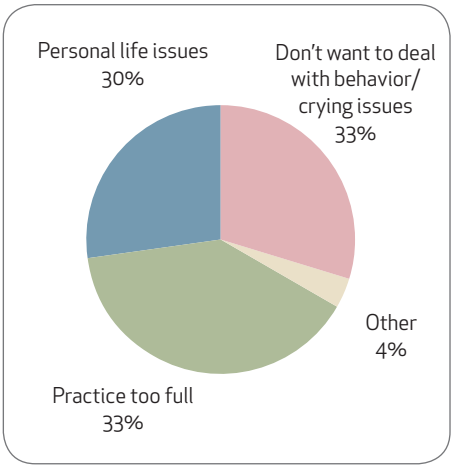

FIGURE 3. Main reasons for dentists not taking more children 0–5 (telephone interviews, n=102)

TABLE 10

What Dental Providers Said it Would Take to See More Children 0-5, Initial Survey

What would it take for you to see more (or any) children 0 to 5 in your practice?

Strategy	Number and Percent Agreeing	Response When Specified	n
More training for the staff	1,298 (55%)	Managing behavior	126
		Clinical skills	63
		Billing	21
		Parent education	129
		This type of course	85
Higher reimbursement for procedures	890 (41%)	Fluoride varnish	55
		Saliva testing	12
		Parent education	80
		Exam/prophy	13
		Sedation/anesthesia	4
		Dental sealants	7
		Other	60

was necessary, citing parent education and fluoride varnish most often. Examples of "other" procedures were visual exam consults, recall X-rays, and ART (alternative [or atraumatic] restorative treatment).

Risk Assessment

More than one-third of all dentists at follow-up reported they always peformed a formal oral health risk assessment on new patients aged newborn to 5 (TABLE 11). However, while close to two-thirds (63.2 percent) of the pediatric dentists reported always performing risk assessment, general dentists were more inconsistent, with a little over a quarter (28.6 percent) of them reporting regularly performing risk assessment. (On the other hand, 40 percent of the medical providers at follow-up reported always doing a formal oral health risk assessment on new patients aged newborn to 5.)

Referrals From Physicians to Dentists

There were also positive, though not statistically significant, changes in the oral health practices of primary care providers at follow-up as a result of the training. With regard to pregnant women, 51.7 percent of the primary care providers reported always or almost always referring these patients to a dentist, up from 18.5 percent who initially reported doing so. The medical providers also increased their frequency of always or almost always coordinating care with a pregnant patient's dental provider.

Dental School Curricula

One of the indicators for systems change this project hoped to influence was California dental schools increasing the percentage of curriculum focus on children age newborn to 5, including children with special needs. At baseline, two of the schools reported that 30 percent to 39 percent of the pediatric portion of the general dentistry curricula focused on the newborn to 5 age group, one school reported 20 percent to 29 percent pediatric focus, and two schools reported less than 10 percent. Three years later the overall pediatric curricula focus on newborn to age 5 children increased with two schools reporting more than 40 percent; however, three schools, one more than at baseline, reported less than 10 percent focus on this age group. Also at the time of follow-up, the percentages of didactic pediatric curriculum and clinical experience focused on newborn to age 5 had lessened slightly.

California dental schools' focus on children aged newborn to 5 did not appear to be much different than other dental schools in the nation according to the comparative analysis of nearly half of the other U.S. dental schools.

Discussion

First Smiles attracted a more diverse group of dentists than generally practice in California, participant characteristics that have the potential of influencing future practice behaviors and increasing the impact of the training. Having trained a large group of general dentists with fewer years in practice, for example, may have the payoff of a longer time span for implementing new knowledge and skills. And, having trained a relatively large group of female dentists who see children at younger ages and at least indicate a willingness to see more appears also to be beneficial.

First Smiles was effective in increasing dental professionals' knowledge, skills and practice behaviors associated with providing oral health services to children age

TABLE 11

Dentists' Frequency of Conducting Formal Risk Assessment at Follow-Up

Survey Question	All Dentists (n=182)		General Dentists (n=154)		Pediatric Dentists (n=19)		Other Dental Specialty (n=4)	
	n	%	n	%	n	%	n	%
How often do you do a formal oral health risk assessment on new patients aged 0 – 5?								
Never	35	19.2	31	20.1	2	10.5	1	25.0
Seldom	23	12.6	20	13.0	3	15.8	–	–
Sometimes	47	25.8	45	29.2	2	10.5	–	–
Always	62	34.1	44	28.6	12	63.2	2	50.0
No response/missing data	15	8.2	14	9.1	–	–	1	25.0

newborn to 5. Participants gained knowledge particularly in areas of the curricula as age of recommended first visit, role of xylitol gum and remineralization with fluoride varnish. The statewide training program also offered a model for bringing medical and dental providers together, a collaboration that can result in important clinical care outcomes for children.

While dental providers recognized dental care as the leading unmet health care need for children with special needs, they did not seem to understand that the behavioral issues for these children are generally the same as for the newborn to age 5 population. Training related to children with special needs continues to be a high priority as dentists need assurance of their ability to integrate these children into their practice.

It is significant that the highest degree of skill increase reported by all participants was in the area of communicating with parents. Since parents are the gatekeepers of children's health and educating them about ways to prevent early childhood caries in dental settings is "frequently an exercise in overt persuasion," increased skills in parent counseling and anticipatory guidance is likely to lead to improvements in children's oral health.[6]

Because general dentists encounter pregnant women and new mothers in their practices, they have a unique opportunity to ask about and look for indications of dental disease and other oral health conditions as early as the prenatal period provided they are sufficiently aware and trained to do so. The medical-dental collaboration, evidenced by medical providers increasing "always or almost always" referring pregnant women to a dentist and coordinating/consulting with the dental provider, and dentists increasingly conferring with a pregnant patient's medical provider, is promising.

Changes in behavior are made slowly and in small steps. It has been observed that a generational shift is underway on professional recommendations for dental care so that the idea of a "first dental visit at the first birthday" is still widely unexpected and questioned by many who advise parents and caregivers, including dental professionals.[5] The fact that 15 percent of the general dentists reported seeing more newborns to age 5 children six months after training due to taking the course was a very positive program outcome.

It may not be realistic to think that a two-hour or a four-hour course would have a greater measurable impact than that on this program goal. Other factors such as low reimbursement rates and client behaviors (appointment keeping and timeliness) are likelier to have a far greater influence on provider willingness to see children age newborn to 5, particularly those on some form of public assistance such as Medicaid, but were beyond the scope of this program to affect.[7]

Long-term systems change will need to come from the institutions that educate dental professionals. Many general dentists are not comfortable treating young children, and classroom and chairside education focusing on newborn to age 5 at the predoctoral level varies. Overall, California dental schools do not currently direct a high percentage of their general didactic or clinical experience curricula on the newborn to 5 age group. The exposure dental students have to very young patients with disabilities and other special needs is even lower.

While the California schools varied in experience, and First Smiles might have influenced some of the more recent curricula updates and age focus, overall it appears the exposure dental students get to this young age group, particularly children with special needs, is still relatively small compared to their exposure to older children and adult patients. ■■■■

REFERENCES

1. U.S. Department of Health and Human Services. Oral Health in America: A Report of the Surgeon General. Rockville, Md., May 2000.
2. Boggess KA, Maternal oral health in pregnancy. *Obstet Gynecol* 111(4);976-86, 2008.
3. American Academy of *Pediatric Dentistry*, Council on Clinical Affairs. Guideline on management of persons with special health care needs (adopted 2004). *Pediatric Dent* 27(2):80-3, 2005.
4. California Health Interview Survey, 2005.
5. Edelstein BL, Dental care considerations for young children. *Spec Care Dentist* 22(3);11S-25S, 2002.
6. Weinstein P, Harrison R, Benton T, Motivating parents to prevent caries in their young children. *J Am Dent Assoc* 135:731-7, 2004.
7. U.S. Department of Health and Human Services, Office of the Inspector General. Children's Dental Services Under Medicaid, Access and Utilization. (OEI-09-93-00240;04/96).

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Use of Prophylactic Antibiotic Therapy in Oral Surgical Procedures: A Critical Review

JAIME SANTIAGO GUERRERO, DDS

ABSTRACT Despite myriad evidence-based data on the efficacy of prophylactic antibiotics in oral surgical procedures, their inaccurate use and indiscriminate abuse still continues in all clinical settings. Although controversy remains, clear-cut guidelines relying on established scientific principles do exist and must be followed. This paper provides a critical and systematic review of each principle and encourages practitioners fit to what current evidence demands.

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A great number of ambulatory minor oral surgery procedures are practiced everyday in many outpatient clinical facilities by specialists, as well as residents and general dental practitioners. Oral surgery has been usually classified as class 2 or clean-contaminated surgery (that is endogenous flora organisms are present) by some authors, thus enclosing a low percentage of infection possibility.[1-5]

For many centuries the true interest of investigators was focused on surgical wound infections prevention. The development of this topic started in 1847 when Ignacz Semmelweis inferred the power of unclean hands, instruments, and drapes, employed by obstetricians, in the transmission of puerperal fever lethal agents. This induced the introduction of a strict prophylactic surgical antisepsis protocol, which involved the scrubbing of hands and immersing the instruments in chlorine solutions.[6] Twenty years later, in 1867, Sir Joseph Lister associated airborne germs with surgical infections. He sprayed carbolic acid in the operating room and instilled it into different surgical wounds, giving a great step toward modern asepsis practices in the operating room.[6,7]

In 1876, Robert Koch demonstrated the pathogenicity of bacteria and by 1878 Louis Pasteur recognized the importance of microorganisms' presence on all different surfaces coming in direct contact with the operative field.[5] His observations led into the adoption of asepsis as a

technique.[7] It passed less than a century after these authors' amazing inductions for recognizing the real role of microscopic living germs in surgical infections.

Over the years, the circumstances of time — war times — showed the way to significant advances regarding principles to treat and prevent infections. Within a few years, the value and success of chemotherapy was entirely verified and the discovery of different antibacterial agents set the basis for using antibiotics in either therapeutic or prophylactic fashion.[7,8]

Contemporary Development

Since the late 1940s, when introduced, prophylactic antibiotic therapy, PAT, was overused, disproportionate, and imprecise, creating controversy about its effectiveness.[2,8,9] Many early studies showed no benefit, higher infection rate and emergence of microorganism-resistant infections related with such prophylaxis.[6,10-14]

The pathway to the understanding and subsequent establishment of actual prophylaxis principles did begin to be defined with the studies of Miles about the relationship of host defense mechanisms and bacterial lodgment.[15] It would get consolidated in the early 1960s with Burke's work. He described the decisive period during a bacterial invasion and demonstrated the importance of antibiotic administration timing in order to be prophylactically effective.[13-18] Burke's findings were later confirmed by other authors and in clinical practice.[19-44] These studies throw light on definitive and current principles to approach antibiotic prophylaxis in surgery, including oral surgery.

Concerned about identifying and treating patients at high risk of postoperative surgical wound infections, Altemeier was the first in suggesting some criteria for the prophylactic use of antibiotics and developed a classification of surgical wounds in relation to its degree of contamination. They were divided in four classes as: clean, clean-contaminated, contaminated, and dirty.[7,45,46] In 1964, the National Academy of Sciences-National Research Council Study (NRC) defined this classification. Clean-contaminated surgery was defined as a nonelective surgery that is otherwise a clean, controlled opening of a normally colonized body cavity; no significant spillage and/or minor break in sterile technique, reoperation via clean incision within seven days; blunt trauma, intact skin, negative exploration through intact skin.[4,6,47-50] Regarding the probability of predicting wound infection, this approach was very simple and practical, actually, it still continues to be useful, but unfortunately it depends only on one variable, which is the bacterial contamination.

WITHIN A FEW YEARS, the value and success of chemotherapy was entirely verified and the discovery of different antibacterial agents set the basis for using antibiotics.

In 1977, Cruse and Foord in their large 10-year prospective study established the infection rate for each class (clean 1.5 percent, clean-contaminated 7.7 percent, contaminated 15.2 percent, and dirty 40 percent). Oral surgery procedures were not included in this interesting study.[49,51]

The understanding about surgical wound infections would progress. Probes concerning the importance of finding other risk variables conducted Ehrenkranz in 1981 to identify and correlate some patients' factors (remote infection, diabetes mellitus and/or operations lasting more than four hours) in clean operations with high risk of infection.[52] Similarly in 1985, Haley and colleagues in the study of the efficacy of nosocomial infection control, SENIC, identified three independent risk factors — operations on the abdomen or chest, operations lasting beyond two hours and patient clinical status (at least three medical diagnoses on discharge) — in addition to wound class, for postoperative wound infections. In this study the infection rate for each wound class was: clean 2.9 percent; clean-contaminated 3.9 percent; contaminated 8.5 percent; and dirty 12.6 percent.[53]

In 1991, after the work of Haley and colleagues, the National Nosocomial Infection Surveillance, NNIS, study reduced the four risk factors to three: wound class, length of the surgery and patients with American Society of Anesthesiologists, ASA, scores of III to V. In this study, infection rates were reported to be: clean 2.1 percent; clean-contaminated 3.3 percent; contaminated 6.4 percent; and dirty 7.1 percent.[54]

As in the Cruse and Foord study, neither the SENIC study nor NNIS included oral surgery procedures. These two assessments, SENIC and NNIS, showed to be appropriated as a guide for antibiotic prophylaxis since they do integrate the determinant factors — surgical wound class, presence of bacteria, procedure duration and host defenses — which are required for the development of an infection.[55-58]

However, neither SENIC scheme nor NNIS incorporate many other known risk factors affecting wound healing, which could be additional predictors of host susceptibility, like alcoholism, obesity, smoking, advanced age, tissue perfusion, glucose control, poor nutrition, corticosteroid use, medication,

previous radiotherapy or chemotherapy and anemia that either may or may not be alterable before surgery.[50,59-81] Among others, all of these independent variables are frequently hard to check and to be adapted into a controllable risk scheme.

In 1992 the Centers for Disease Control and Prevention established some guidelines, described a classification of surgical infections and standardized some definitions. The term surgical wound infection was changed for surgical site infection, SSI, to include superficial, deep wound, and organ space infections, such as those arising from bone. Besides making the distinction between an infection of a surgical incision and one of a traumatic wound, this will allow more effective surveillance, prevention and control of SSI.[82]

Subsequently in 1999, the CDC Hospital Infection Control Practices Advisory Committee published a set of recommendations for the prevention of SSI. Specific guidelines regarding preoperative antimicrobial prophylaxis are included.[83]

Principles: State of the Art

Five evidence-based basic principles must be accurately understood and followed to warrant PAT effectiveness. The first and most essential principle of PAT is to understand the difference between "to prevent" and "to treat." The purpose of prophylactic antibiotics is to help prevent infections, while therapeutic antibiotics actually treat ongoing infections. Perhaps the local chaotic state of antibiotic use arises in the misconception of this elementary statement, since many practitioners in the clinical scenario deliberately, and wrongly, insist on approaching every situation through a "therapeutic" perspective.

The surgical procedure should have an increased risk of infection.[2] This second principle is in relation with the variables that have proven to be reliable predictors of SSI risk, the intrinsic degree of microbial contamination of the surgical site, duration of the operation and markers for host susceptibility, so that it implicates using an agent for operations or classes of operations in which its use has been shown to reduce SSI rates based on evidence from clinical trials or for those operations where incisional or organ/space SSI would have a catastrophic outcome.[83]

TRYING TO ALWAYS apply a PAT scheme in oral surgery by approaching the "expected" SSI rates based only on wound class is inaccurate.

Oral surgery has been classified as class 2. For this type of surgery current literature suggests an estimated infection rate of 5 percent to 15 percent, but this percentage is far from being a realistic cipher expected for procedures that involve practicing intraoral wounds.[1-5,84] It actually represents the erroneous and simplistic extrapolation of some results, the majority arising from trials which include different procedures from other surgical specialties. It is not a correct reasoning, from any standpoint, to assume an appendectomy, hysterectomy, cholecystectomy, or nephrectomy resemble multiple exodontias, impacted third molars, dental implants, or dentoalveolar surgery. Therefore, trying to always apply a PAT scheme in oral surgery by approaching the "expected" SSI rates based only on wound class is inaccurate.

Another variable that has been associated with SSI risk and postoperative morbidity is the length of operation.[51,53,54,85-87] A prolonged operative time (longer than either two hours or the approximate 75th percentile of the duration of the "specific" procedure being performed) has an increased risk of infection because it augments the likelihood of normal wound contamination, what could lead up to bacterial dissemination inside and from the surgical wound. Although this correlation has been found to be positive, specifically in the oral and maxillofacial field, it has not been verified so far.

Unfortunately, the surgical schemes and scenarios applied as evidence for this have been also completely different. Besides, T times for oral surgery procedures have not been established. After how long can a particular oral surgery procedure be designated as prolonged? Possessing this evidence-based information as reference would be of great asset to our professional community, in which myriad of practitioners (general, residents, and specialists) perform oral surgery. However, the surgical exposition time and transient bacteraemia provoked by intraoral invasive procedures could play a key role in this aspect, given that the occurrence of bacteraemia increases with the duration of operation, and there appears to be a direct relationship between its incidence and magnitude and the extent of underlying oral inflammation and infection.[88,89] This conceptualization would be of relevancy depending on which hands are holding "the knife."

A large longitudinal, prospective and controlled surveillance trial to determine the actual incidence of SSI (percent) in oral and maxillofacial surgery commonly performed operative procedures, ranging from "minor" dental to "major" head and neck surgery, regarding both former variables is mandatory.

The other variable proven to be a

dependable predictor of SSI risk is host susceptibility. Besides surgical or environmental factors, host susceptibility can also be influenced by significant local and systemic factors which can compromise the host defense mechanisms response.[4,21,50,60,83,84,90,91] Under regular physiological and immunological conditions, PAT would not be necessary, except when the procedure per se entails some evidence-based risk, because a patient's immune system is able to deal with the surgical site microbial contamination and the high transient bacteraemia elicited by the invasive procedure.[88,92,93]

In susceptible or at-risk patients who present a significant underlying medical condition affecting their host defense status, such as immunocompromising situations/disease or metabolic disorders, PAT should always be considered, not only in oral surgery but also in class I or clean surgical procedures. Such being the case, the clinicians' rational judgment is decisive to avoid a ruinous outcome.

Select the correct antibiotic for the surgical procedure.[2] This principle emphasizes using an agent that is safe, inexpensive, and bactericidal with an in vitro spectrum that covers the most probable intraoperative contaminants for the operation.[83]

In spite of the more than 300 to 700 species of microorganisms coexisting in the healthy human oral cavity, when performing intraoral surgical procedures the most commonly encountered and likely infecting pathogens are primarily facultative streptococci (e.g., *viridians* group species, such as *S. mutans, S. salivarius, S. anginosus, S. sanguinis* and *S. mitis*), anaerobic gram-positive cocci (e.g., *peptostreptococci* species) and anaerobic gram-negative rods (e.g., *prevotella* and *porphyromonas* species, *fusobacterium* species).[94,95] Therefore, any PAT attempt should be aimed toward this limited group of potential endogenous pathogens and be based on their susceptibility to specific antibiotics. The agents that fulfill aforementioned requirements and still considered to be effective and suitable for this purpose are penicillins.

In spite of some evidence that indicates a tendency of bacteria to become more resistant to penicillins, globally marked differences in resistance levels do exist. By inducing and synthesizing inactivating and neutralizing enzymes, these agents, either alone or combined with a ß-lactamase inhibitor, continue to be the first choice in oral surgery.[96,97-117] In cases of true penicillin allergic patients clindamycin is the best alternative.[118-120]

EXTENDING antibiotic administration beyond 24 hours or longer after surgery is neither necessary nor prudent.

Antibiotic level and administration.[2] This principle implies to time the initial dose of antibiotic so that a high, bactericidal concentration of the drug is established in serum and tissues by the time the mucosa is incised.[41,83]

Beyond selecting the antibiotic, there are other important choices to take care about. These are, how much and when should it be administered?

To guarantee the success of PAT, the chosen agent should be given minimum at twice the therapeutic dose, so that levels in plasma and tissues are sufficiently high and available during the incision, the whole intraoperative and early postoperative periods to prevent contamination of the surgical site.

On the other hand, timing of initial administration is crucial.[16,41,121] To achieve the maximum effectiveness, the antibiotic must be administered parenterally within 30 minutes before the incision. Oral administration is also a valid and effective regimen. In this instance, it must be given one hour before the intervention.[122-125] Both of these preoperative schemes are optimal, therefore there is no rationale for beginning administration of PAT more than one hour preoperative so neither the day nor night before. Intraoperative and postoperative administrations are suboptimal and not good at all, hence they cannot be advisable in elective surgery.

Use the shortest effective antibiotic exposure.[2] This principle relates to maintain therapeutic levels of the antibiotic in both serum and tissues throughout the operation and until, at most, a few hours after the incision is closed in the operating room.[43,83,126] It encloses the question, for how long should PAT be administered?

It is well understood and established today that PAT should finish when the last suture is placed to close the incision. Extending antibiotic administration beyond 24 hours or longer after surgery is neither necessary nor prudent. First, this conduct does not have impact on the infection risk, and second, it confers additional risks without any benefits.[127] Of great concern when routinely prescribing improperly a therapeutic modality of antibiotics, supposedly as prophylaxis, are the likelihood of an adverse medication reaction and the widespread emergence of resistant organisms.[126,128,129]

In short procedures, a single dose or one shot of antibiotic preoperatively are enough to set proper serum and tissue concentrations before contamination occurs. During long operations or when its duration exceeds the ex-

pected time, an extra intraoperative dose should be given. The timing of an additional dose of any antibiotic depends on its pharmacokinetics, for penicillins, specifically in its half-life.[96]

A supplementary principle, added by Laskin, would emphasize not to rely solely on PAT to prevent postoperative SSI.[130]

The value and effectiveness of PAT has been widely proven. Besides this stratagem, there are, among others, two critical factors influencing prevention and reduction of postoperative SSI, which are: aseptic operation technique and proper soft and hard tissue handling. Sources of alarm are those practitioners who, in many dental office settings with a limited bacterial control environment and are unskilled, want to compensate the deficiencies in both the aseptic-antiseptic ritual and proper surgical technique by prescribing antibiotics. The utopical idea of the more one gives antibiotics the more one protects the patient sounds very attractive, but it is unwise and mistaken.

Outpatient Oral Surgery Procedures

Hundreds of oral surgical procedures on an outpatient basis are performed every day in our local community. Uncomplicated tooth extractions and dentoalveolar surgery are among the most frequently practiced.

A great subject of controversy has to do with impacted third molar surgery. Some authors claim routine PAT is effective and of some benefit, while others do not recommend it. These two contrasting positions are well represented in current literature.[131-140] However, with regard to the available evidence, the lack of consensus can be partially explained. First, by the fact that in some clinical trials, unreliable outcome variables, such as alveolar osteitis, pain, swelling, trismus, and clinical recovery, have been used by mistake as indicators of SSI.[141-154] Second, antibiotics are frequently given after surgery as a prophylactic measure against SSI.[155-158] These reasons do imply methodological limitations and violation of PAT principle No. 4.

Dentoalveolar procedures, including third molar surgery, have both a so very low infection rate and rarely severe adverse consequences.[131,132,159] Therefore, in healthy patients, any PAT is not required. In those cases where PAT needs to be considered, because of a patient's comorbidities or pre-existing conditions, a single, high preoperative dose should be given.[157,159]

THE UTOPICAL IDEA of the more one gives antibiotics the more one protects the patient sounds very attractive, but it is unwise and mistaken.

Another controversial issue has to do with the use of PAT when practicing dental implants placement surgery. Viewed in this light, some studies have tried to elucidate the relationship between antibiotics and implant survival/failures instead of true SSI.[3,160,161] Many do share similarities as to the matter of their study design weaknesses, once again by virtue of the methodological limitations or because they deviate from PAT principles.[162,163]

Anyway, results vary and coming to a consensus has been a tough sell.[164] Nevertheless, the current evidence neither recommend nor advise against the use of PAT to prevent SSI when placing dental implants.[165] Thereby, a sound clinical judgment is paramount and the recommendation would be to adhere strictly to PAT principles whenever patients present formerly mentioned risk factors.

Other procedures involving incisions within the oral cavity with manipulation of either soft or hard tissues, as well as those requiring either only or combined transoral and extraoral approaches — orthognathic, reconstructive and trauma surgery — must be subject to application of PAT principles.

Facing up to Future Challenges

Apparently, everything points to the fact that there is a lack of knowledge among most clinicians concerning prophylactic antibiotics prescription. The common belief and iterative idea "The more antibiotics I give to my patient, the more I protect them" is at the present unjustifiable. We are contributing to magnify day by day, the existing chaotic state around these agents by ignoring the current evidence and adopting this harmful behavior, which has poor scientific basis.

Notwithstanding, they are a wonderful and life-saving tool and causes of great concern to all because of the widespread overuse, must be the adverse consequences — the superinfections and the development of resistant strains they are producing.[166-168]

Down the years, the motivation to use this practice has been unclear. Long-standing habit and tradition have played key roles. Whatever it is, we have in each of our hands the obligation of changing this mindset from now on. The evidence and facilities for are available to undertake such mission. ■■■■

REFERENCES

1. Tong DC, Rothwell BR, Antibiotic prophylaxis in dentistry: a review and practice recommendations. *JADA* 131:366-74, 2000.
2. Peterson LJ, Antibiotic prophylaxis against wound infections in oral and maxillofacial surgery. *J Oral Maxillofac Surg* 48:617-60, 1990.
3. Dent CD, Olson JWF, et al, The influence of preoperative antibiotics on success of endosseous implants up to and including stage II surgery: a study of 2,641 implants. *J Oral Maxillofac*

Surg 55(12 Suppl 5):19-24, 1997.
4. Page CP, Bohnen JMA, et al, Antimicrobial prophylaxis for surgical wounds. Guidelines for clinical care. *Arch Surg* 128:79-88, 1993.
5. Salmerón JI, Fernández A del A, Antibiotic prophylaxis in oral and maxillofacial surgery. *Med Oral Patol Oral Cir Bucal* 11:E292-96, 2006.
6. Wangensteen OH, Wangensteen SD, Klinger CF, Surgical infection and history. In, Simmons RL, Howard RJH, eds. Surgical infections diseases. New York, Appleton-Century-Crofts, pp1-10, 1982.
7. MacFee WF, Infections in their relation to surgery. In, Walters W, ed. Lewis' practice of surgery, Volume I. Hagerstown, Maryland, W.F. Prior Company, Inc, pp1-51, 1961.
8. Nichols RL, Condon RE, Barie PS, Antibiotic prophylaxis in surgery — 2005 and beyond. *Surg Infect* 63(3):349-61, 2005.
9. Seymour RA, Lowry R Whitworth JM, Infective endocarditis, dentistry and antibiotic prophylaxis; time for a rethink? *Br Dent J* 189(11):610-16, 2000.
10. Kaiser AB, Antimicrobial prophylaxis in surgery. *N Engl J Med* 315(18):1129-38, 1986.
11. Swartz MN, Use of antimicrobial agents and drug resistance. *New Engl J Med* 337:491-2, 1997.
12. Howe CW, Postoperative wound infections due to *Staphylococcus aureus*. *N Engl J Med* 251:411-7, 1954.
13. Pulaski E, Discriminate antibiotic prophylaxis in elective surgery. *Surg Gynecol Obstet* 108:385-8, 1959.
14. McKittrick LS, Wheelock FC Jr, The routine use of antibiotics in elective abdominal surgery. *Surg Gyn Obstet* 99:376-7, 1954.
15. Miles AA, Miles EM, Burke J, The value and duration of defense reactions of the skin to the primary lodgment of bacteria. *Br J Exp Pathol* 38:79-96, 1957.
16. Burke JF, The effective period of preventive antibiotic action in experimental incision and dermal lesions. *Surgery* 50:161-8, 1961.
17. Burke JF, Infection. In, Hunt TK, Englebert Dunphy J, eds. Fundamentals of wound management. New York, Appleton-Century-Crofts, pp170-240, 1979.
18. Nichols RL, Preventing surgical site infections: a surgeon's perspective. *Emerg Infect Dis* 7(2):220-4, 2001.
19. Bernard HR, Cole WR, The prophylaxis of surgical infection: the effect of prophylactic antimicrobial drugs on the incidence of infection following potentially contaminated operations. *Surgery* 56:151-7, 1964.
20. Alexander JW, Altemeier WA, Penicillin prophylaxis of experimental staphylococcal wound infections. *Surg Gynecol Obstet* 120:243-54, 1965.
21. Polk HC Jr, Lopez-Mayor JF, Postoperative wound infection: a prospective study of determinant factors and prevention. *Surgery* 66:97-103, 1969.
22. Fullen WD, Hunt J, Altemeier WA, Prophylactic antibiotics in penetrating wounds of the abdomen. *J Trauma* 12(4):282-9, 1972.
23. Chetlin SH, Elliot DW, Preoperative antibiotics in biliary surgery. *Arch Surg* 107:319-23, 1973.
24. Ledger WJ, Sweet RL Headington JT, Prophylactic cephaloridine in the prevention of postoperative pelvic infections in premenopausal women undergoing vaginal hysterectomy. *Am J Obstet Gynecol* 115:766-74, 1973.
25. Stokes EJ, Waterworth PM, et al, Short term routine antibiotic prophylaxis in surgery. *Br J Surg* 61(9):739-42, 1974.
26. Griffiths DA, Simpson Shorey BA, et al, Single-dose preoperative antibiotic prophylaxis in gastrointestinal surgery. *Lancet* 2(7981):325-8, 1976.
27. Galland RB, Saunders JH, et al, Prevention of wound infection in abdominal operations by perioperative antibiotics or povidone-iodine: a controlled trial. *Lancet* 2(8047):1043-5, 1977.
28. Strachan CJ, Black J, et al, Prophylactic use of cephazoline against wound sepsis after cholecstectomy. *Br Med J* 1:1254 -6, 1977.
29. Lander JL, Steigrad SJ, Single dose preoperative prophylactic antibiotic in vaginal hysterectomy. *Aust NZ J Obstet Gynecol* 18:73-5, 1978.
30. Holman JF, McGowan JE, Thompson JD, Perioperative antibiotics in major elective gynecologic surgery. *South Med J* 71(4):417-20, 1978.
31. Kaiser AB, Clayson KR, et al, Antibiotic prophylaxis in vascular surgery. *Ann Surg* 188(3):283-9, 1978.
32. Roberts JM, Homesley HD, Low dose carbenicilin prophylaxis for vaginal and abdominal hysterectomy. *Obstet Gynecol* 52:83-7, 1978.
33. Shapiro M, Shimon D, et al, A decisive period in the antibiotic prophylaxis of cutaneous lesions caused by bacterioides fragilis in guinea pigs. *J Infect Dis* 141(4):532, 1980.
34. Lazorthes F, Legrand G, et al, Comparison between oral and systemic antibiotics and their combined use for the prevention of complications in colorectal surgery. *Dis Colon Rectum* 25(4):309-11, May-June 1982.
35. Burdon DW, Principles of antimicrobial prophylaxis. *World J Surg* 6:262-7, 1982.
36. Naessens A, Lauwers S, Prophylactic antibiotics in surgery. *Acta Anaesthesiol Belg* 34(3):163-71, 1983.
37. Bergamini TM, Polk HC Jr, Pharmacodynamics of antibiotic penetration of tissue and surgical prophylaxis. *Surg Gynecol Obstet* 168:283-9, 1989.
38. Galanduik S, Polk HC, et al, Re-emphasis of priorities in surgical antibiotic prophylaxis. *Surg Gynecol Obstet* 169:219-22, 1989.
39. Nichols RL, Antibiotic prophylaxis in surgery. *J Chemother* 1(3):170-8, 1989.
40. Waldvogel FA, Vaudaux P, et al, Perioperative antibiotic prophylaxis of wound and foreign body infections: microbial factors affecting efficacy. *Rev Infect Dis* 13(suppl 10):s782-9, 1991.
41. Classen DC, Evans RS, et al, The timing of prophylactic administration of antibiotics and the risk of surgical wound infection. *N Engl J Med* 326(5):281-6, 1992.
42. Munoz Platon E, Jimenez Antolin JA, et al, The effect of surgical antibiotic prophylaxis and the timing of its administration on the risk of surgical wound infection. *Rev Clin Esp* 195(10):669-73, 1995.
43. Scher KS, Studies on the duration of antibiotic administration for surgical prophylaxis. *Am Surg* 63(1):59-62, 1997.
44. No authors listed, Antimicrobial prophylaxis in surgery. *Med Lett Drugs Ther* 39(1012):97-101, 1997.
45. Altemeier WA, Culbertson WR, et al, Critical re-evaluation of antibiotic therapy in surgery. *J Am Med Assoc* 157(4):305-9, 1955.
46. Altemeier WA, Culbertson WR, Veto M, Prophylactic antibiotic therapy. *AMA Arch Surg* 71(1):2-6, 1955.
47. Berard F, Gandon J, Postoperative wound infections: the influence of ultraviolet irradiation of the operating room and of various other factors. *Ann Surg* 160(suppl 1):1-192, 1964.
48. National Academy of Sciences, National Research Council, Division of Medical Sciences, Ad Hoc Committee on Trauma: Postoperative wound infections: the influence of ultraviolet irradiation on the operating room and of various other factors. *Ann Surg* 160(Suppl 2):1-196, 1964.
49. Cruse PJE, Wound infections: epidemiology and clinical characteristics. In, Simmons RL, Howard RJH, eds. Surgical infectious diseases. New York, Appleton-Century-Crofts, pp 429-41, 1982.
50. Sawyer RG, Pruett TL, Wound infections. *Surg Clin North Am* 74(3):519-36, 1994.
51. Cruse PJE, Foord R, The epidemiology of wound infection: a 10-year prospective study of 62,939 wounds. *Surg Clin North Am* 60:27-40, 1980.
52. Ehrenkranz NJ, Surgical wound infection occurrence in clean operations: risk stratification for interhospital comparisons. *Am J Med* 70(4):909-14, 1981.
53. Haley RW, Culver DH, et al, Identifying patients at high risk of surgical wound infection. A simple multivariate index of patient susceptibility and wound contamination. *Am J Epidemiol* 121(2):206-15, 1985.
54. Culver DH, Horan TC, et al, Surgical wound infection rates by wound class, operative procedure, and patient risk index. National Nosocomial Infections Surveillance System. *Am J Med* 91(3B):152S-57S, 1991.
55. Farinas-Alvarez C, Farinas MC, et al, Applicability of two surgical-site infection risk indices to risk of sepsis in surgical patients. *Infect Control Hosp Epidemiol* 21(10):633-8, 2000.
56. Nguyen D, MacLeod WB, et al, Incidence and predictors of surgical-site infections in Vietnam. *Infect Control Hosp Epidemiol* 22(8):485-92, 2001.
57. Barrasa Villar JI, Domingo Cuevas I, et al, Use of the NNIS index for determining the intrinsic risk of surgical infection. *Med Clin* (Barc) 107(20):767-71, 1996. Erratum in: *Med Clin* (Barc) 108(10):384, 1997.
58. Inigo JJ, Bermejo B, et al, Surgical site infection in general surgery: five -year analysis and assessment of the National Nosocomial Infection Surveillance (NNIS) index. *Cir Esp* 79(4):224-30, 2006.
59. Cheadle WG, Risk factors for surgical site infection. *Surg Infect* (Larchmt) 7 Suppl 1:S7-11, 2006.
60. Malone DL, Genuit T, et al, Surgical Site infections: reanalysis of risk factors. *J Surg Res* 103(1):89-95, 2002.
61. Gottrup F, Melling A, Hollander DA, An overview of surgical site infections: aetiology, incidence, and risk factors. *EWMA J* 5(2):11-5, 2005.
62. Rantala A, Lehtonen OP Niinikoski J, Alcohol abuse: a risk factor for surgical wound infections. *Am J Infect Control* 25(5):381-6, 1997.
63. Nystrom PO, Jonstam A, et al, Incisional infection after colorectal surgery in obese patients. *Acta Chir Scand* 153:225-7, 1987.
64. Lilienfeld DE, Vlahov D, et al, Obesity and diabetes as risk factors for postoperative wound infections after cardiac surgery. *Am J Infect Control* 16:3-6, 1988.
65. Barber GR, Miransky J, et al, Direct observations of surgical wound infections at a comprehensive cancer center. *Arch Surg* 130(10):1042-7, 1995.
66. Vilar-Compte D, Mohar A, et al, Surgical site infections at the National Cancer Institute in Mexico: a case-control study. *Am J Infect Control* 28(1):14-20, 2000.

67. McLaws ML, Irwig LM, et al, Predictors of surgical wound infection in Australia: a national study. *Med J Aust* 149(11-12): 591-5, 1988.
68. Sorensen LT, Karlsmark T, Gottrup F, Abstinence from smoking reduces incisional wound infection: a randomized controlled trial. *Ann Surg* 238(1):1-5, 2003.
69. Kuri M, Nakagawa M, et al, Determination of the duration of preoperative smoking cessation to improve wound healing after head and neck surgery. *Anesthesiology* 102(5):892-6, 2005.
70. Jones JK, Triplett RG, The relationship of cigarette smoking to impaired intraoral wound healing: a review of evidence and implications for patient care. *J Oral Maxillofac Surg* 50(3):237-9, 1992.
71. Mishriki SF, Law DJ, Jeffery PJ, Factors affecting the incidence of postoperative wound infection. *J Hosp Infect* 16:223-30, 1990.
72. Gottrup F, Oxygen in wound healing and infection. *World J Surg* 28(3):312-5, 2004.
73. Casey J, Flinn WR, et al, Correlation of immune and nutritional status with wound complications in patients undergoing vascular operations. *Surgery* 93(6):822-7, 1983.
74. Greene KA, Wilde Stulberg BN, Preoperative nutritional status of total joint patients. Relationship to postoperative wound complications. *J Arthroplasty* 6(4):321-5, 1991.
75. Putwatana P, Reodecha P, et al, Nutrition screening tools and the prediction of postoperative infectious and wound complications: comparison of methods in presence of risk adjustment. *Nutrition* 21(6):691-7, 2005.
76. Snyderman CH, Kachman K, et al, Reduced postoperative infections with an immune-enhancing nutritional supplement. *Laryngoscope* 109(6):915-21, 1999.
77. Larrea J, Betancor P, Nunez V, The prediction of postoperative septic complications via nutritional parameters. I. The prognostic formulation. *Nutr Hosp* 8(7):424-32, 1993.
78. McPhee IB, Williams RP Swanson CE, Factors influencing wound healing after surgery for metastatic disease of the spine. *Spine* 23(6):726-32; discussion 732-3, 1998.
79. Wimmer C, Gluch H, et al, Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures. *J Spinal Disord* 11(2):124-8, 1998.
80. Velasco E, Thuler LC et al, Risk index for prediction of surgical site infection after oncology operations. *Am J Infect Control* 26(3):217-23, 1998.
81. Dunne JR, Malone D, et al, Perioperative anemia: an independent risk factor for infection, mortality, and resource utilization in surgery. *J Surg Res* 102(2):237-44, 2002.
82. Horan TC, Gaynes RP et al, CDC definitions of nosocomial surgical site infections, 1992:a modification of CDC definitions of surgical wound infections. *Infect Control Hosp Epidemiol* 13(10):606-8, 1992.
83. Mangram AJ, Horan TC et al, Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 20(4):250-78, 1999.
84. Gutiérrez JL, Bagán JV, et al, Consensus document on the use of antibiotic prophylaxis in dental surgery and procedures. *Med Oral Patol Oral Cir Bucal* 11(2):E188-205, March 1, 2006.
85. Leong G, Wilson J, Charlett A, Duration of operation as a risk factor for surgical site infection: comparison of English and US data. *J Hosp Infect* 63(3):255-62, July 2006.
86. Scott CF Jr, Length of operation and morbidity: is there a relationships? *Plast Reconstr Surg* 69(6):1017-21, June 1982.
87. Garibaldi RA, Cushing D, Lerer T, Risk factors for postoperative infection. *Am J Med* 91(3B):158S-63S, Sept. 16, 1991.
88. Huber MA, Terezhalmy GT, The patient with a transient bacteremia. *Gen Dent* 53(2):130-43, 2005.
89. Okabe K, Nakagawa K, Yamamoto E, Factors affecting the occurrence of bacteremia associated with tooth extraction. *Int J Oral Maxillofac Surg* 24:239-42, 1995.
90. Woods RK, Dellinger EP, Current guidelines for antibiotic prophylaxis of surgical wounds. *Am Fam Physician* 57(11):2731-40, 1998.
91. No authors listed. Consensus paper on the surveillance of surgical wound infections. The Society for Hospital Epidemiology of America; The Association for Practitioners in Infection Control; The Centers for Disease Control; The Surgical Infection Society. *Infect Control Hosp Epidemiol* 13(10):599-605, 1992.
92. Walker DM, Oral mucosal immunology: An Overview. *Ann Acad Med Singapore* 33(4 Suppl):27S-30S, 2004.
93. Maestre Vera JR, Gómez-Lus Centelles ML, Antimicrobial prophylaxis in oral surgery and dental procedures. *Med Oral Patol Oral Cir Bucal* 12(1):E44-52, 2007.
94. Hull MW, Chow AW, Indigenous microflora and innate immunity of the head and neck. *Infect Dis Clin N Am* 21(1):265-82, 2007.
95. Aas JA, Paster BJ, et al, Defining the normal bacterial flora of the oral cavity. *J Clin Microbiol* 43(11):5721-32, November 2005.
96. Flynn TR, Halpern LR, Antibiotic selection in head and neck infections. *Oral Maxillofacial Surg Clin N Am* 15:17-38, 2003.
97. Knoll B, Tleyjeh IM, et al, Infective endocarditis due to penicillin-resistant viridans group streptococci. *Clin Infect Dis* 44(12):1585-92, June 15, 2007.
98. Al-Nawas B, Maeurer M, Severe versus Local Odontogenic Bacterial Infections: comparison of Microbial Isolates. *Eur Surg Res* 40(2):220-4, Nov. 12, 2007.
99. Flynn TR, Shanti RM, et al, Severe odontogenic infections, part 1: prospective report. *J Oral Maxillofac Surg* 64(7):1093-103, July 2006.
100. Sixou JL, Magaud C, et al, Microbiology of mandibular third molar pericoronitis: incidence of beta-lactamase-producing bacteria. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 95(6):655-9, June 2003.
101. Khemaleelakul S, Baumgartner JCPruksakorn S, Identification of bacteria in acute endodontic infections and their antimicrobial susceptibility. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 94(6):746-55, December 2002.
102. von Konow L, Köndell PA et al. Clindamycin versus phenoxymethylpenicillin in the treatment of acute orofacial infections. *Eur J Clin Microbiol Infect Dis* 11(12):1129-35, December 1992.
103. Ranta H, Haapasalo M et al. Bacteriology of odontogenic apical periodontitis and effect of penicillin treatment. *Scand J Infect Dis* 20(2):187-92, 1988.
104. Lindeboom JA, Frenken JW, et al, A randomized prospective controlled trial of antibiotic prophylaxis in intraoral bone-grafting procedures: preoperative single-dose penicillin versus preoperative single-dose clindamycin. *Int J Oral Maxillofac Surg* 35(5):433-6, May 2006.
105. Brescó Salinas M, Costa Riu N, et al, Antibiotic susceptibility of the bacteria causing odontogenic infections. *Med Oral Patol Oral Cir Bucal* 11:E70-5, 2006.
106. Bratton TA, Jackson DC, et al, Management of complex multi-space odontogenic infections. *J Tenn Dent Assoc* 82(3):39-47, Fall 2002.
107. Kuriyama T, Karasawa T, et al, Antimicrobial susceptibility of major pathogens of orofacial odontogenic infections to 11 beta-lactam antibiotics. *Oral Microbiol Immunol* 17(5):285-9, October 2002.
108. Kuriyama T, Karasawa T, et al, Incidence of beta-lactamase production and antimicrobial susceptibility of anaerobic gram-negative rods isolated from pus specimens of orofacial odontogenic infections. *Oral Microbiol Immunol* 16(1):10-5, February 2001.
109. Kuriyama T, Karasawa T, et al, Bacteriologic features and antimicrobial susceptibility in isolates from orofacial odontogenic infections. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 90(5):600-8, November 2000.
110. Sandor GK, Low DE, et al, Antimicrobial treatment options in the management of odontogenic infections. *J Can Dent Assoc* 64:508-14, 1998.
111. Karlowsky J, Ferguson J, Zhanel G, A review of commonly prescribed oral antibiotics in general dentistry. *J Can Dent Assoc* 59(3):292-4, 297-300, March 1993.
112. Tanner A, Stillman N, Oral and dental infections with anaerobic bacteria: clinical features, predominant pathogens and treatment. *Clin Infect Dis* 16:304-9, 1993.
113. Gill Y, Scully C, Orofacial odontogenic infections: review of microbiology and current treatment. *Oral Surg oral Med Oral Pathol* 70:155-8, 1990.
114. Moenning JE, Nelson CL, Kohler RB, The microbiology and chemotherapy of odontogenic infections. *J Oral Maxillofac Surg* 47:976-85, 1989.
115. Gilmore WC, Jacobus NV, et al, A prospective double blind evaluation of penicillin versus clindamycin in the treatment of odontogenic infections. *J Oral Maxillofac Surg* 46:1065-70, 1988.
116. Heimdahl A, von Konow L, et al, Clinical appearance of orofacial infections of odontogenic origin in relation to microbiological findings. *J Clin Microbiol* 22(2):299-302, August 1985.
117. Heimdahl A, Von Konow L, Nord CE, Isolation of betalactamase producing bacteroides strains associated with clinical failures with penicillin treatment of orofacial infections. *Arch Oral Biol* 25:689-92, 1980.
118. Mueller SC, Henkel KO, et al, Perioperative antibiotic prophylaxis in maxillofacial surgery: penetration of clindamycin into various tissues. *J Craniomaxillofac Surg* 27(3):172-6, June 1999.
119. Brook I, Lewis MA, et al, Clindamycin in dentistry: more than just effective prophylaxis for endocarditis? *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 100 (5):550-8, November 2005.
120. Katoh H, Incidence of transient bacteremia following dental surgery--prophylactic use of cefuroxime, ceftriaxone or clindamycin. *Tokai J Exp Clin Med* 17(3-4):109-13, October 1992.
121. Bryant J, Pfaff S, Perioperative antibiotic prophylaxis: the importance of timing. *Today's OR Nurse* 14(10):8-10, October 1992.
122. Lindeboom JA, van den Akker HP, A prospective placebo-controlled double-blind trial of antibiotic prophylaxis in intraoral bone grafting procedures: a pilot study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 96(6):669-72, December 2003.
123. Tan JS, Salstrom SJ, File TM Jr, Levels of antibiotic in

human blood and interstitial fluid after oral administration of bacampicillin or phenoxymethyl penicillin and intravenous administration of amoxicillin or ampicillin. *Rev Infect Dis* 3(1):121-4, January-February 1981.
124. Dajani AS, Bawdon RE, Berry MC, Oral amoxicillin as prophylaxis for endocarditis: what is the optimal dose? *Clin Infec t Dis* 18(2):157-60, February 1994.
125. Cannon PD, Black HJ, et al, Serum amoxycillin levels following oral loading dose prior to outpatient general anaesthesia for dental extractions. *J Antimicrob Chemother* 13(3):285-9, March 1984.
126. McDonald M, Grabsch E, et al, Single- versus multiple-dose antimicrobial prophylaxis for major surgery: a systematic review. *Aust N Z J Surg* 68(6):388-96, June 1998.
127. Stone HH, Haney BB, et al, Prophylactic and preventive antibiotic therapy: timing, duration and economics. *Ann Surg* 189(6):691-9, June 1979.
128. Neu HC, Emerging trends in antimicrobial resistance in surgical infections. A review. *Eur J Surg Suppl* (573):7-18, 1994.
129. Harrison GA, Rubin MP, et al, Resistance in oral streptococci after repetition of a single-dose amoxycillin prophylactic regimen. *J Antimicrob Chemother* 15(4):501-3, April 1985.
130. Laskin DM, The use of prophylactic antibiotics for the prevention of postoperative infections. *Oral Maxillofac Surg Clin N Am* 15. 155-60, 2003.
131. Piecuch JF, Arzadon J, Lieblich SE, Prophylactic antibiotics for third molar surgery: a supportive opinion. *J Oral Maxillofac Surg* 53(1):53-60, January 1995.
132. Zeitler DL, Prophylactic antibiotics for third molar surgery: a dissenting opinion. *J Oral Maxillofac Surg* 53(1):61-4, January 1995.
133. Ren YF, Malmstrom HS, Effectiveness of antibiotic prophylaxis in third molar surgery: a meta-analysis of randomized controlled clinical trials. *J Oral Maxillofac Surg* 65(10):1909-21, October 2007.
134. Halpern LR, Dodson TB, Does prophylactic administration of systemic antibiotics prevent postoperative inflammatory complications after third molar surgery? *J Oral Maxillofac Surg* 65(2):177-85, February 2007.
135. Yoshii T, Hamamoto Y, et al, Differences in postoperative morbidity rates, including infection and dry socket, and differences in the healing process after mandibular third molar surgery in patients receiving one-day or three-day prophylaxis with lenampicillin. *J Infect Chemother* 8(1):87-93, March 2002.
136. Bulut E, Bulut S, et al, The value of routine antibiotic prophylaxis in mandibular third molar surgery: acute-phase protein levels as indicators of infection. *J Oral Sci* 43(2):117-22, June 2001.
137. Sekhar CH, Narayanan VBaig MF, Role of antimicrobials in third molar surgery: prospective, double blind,randomized, placebo-controlled clinical study. *Br J Oral Maxillofac Surg* 39(2):134-7, April 2001.
138. Martin MV, Kanatas AN, Hardy P, Antibiotic prophylaxis and third molar surgery. *Br Dent J* 198(6):327-30, March 26, 2005.
139. Happonen RP, Bäckström AC, Ylipaavalniemi P, Prophylactic use of phenoxymethylpenicillin and tinidazole in mandibular third molar surgery, a comparative placebo controlled clinical trial. *Br J Oral Maxillofac Surg* 28(1):12-5, February 1990.
140. Goldberg MH, Nemarich ANMarco WP 2nd, Complications after mandibular third molar surgery: a statistical analysis of 500 consecutive procedures in private practice. *J Am Dent Assoc* 111(2):277-9, August 1985.
141. Kaczmarzyk T, Wichlinski J, et al, Single-dose and multi-dose clindamycin therapy fails to demonstrate efficacy in preventing infectious and inflammatory complications in third molar surgery. *Int J Oral Maxillofac Surg* 36(5):417-22, May 2007.
142. Ishihama K, Kimura T, et al, Azithromycin as prophylaxis for the prevention of postoperative infection in impacted mandibular third-molar surgery. *J Infect Chemother* 12(1):3 1-5, February 2006.
143. Foy SP, Shugars DA, et al, The impact of intravenous antibiotics on health-related quality of life outcomes and clinical recovery after third molar surgery *J Oral Maxillofac Surg* 62(1):15-21, January 2004.
144. Yoshii T, Hamamoto Y, et al, Differences in postoperative morbidity rates, including infection and dry socket, and differences in the healing process after mandibular third molar surgery in patients receiving one-day or three-day prophylaxis with lenampicillin. *J Infect Chemother* 8(1):87-93, March 2002.
145. Sekhar CH, Narayanan V, Baig MF, Role of antimicrobials in third molar surgery: prospective, double blind,randomized, placebo-controlled clinical study. *Br J Oral Maxillofac Surg* 39(2):134-7, April 2001.
146. Akota I, Alvsaker B, Bjørnland T, The effect of locally applied gauze drain impregnated with chlortetracycline ointment in mandibular third-molar surgery. *Acta Odontol Scand* 56(1):25-9, February 1998.
147. Macgregor AJ, Addy A, Value of penicillin in the prevention of pain, swelling and trismus following the removal of ectopic mandibular third molars. *Int J Oral Surg* 9(3):166-72, 1980.
148. Capuzzi P, Montebugnoli L, Vaccaro MA, Extraction of impacted third molars. A longitudinal prospective study on factors that affect postoperative recovery. *Oral Surg Oral Med Oral Pathol* 77(4):341-3, April 1994.
149. Bystedt H, von Konow L, Nord CE, A comparison of the effect of phenoxymethylpenicillin and azidocillin on post-operative complications after surgical removal of impacted mandibular third molars. *Swed Dent J* 5(5-6):225-34, 1981.
150. Barclay JK, Metronidazole and dry socket: prophylactic use in mandibular third molar removal complicated by non-acute pericoronitis. *N Z Dent J* 83(373):71-75, July 1987.
151. Kaziro GS, Metronidazole (Flagyl) and Arnica Montana in the prevention of postsurgical complications, a comparative placebo controlled clinical trial. *Br J Oral Maxillofac Surg* 22(1):42-49, February 1984.
152. Bystedt H, Nord CE, Effect of antibiotic treatment on postoperative infections after surgical removal of mandibular third molars. *Swed Dent J* 4(1-2):27-38, 1980.
153. Krekmanov L, Hallander HO, Relationship between bacterial contamination and alveolitis after third molar surgery. *Int J Oral Surg* 9(4):274-80, August 1980.
154. Krekmanov L, Alveolitis after operative removal of third molars in the mandible. *Int J Oral Surg* 10(3):173-9, June 1981.
155. Poeschl PW, Eckel D, Poeschl E, Postoperative prophylactic antibiotic treatment in third molar surgery — a necessity? *J Oral Maxillofac Surg* 62(1):3-8, January 2004.
156. Lloyd CJ, Earl PD, Metronidazole: two or three times daily — a comparative controlled clinical trial of the efficacy of two different dosing schedules of metronidazole for chemoprophylaxis following third molar surgery. *Br J Oral Maxillofac Surg* 32(3):165-7, June 1994.
157. Hill M, No benefit from prophylactic antibiotics in third molar surgery. *Evid Based Dent* 6(1):10, 2005.
158. Monaco G, Staffolani C, et al, Antibiotic therapy in impacted third molar surgery. *Eur J Oral Sci* 107(6):437-41, December 1999.
159. Savage MG, Antibiotic prophylaxis in dentoalveolar surgery. *Oral Maxillofacial Surg Clin N Am* 14:231-40, 2002.
160. Laskin DM, Dent CD, et al, The influence of preoperative antibiotics on success of endosseous implants at 36 months. *Ann Periodontol* 5(1):166-74, December 2000.
161. Kashani H, Dahlin C, Alse'n B, Influence of different prophylactic antibiotic regimens on implant survival rate: a retrospective clinical study. *Clin Implant Dent Relat Res* 7(1):32-5, 2005.
162. Gynther GW, Köndell PA, et al, Dental implant installation without antibiotic prophylaxis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 85(5):509-11, May 1998.
163. Binahmed A, Stoykewych A, Peterson L, Single preoperative dose versus long-term prophylactic antibiotic regimens in dental implant surgery. *Int J Oral Maxillofac Implants* 20(1):115-7, January-February 2005.
164. Mazzocchi A, Passi L, Moretti R, Retrospective analysis of 736 implants inserted without antibiotic therapy. *J Oral Maxillofac Surg* 65(11):2321-3, November 2007.
165. Esposito M, Coulthard P, et al, Antibiotics to prevent complications following dental implant treatment. The Cochrane Database of Systematic Reviews, 2003.
166. Zdziarski P, Simon K, et al, Overuse of high stability antibiotics and its consequences in public and environmental health. *Acta Microbiol Pol* 52(1):5-13, 2003.
167. Cunha BA, Antibiotic resistance. *Med Clin North Am* 84(6):1407-29, November 2000.
168. Cunha BA, Antibiotic side effects. *Med Clin North Am* 85(1):149-85, January 2001.

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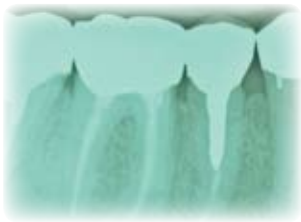

Effect of Preflaring on Working Length Determination: An In Vivo Study

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ABSTRACT This study is designed as an in vivo study to evaluate the impression of the preflaring method on working length determination in curved canals.

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Forty mandibular first molars with apical curvatures of 30 to 40 degrees were selected. The samples were randomly categorized to two groups each containing 20 teeth. A file in each mesial canal was measured, one with and one without preflaring.

In the first group, the initial instrumentation with preflaring on the mesiobuccal canal and in the second group without preflaring on mesiolingual canals were performed. A No. 15 file was inserted in the canals until the apical constriction could be felt (tactile sense) and a radiograph was prepared. Paired T-tests were used to analyze the file tip location and distance from apices.

Applying the early preflaring method, the file penetration was significantly closer to the true working length ($p<0.001$). Compared to the canals which early preflaring method was not applied, and file penetration decreased and there proved to also be a significant difference ($p<0.000$).

Working length determination has an essential impression on root canal treatment prognosis. If the working length is estimated to be short, the preparation will also be of inadequate length and will finally lead to treatment failure.[1-3]

Morgan and Montgomery presented the crown-down technique in 1984.[4] This technique indicates the cleaning and shaping of the coronal portion of the canal and incremental progression to the apical area. The aim is to decrease the microorganisms which may be pushed apically later.[5]

In a study performed by Stabholz, Rotstein, and Torabinejad in 1995 on 120 adult patient root canals, it was shown that in 76 percent of the teeth that underwent preflaring, the apical constriction was felt.[6]

Baumgartner, Marshal, and Davis published a study in 2002 that showed the variation in the working length of root canals with early coronal flaring has been at minimum during the instrumentation.[7]

Considering the previously mentioned descriptions, this study was designed to evaluate the impression of the preflaring method using Protaper rotary files on working length determination, to compare the preflared and nonpreflared canals.

TABLE 1

Working Length in the Group With Preflaring

Index Observational method	X+sd	X+ sd differences	Paired T-test result
Preflaring (n=40)	20.01+ 1.4	-1.2+0.8	P<0.001
True working length	20.21+1.3		

TABLE 2

Working Length in the Group Without Preflaring

Index Observational method	X+sd	X+ sd differences	Paired T-test result
Without preflaring (n=40)	18.7+ 1.4	-2.5+1.1	P<0.000
True working length (n=40)	20.21+1.3		

A significant difference was shown in the measured working length (p<0.000).

Materials and Methods

This clinical trial study was performed on 40 mandibular molars with a 30- to 40-degree apical curvature (Schneider's method) in the patients' mesial root of the molar teeth. The patients were selected from the endodontics department at the Islamic Azad dental school.

First, a radiograph with paralleling technique was taken using Endoray (Dentsply, Rinn), then the apical curvature was measured with Schneider's index to ascertain the inclusion criteria. Next, case selection, anesthesia, access cavity preparation, and isolation were performed on every patient. To instrument the coronal portion, Protaper S1, and SX rotary files (Maillefer, Swiss) were used.

One mesial root canal (mesiobuccal or mesiolingual) was randomly chosen, and using the aforementioned files, two-thirds of the canal length was inactively prepared. A No. 15 file (K-file Maillefer) was inserted in the canal, concerning the reference point, until the apical constriction was felt (tactile sense). Likewise, in the other mesial canal, which has no preflaring, another No. 15 file was inserted. A radiograph was taken using the Endoray, applying the X-rays 15- to 20-degrees mesially to the original. The working length for each canal and tooth was recorded and analyzed using Paired T-test.

Results

Forty patients who were referred to the endodontics department were studied. TABLE 1 shows a significant difference between the working length measured on preflared samples and the true working length (p<0.001).

TABLE 2 reveals a significant difference between the measured working length on samples not undergoing the preflare process (p<0.000) while TABLE 3 compares the two experimental groups with and without preflaring.

TABLE 4 reveals the file location with apical index in the two groups (preflared and without preflaring). In 29 cases (72.5 percent) with preflaring method the file was located within 1 mm to apex, and in 6 cases the file passed the apex. Meanwhile in the 40 canals without preflaring, 11 cases (27.5 percent) were within 1 mm from apex and 19 were more than 1 mm from the apex. In 10 cases (25 percent) the file passed the apex.

Discussion

This study revealed that with early preflaring in root canal preparation, file penetration would be closest to the true working length. On the other hand, in canals without preflaring, file penetration is less and the difference is significant (p<0.000).

This study also proved that in working length determination without preflaring in only 27.5 percent of cases the file will be located within 1 mm from the radiographic terminus. In all other cases, either the file cannot reach the radiographic terminus or will pass it. These conclusions are in agreement with Stabholz studies.[6] This can be interpreted as the canal entrance or the coronal part inhibit the file from reaching the apex and give a false feeling of apical constriction.

On the contrary, removal of the coronal part by preflaring will enhance the tactile sense to apical constriction and the file will have retention in this location. Hence, in 72.5 percent of cases apical constriction was felt within 1 mm of the apex and the number of files pass-

TABLE 3

Comparing the Two Experimental Groups With and Without Preflaring

Index Observational method	X+sd	X+ sd differences	Paired T-test result
Preflared (n=40)	20.01+1.4	1.3+0.8	P<0.000
Nonpreflared (n=40)	18.7+ 1.4		

TABLE 4

The Location of File Tip in Two Experimental Groups

	Preflared (n=40)		Nonpreflared (n=40)	
Distance to apex	Number	Percentage	Number	Percentage
Within 1 mm	20	72.5%	11	27.5%
More>1 mm	5	12.5%	19	47.5%
Overextended	6	15%	10	25%

ing the apex had considerably decreased. This will lead to a prevention of the debris harbor throughout the apex.[8]

This study is also in agreement with Davis et al., Schroeder et al., and Contreras et al. who proved that estimated working length will decrease while instrumentation is performed, early coronal flaring was more precise, and the working length had the lowest variation while preparation was done.[7, 9,10] More importantly, Ibarrola et al. found that flaring at the coronal before working length determination with an electronic apex locator significantly improves the accuracy with which the apex locator is able to identify apical constriction.[5]

Luiten verified that, apical transportation in preflared canals is minimal and will lead to better shaping.[11] This too is in agreement with the present study, which also showed that early coronal preflaring assists in canal cleaning and enhances the tactile sense to apical constriction. It will also lower the zipping possibility which can overextend leading to overfilling, which will in turn cause post-treatment pain and discomfort and minimize treatment failure. ■■■■

REFERENCES

1. Walton RE, Torabinejad M, Principles and practice of endodontics, third ed., Philadelphia, WB Saunders, 200-2, 2002.
2. Weine FS, Endodontic therapy, fourth ed., St. Louis, CV Mosby, 240-1, 2004.
3. Jubach T, Tactile assist to working length determination. *Practical Endod* April-May 28-30, 1995.
4. Morgan LA, Montgomery S, An evaluation of the crown-down pressureless technique. *J Endod* 10(10):491-3, 1984.
5. Ibarrola JI, Chapman BL, Howard JH, Knowles KI, Ludlow MO, Effect of preflaring on root zx apex locators. *J Endod* 25(9):625-6, 1999.
6. Stabholz A, Rotstein L, Torabinejad H, Effect of preflaring on tactile detection of the apical constriction. *J Endod* 21(2):92-4, 1995.
7. Davis D, Marshal JG, Baumgartner JC, Effect of early coronal flaring on working length change in curved canals using rotary nickel titanium versus stainless steel instruments. *J Endod* 28 (6):438-41, 2002.
8. Leeb J, Canal orifice enlargement as related to biomechanical preparation. *J Endod* 9(11):463-70, 1983.
9. Schroeder KP, Walton RE, Rivera EM, Straight line access and coronal flaring: effect on canal length. *J Endod* 28(6):474-6, 2002.
10. Contreras MA, Zinman EH, Kaplan SK, Comparison of the first file that fits at the apex, before and after early flaring. *J Endod* 27(2):113-6, 2001.
11. Luiten DJ, Morgan LA, Baumgartner JC, Marshal JG, Comparison of four instrumentation techniques on apical transposition. *J Endod* 21(1):26-32, 1995.

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Research: Something to Sink Your Teeth Into

A close encounter with calculus and trigonometry effectively nullified a career as any kind of an engineer.

Robert E. Horseman, DDS

ILLUSTRATION BY CHARLIE O. HAYWARD

When I was 15 I aspired to be an electrical engineer. With little or no concept of what an electrical engineer did — other than wear a pocket protector with half a dozen pens — the assumption there had to be electricity involved somehow was enough to sustain me. At the time, I was a ham radio enthusiast to the extent that my mother refused to enter my room for fear of being electrocuted. That I repeatedly subjected myself accidently to the same treatment Jack Nicholson later received in *One Flew Over the Cuckoo's Nest* without actually dying, did little to allay my mother's fears.

It was a lonesome avocation inasmuch as the friends I made were usually thousands of miles distant and we conversed only in Morse code. Texting and surgically attached iPhones had not been invented yet. This delayed my social life and the discovery of girls by several years during which I mistakenly assumed they were just soft boys. Had I pursued my hobby much longer, I would have most surely fried myself before graduating from high school.

A close encounter with calculus and trigonometry effectively nullified a career as any kind of an engineer, a profession that seemed to me to have an unreasonable and incomprehensible reliance on numbers. Later, when I had transferred my interest to archeology, it was without any impetus from Indiana Jones who hadn't been born at the time. The thrill of discovering an ancient temple in some exotic locale loaded with gold and pre-

CONTINUES ON 993

DR. BOB, CONTINUED FROM 994

cious stones enthralled me for years until I realized later that "Kansas Horseman" would never fit well on the marquee.

This chimera finally dissolved upon observing newsreels of the late Dr. Leaky and his crew squatting in some godforsaken dig in the desert painstakingly applying little paintbrushes to amorphous chunks of unidentifiable dirt that would prove later to be discarded chicken bones or an ancient Coke bottle.

Thus, it was at age 19 I found myself fulfilling the dreams of my father. "People have 32 teeth," he shrewdly pointed out, "and at any given moment the odds are something is wrong with at least one of them. Plus, by the time you graduate, the world population will be something like 150 quadrillion people." And he was right, so I retreated to a life of repetitive work, innocent pleasures and as little reflection as I can manage.

Until now. One profession I overlooked 65 years ago before acceding to my father's ambitions — researcher — seems to offer unlimited opportunities. Apparently there isn't a single solitary thing on earth that doesn't cry out for researching. From the toxicity of hotdogs to the rate of nasal hair growth in the 65- to 75-year-old age bracket, the field is wide open. The trick seems to be getting a sponsor to pay for your efforts, but as somebody who already has plenty of money once observed, "If you love what you are doing, then it isn't work." Yes, it is.

The point is, as dentists, we could do a lot of this researching in our spare time. You know when you are talking face-to-face with somebody and they think you are looking them in the eye like a forthright, honest person is supposed to? Well, of course, we aren't, we're looking at their teeth. We're thinking, "Number 9 has that little incisal chip and the thing is at least two shades darker than 8. Does she know this? Got to be a root canal or maybe whacked against a drinking fountain at school 30 years ago."

There isn't a single solitary thing on earth that doesn't cry out for researching.

The worst thing a dentist can imagine other than spying a totally missing anterior is an unreplaced upper first bi. What kind of a person would recklessly smile in public unless ortho treatment accounted for the space? A dental researcher would determine with direct, yet subtle questioning such as the make of the offender's car, his gross adjusted income if more than $100,000 per year and the number of his wife's shoes that didn't come from Payless before recommending he be taken right out and summarily shot.

A recent case in point was an in-depth study done to determine the validity of the old German folk saying that means "every child costs the mother a tooth." Serious researchers do not believe German obstetricians considered this in any way replaced the deutsche mark as acceptable currency. In fact, this axiom risked disbelief when it was pointed out there are literally dozens of edentulous women who have not birthed 32 children, except possibly Old Mother Hubbard whose cupboard was later determined to be full of denture adhesives the dog didn't care for.

U.S. researchers examined data on 2,635 women ages 18 to 64. These were sorted into low, middle, and high socioeconomic status. In the last category, "women with no children were missing on average less than one tooth." This could be interpreted as a retained root tip from a do-it-yourself extraction attempted with a Revlon eyelash curler to save money, thus accounting for the higher economic status. In this same group, those women with four or more children were found to be "missing about five teeth." *About five?* This is pretty shoddy researching if you ask me. Let us hope any dentists who elect to go into research will retain the same high standards they applied in their practices where they knew without question whether a patient had five missing teeth or not.

Women in the lowest socioeconomic group with no children they could recall, were missing two teeth. If the old German saying was correct, these women have two unaccounted for kids. Somebody in the family should have been curious about what happened to them, at least to the extent of putting their pictures on milk cartons.

Finally, in this lowest economic group, those with four or more teeth were missing eight children. **NO**, wait, the other way around. I suspect a sizeable number of these women when accosted by a researcher and asked how many missing teeth they had and what was the limit on their VISA cards, would shout, "Harold! There's some nut at the door wanting to know how many teeth I've lost. Call 911!"

Researching doesn't have to be this complicated. Taking a tip from lawyers, researchers should never ask questions they don't already know the answers to. This saves a lot of confusion and would have revealed old German folk sayings are no more reliable than old American folk sayings such as claiming "It ain't over 'til the fat lady sings." More often than not, it is. ■■■■