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Journal

AUGUST 2013

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Gary D. Sabbadini, DDS

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CDA JOURNAL, VOL 41, Nº8

Practice Management Predicament

RUCHI K. SAHOTA, DDS, CDE

Starting from scratch does not mean the same thing it meant 20 years ago. A shingle featuring the dentist's name and her degree has been replaced by impactful logos and catchy fictitious names. Word of mouth travels through Facebook faster than it used to through mothers exchanging referrals on a soccer field. Paperless offices have electronic kiosks checking patients into their appointments. Forget the glitz and glamour of digital impressions. Peek into a new world of running a dental practice. New dentists may have a lot to learn.

One attorney, a few practice management consultants and an accountant. Maybe a broker or two and perhaps a marketing specialist. Our "practice management" courses in dental school muddle together in the background of what is a very hectic, perhaps stressful, senior year. Multiple one-hour lectures are useful, but do they help us comprehend the business issues we will face after dental school?

Multiple one-hour lectures are useful, but do they help us comprehend the business issues we will face after dental school?

Third-party payer issues have quadrupled. The dollars and cents need to be calculated. Compensation is harder to track. Practice owners arrive early and leave late — to ensure that all is in order. Many of us are lucky to have staff that is diligent, efficient and dependable. But there are other players in the game. There are many other parties involved in the mechanics of front-office business: regulators, third-party payers, dental service organizations, employers purchasing plans, financial agreements and of course, patients.

After graduation, "private practice" can seem like a black hole to some. If new dentists do not know the ins and outs of running a practice, it could swallow them. An enormous amount of debt hovering over a new dentist does not help. Could this be a factor in the appeal of large corporate practices? Management education and experience is less utilized and less necessary in these settings. An employee dentist does not need to do the math — to calculate how much he needs to produce to keep the doors open, to pay her staff or to stock the shelves with materials. Though the "9-5" schedule may sound alluring, many new dentists report pressure to complete procedures in a short amount of time. Employee dentists do not analyze profit and loss statements, but they are reminded of their production needs and goals. How do these goals affect treatment planning? When a corporate office manager, lacking dental school experience, is running the show, do production goals affect the quality of dental care administered?

The challenges of production and profit exist in conventional private practice settings as well. Recent survey information from Edge Research revealed that new dentists lacked a firm foundation in the business of dentistry and required more and more information as their careers developed.

Dental schools may start doing things differently. One practice management course director has reconstructed the curriculum to utilize the CDA's *Guide for the New Dentist*, review work and contractual agreements and integrate TDIC's risk management articles within the course. Communication, rapport and the trust that is integral to the patient-doctor relationship are highlighted. Students learn the importance of tracking "what it costs to provide care." More patients in the chair provide a sense of accomplishment and the positive feeling of being busy. However, if the speedy and busy new dentist does not realize the importance of calculating the "math" involved in running a business, the practice may not be able to support itself or the new dentist. Thus, today may be an opportune time for our state's six dental schools to take a fresh look at their practice management curricula.

For dentists who have already graduated, organized dentistry provides a few solutions. The American Dental Association offers a joint program with the Kellogg School of Management. The ADA/Kellogg Executive Management program is a three-week intensive business education program at Northwestern Kellogg School in Chicago. The program allows dentists to learn the "core principles of an MBA program." Though she bought a well-run dental practice upon graduation, one new dentist felt she had a lack of business experience to successfully run the dental office. She completed the ADA/Kellogg course and graduated with a better understanding of investing, business decisions, hiring, employment law, marketing and the core principles needed to run a practice.

Members often turn to our California Dental Association's Practice Support Center for this type of information as well. The PSC has "established itself as a credible, knowledgeable and relevant source of information and education about the business side of dental practice." We are not limited to only textbook-format pieces of information on the CDA Compass website. Webinars, podcasts and one-on-one seminars are also available. In 2014, a New Graduate Boot Camp will also be offered to new dentists upon receipt of a dental license and within the first three months of graduation. The *Guide for the New Dentist* (available on cda.org/compass), which is already popular among Stage 1 and Stage 2 dentists, will serve as groundwork for the Boot Camp's training curriculum. The two- to three-day program will focus on career planning, financial planning and practice management.

Fortunately for our profession, the ADA and CDA provide such resources after graduation, but this management education cannot be organized dentistry's responsibility.

It is safe to admit that even the fundamental core values of proper practice management are hard to teach in a series of a few one-hour lectures. But some say it is impossible to reach senior dental students. They are distracted by pending board examinations. They feel the pressure of unfinished curriculum checkpoints. Many seniors skip practice management lectures. It is hard to anticipate the immense depth of the "black hole" that is just around the corner. There is more to starting a practice, getting a "first job" and embarking on an associateship than there was 20 years ago. So again, avoid the sometimes-misleading glitz and glamour of "life after graduation," and peek into the real world of business issues in today's dental practice. There is indeed a lot to learn. ■■■■

The *Journal of the California Dental Association* welcomes letters.

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

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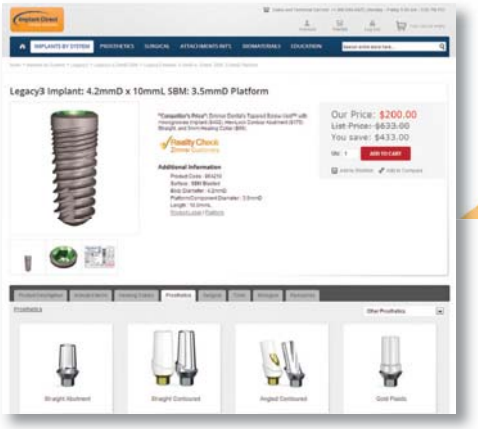

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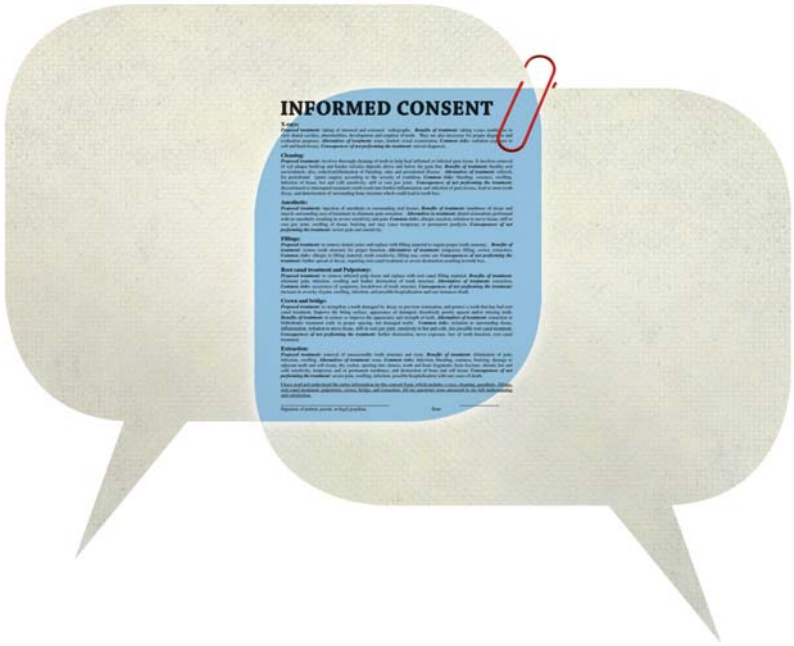

Duty to Be Understood

BY DAVID W. CHAMBERS, PHD

My first mortgage agreement was on two legal-sized papers. The last time we refinanced, it took 45 minutes of robo-signing, and I think I am now suffering from carpal-tunnel syndrome. At one point, I balked. My wife, a former banker, said it was okay because one of the documents I had signed said if the bank was not really satisfied it could change things. There is hope for getting around this inefficiency. Now all we need is a click-of-the-mouse on the computer screen saying we agree with everything, whatever it is. Some of this is enforceable and some of it is not, but it has boosted enrollments in law schools.

New York City dentist and opera singer Stacy Makhnevich discovered this recently. She requires as a precondition

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Correction

The July 2013 editorial, "Happy Birthday JCDA," incorrectly identified the California Dental Service (CDS) as the California Dental Society.

The *Journal* regrets the error.

'Superb Method' Found to Stimulate Bone Regeneration

Researchers recently found that bio-resorbable synthetic hydroxyapatite granules, when exposed to a 4 percent sodium fluoride solution, stimulate bone regeneration, according to the report in the *Journal of Oral Implantology*.

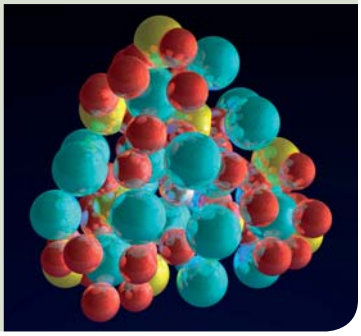
"When resorbable hydroxyapatite (HA) granules, which are used as a bone supplement material, were treated in neutral 4% sodium fluoride (NaF) solution, formation of a reactant resembling calcium fluoride was observed on the surface of the granules," the authors wrote.

Immediate but slow release of fluoride came from the granules, and the concentration increased over time, according to a news release from the journal, which also said that migration of human osteoblast-like MG-63 cells was confirmed when compared to a nonfluoridated control sample.

Fluoride concentrations of up to 2.0 parts per million (ppm) showed this positive effect. When the concentration reached 5.0 ppm, however, the opposite effect was observed — the fluoride significantly inhibited cell proliferation.

Authors concluded that the fluoride solution stimulates bone regeneration and the slow release of fluoride from hydroxyapatite granules facilitates osteogenesis, making this a "superb method" to supply fluoride and promote cell proliferation.

For more information, see the study in the *Journal of Oral Implantology*, vol. 39, no. 1, 2 013.



Scott Camazine / Science Source

***Right**: A computer-generated molecular model of hydroxyapatite, the mineral component of bones and teeth. Blue atoms are calcium, red atoms are oxygen, yellow atoms are phosphorus and gray atoms are hydrogen.*

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The Science Behind Brain Freeze

It happens when you eat ice cream or gulp something ice cold too quickly — the dreaded brain freeze, or in scientific terms, sphenopalatine ganglioneuralgia. Brain freeze is your body's way of telling you to slow down, according to a news release from the Wake Forest Baptist Medical Center, whose neuroscientist Dwayne Godwin, PhD, recently broke down the science behind brain freeze.

"Brain freeze is really a type of headache that is rapid in onset, but rapidly resolved as well," Godwin explained in the news release. "Our mouths are highly vascularized, including the tongue — that's why we take our temperatures there. But drinking a cold beverage fast doesn't give the mouth time to absorb the cold very well."

When you swallow a very cold drink or eat ice cream too quickly, you are rapidly changing the temperature in the back of the throat at the juncture of the internal carotid artery, which feeds blood to the brain, and the anterior cerebral artery, which is where brain tissue starts.

"One thing the brain doesn't like is for things to change, and brain freeze is a mechanism to prevent you from doing that," Godwin said.

The brain can't actually feel pain despite its billions of neurons, Godwin said, but the pain associated with brain freeze is sensed by receptors in the outer covering of the brain called the meninges, where the two arteries meet. When the cold hits, it causes a dilation and contraction of these arteries and that's the sensation that the brain is interpreting as pain.

While studying brain freeze may seem silly to some, Godwin said it's helpful in understanding other types of headaches, as brain freeze can be easily induced without long-term problems, allowing researchers to study headache mechanisms and develop better treatments for patients.

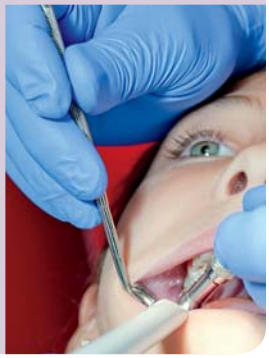
For more, see the news release at wakehealth.edu/News-Releases/2013/Brrrrrrrrr!_It%E2%80%99s_Brain_Freeze_Season.htm.

MTA Provides 'Superior Performance' for Direct Pulp Capping

In a recent practice-based, randomized clinical trial, researchers evaluated and compared the success of direct pulp capping in permanent teeth with mineral trioxide aggregate (MTA) or calcium hydroxide (CaOH) and found MTA to provide a "superior performance" as a direct pulp-capping agent, according to a study in the *Journal of Dental Research*.

Researchers utilized 376 individuals who received a direct pulp cap with CaOH (181) or MTA (195) and followed them for up to two years at regular recall appointments, or as dictated by tooth symptoms, authors wrote.

According to the researchers, the primary outcomes were the need for extraction or root canal therapy. Teeth were also evaluated for pulp vitality, and radiographs were taken at the dentist's discretion. The study reports the probability of failure at 24 months was 31.5 percent for CaOH and 19.7 percent for MTA.



This large randomized clinical trial provided confirmatory evidence for a superior performance with MTA as a direct pulp-capping agent as compared with CaOH when evaluated in a practice-based research network for up to two years, authors concluded.

For more information, see the study, "Comparison of CaOH with MTA for Direct Pulp Capping: A PBRN Randomized Clinical Trial," published in the *Journal of Dental Research*, July 2013, vol. 92, no. 7, suppl S16-S22.

Risks of Attachment Failure for Orthodontic Bonding

Recent research reviewing different curing lights for orthodontic bonding and their associated risks of bond failure has found there is no evidence to support the use of one light cure type over another based on risk of attachment failure.

"Light cure of resin-based adhesives is the mainstay of orthodontic bonding," authors wrote in the study, published in the *American Journal of Orthodontics and Dentofacial Orthopedics*. "In recent years, alternatives to conventional halogen lights offering reduced curing time and the potential for lower attachment failure rates have emerged," the study noted. However, until now, the relative merits of curing lights in current use, had not been analyzed systematically.

For this study, authors reviewed randomized controlled trials and clinical controlled trials directly comparing conventional halogen lights, light emitting diodes (LEDs) or plasma arc systems involving patients with full arch, fixed or bonded orthodontic appliances (not banded) with follow-up periods of a minimum of six months.

In the comparison of bond failure risk with halogen lights and plasma arc lights, 1,851 brackets were included in both groups with no statistical difference found in bond failure risk between the groups, authors wrote. Additionally, no statistical difference in bond failure risk was seen in the meta-analysis comparing halogen lights and LEDs.

For more information, see the study in the *American Journal of Orthodontics and Dentofacial Orthopedics*, April 2013, 143(4 Suppl):S92-103.

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for treating patients that they sign an agreement not to post negative comments on social media. Sometimes things go wrong, sometimes the office fails to manage the patient with a complaint, sometimes the patient lets the world know his side of the story, sometimes the dentist tries legal intimidation and sometimes the courts find in favor of the patient. Then the dentist is several hundred thousand dollars poorer and has a PR nightmare on her hands. Courts have always looked beyond the signature on the dotted line and declared some agreements unenforceable. It all depends on whether both parties understood what was signed, if they had the capacity to act based on that understanding and whether reasonable people would have signed.

I recently had some surgery and was "given" informed consent via the computer. I scrolled and read for about 25 minutes. The doctor was impressed, saying, "Gosh, you must have read it." He was further amazed when I gave him a page of notes about things that were illegal, unintelligible and simply misstated. The champ was the phrase "the patient may use ..." where the three letters in the word "use" had been misarranged.

From an ethical perspective, it is very simple. Patients give informed consent — dentists, staff, piles of papers and computers do not. The giving of consent is an act that signals patients understand enough about what is going to happen to them that they would not change their minds if they knew any more details. Of course, there is a "reasonable person" rule that sets a practical limit. A good check to see whether one has gone far enough to be understood is to ask the patient to repeat back his or her understanding of the key points. Having that in the charts is about as bullet proof as one needs to be.

The nub:

1. "I told them so and it is in the chart," plus good luck, are all that is needed to prevail in court.
2. Patients will always judge treatment experiences against their expectations. Informed consent is the place to make sure that the comparison will be positive.
3. Know what the patient expects before you try to give it to him or her.

David W. Chambers, PhD, is professor of dental education, Arthur A. Dugoni School of Dentistry, San Francisco, and editor of the Journal of the American College of Dentists.

Practice Support

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ADA Responds to Pacifier Study: Saliva Harbors Cavity-causing Bacteria

After a recent study was published in the journal *Pediatrics* about the immunological benefits of adult saliva, the American Dental Association quickly responded to remind parents that saliva harbors cavity-causing bacteria that can be transmitted to babies.

The ADA warned parents that sharing eating utensils with a baby, or the parent sucking on a pacifier to clean it, can also increase the likelihood of transmitting decay-causing bacteria.

According to the ADA, the recent study, published in the American Academy of Pediatrics' journal, "does not provide the full picture that adult saliva may also contain bacteria that causes decay."

"A child's teeth are susceptible to decay as soon as they begin to erupt," said Jonathan Shenkin, DDS, MPH, a pediatric dentist in Maine and a pediatric dental spokesperson for the ADA. "Cavity-causing bacteria, especially Streptococcus mutans, can be transferred from adult saliva to children, increasing their risk of getting cavities."

There are other steps that parents can take to help children develop a healthy immune system, added Shenkin.

"Breast milk is widely acknowledged as a good immunity-builder as well as the most complete form of nutrition for infants," he said. "This is something on which both the ADA and the AAP agree."

According to its website, the ADA recommends parents "protect the dental health of young children by promoting a healthy diet, monitoring their intake of food and drink, brushing their teeth or wiping gums after mealtimes and by having infants finish their bedtime or naptime bottle before going to bed."

For more information or to see the ADA's statement, visit ada.org/news/8582.aspx.

Success Rates of Restorations Placed on Endodontically Treated Teeth, Evidence Not Strong

A study aiming to investigate the success rates of prosthetic restorations on endodontically treated teeth and their manner of failure has found that single crowns seem to be the best treatment modality for these teeth.

The study, published in the *Journal of Oral Rehabilitation*, assessed the success rates for single crowns and fixed and removable dental prostheses, as well as for the different kinds of posts placed on root canal treatment teeth. With a total of four studies identified, authors report the success rate after six years for single crowns and fixed dental prostheses was 92 percent and 79 percent, respectively. According to the study, single crowns on teeth restored without posts demonstrated a success rate of 94 percent, while those with posts had a lower success rate of 92 percent.

"The most common reason for failure was post-debonding," authors wrote. The study concluded that single crowns seem to be the best treatment modality for endodontically treated teeth, but authors noted that "due to the low number of studies included and their design, the results of this systematic review should be interpreted with caution. Further clinical studies are needed to provide high-quality evidence on the topic."

For more information, see the study, "Success rates of prosthetic restorations on endodontically treated teeth; a systematic review after 6 years," in the *Journal of Oral Rehabilitation* published online first May 10, 2013.

Review Finds Toothbrushing Does Not Significantly Reduce Risk of Ventilator-associated Pneumonia

Researchers of a new study found that in intubated, mechanically ventilated critically ill patients, toothbrushing did not significantly reduce the risk of ventilator-associated pneumonia (VAP) overall, according to the study published in the journal *Critical Care Medicine*.

Authors said they aimed to "summarize and critically appraise" randomized trials in mechanically ventilated patients in the ICU testing the effect of oral care strategies involving toothbrushing on ventilator-associated pneumonia.

The study included six trials enrolling 1,408 patients, five of which compared toothbrushing to usual oral care and one of which compared electric with manual toothbrushing. In four trials, authors reported finding a trend toward lower VAP rates and said this trend was also observed in one trial reporting fewer cases of VAP 1,000 ventilator days in patients receiving toothbrushing versus no toothbrushing. Authors also reported "the use of chlorhexidine antisepsis seems to attenuate the effect of toothbrushing" on VAP.

Toothbrushing has no effect on mortality or length of stay and electric and manual toothbrushing seem to have similar effects, authors concluded, noting that "more research is needed on this aspect of oral care to evaluate its potential to decrease ventilator-associated pneumonia."

For more information, see the study in the journal *Critical Care Medicine*, vol. 41, no. 2, pp. 646-655.

Study Finds Success in Freezing Damaged Nerves to Stop Chronic Pain

Scientists recently found success using a tiny ball of ice to perform a minimally invasive interventional radiology treatment to safely short circuit chronic pain caused by nerve damage, according to a news release from the Society of Interventional Radiology.

The treatment, called cryoneurolysis, is said to have provided nerve-damaged patients with "significant pain relief."

"Cryoneurolysis could have big implications for the millions of people who suffer from neuralgia, which can be unbearable and is very difficult to treat," said William Moore, MD, medical director of radiology at Stony Brook University School of Medicine, in the news release. "Cryoneurolysis offers these patients an innovative treatment option that provides significant lasting pain relief and allows them to take a lower dose of pain medication — or even skip drugs altogether."

Cryoneurolysis uses a small probe that is cooled to minus 10 to minus 16 degrees Celsius, creating a freezer burn along the outer layer of the nerve. This interrupts the pain signal to the brain and blunts or eliminates the pain while allowing the damaged nerves to grow over time, explained Moore.

According to the news release, the study consisted of 20 patients who received cryoneurolysis treatment for a variety of neuralgia syndromes and were evaluated using a visual pain scale questionnaire immediately after treatment during one-week, one-month and three-month follow-ups after the initial procedure. Prior to treatment, patients' pain plummeted from an average of 8 out of 10 on the pain scale to 2.4 one week after treatment. Pain relief was sustained for about two months after the procedure. Pain increased to an average of 4 out of 10 on the scale after six months due to nerve regeneration, Moore said in the news release, acknowledging that additional comparative studies are needed.

For more, see the news release at sirweb.org/news/newsPDF/Release_30_Neuralgia_final.pdf.

"Cryoneurolysis offers these patients an innovative treatment option that provides significant lasting pain relief and allows them to take a lower dose of pain medication — or even skip drugs altogether."

WILLIAM MOORE, MD

Alligator Stem Cell Study Offers Clues to Tooth Regeneration

New research studying American alligators may help scientists learn how to stimulate tooth regeneration in people.

The research, led by the Keck School of Medicine of USC and published in *Proceedings of the National Academy of Sciences*, studied repetitive tooth formation and uncovered unique cellular and molecular mechanisms behind tooth renewal in American alligators.

"Humans naturally only have two sets of teeth — baby teeth and adult teeth," said lead researcher and USC Pathology Professor Cheng-Ming Chuong, MD, PhD, in a news release from the school. "Ultimately, we want to identify stem cells that can be used as a resource to stimulate tooth renewal in adult humans who have lost teeth. But, to do that, we must first understand how they renew in other animals and why they stop in people."

Because alligators have well-organized teeth with similar form and structure as mammalian teeth and are capable of lifelong tooth renewal, the authors reasoned that the reptiles, which can replace their 80 teeth up to 50 times over their lifetime, might serve as models for mammalian tooth replacement, according to the news release.

The team of researchers used microscopic imaging techniques and found that each alligator tooth is a complex unit of three components — a functional tooth, a replacement tooth and the dental lamina — in different developmental stages that are structured to enable a smooth transition from dislodgement to replacement.

The researchers report that the alligator dental laminae contain what appear to be stem cells from which replacement teeth develop.

"Stem cells divide more slowly than other cells," said co-author Randall B. Widelitz, PhD. "The cells in the alligator's dental lamina behaved like we would expect stem cells to behave. In the future, we hope to isolate those cells from the dental lamina to see whether we can use them to regenerate teeth in the lab."

For more, see the study "Specialized stem cell niche enables repetitive renewal of alligator teeth," published online first May 13, 2013.

UPCOMING MEETINGS

2013

Aug. 15–17	*CDA Presents The Art and Science of Dentistry*, San Francisco, 800-CDA-SMILE (232-7645) or cdapresents.com
Sept. 13–15	Fifth Annual Dental Motorcycle Ride, Windsor, sites.google.com/site/dentistrides
Oct. 18–21	The American Institute of Oral Biology 70th Annual Meeting, Palm Springs, theaiob.org
Oct. 31–Nov. 5	154th ADA Annual Session, New Orleans, ada.org/session
Nov. 3–9	U.S. Dental Tennis Association, Big Island, Hawaii, 800-445-2524 or dentaltennis.org
Nov. 10–13	National Primary Oral Health Conference, Denver, nnoha.org/conference/npohc.html

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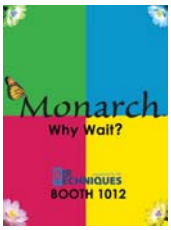	**Monarch™** **Air Techniques Inc.** **airtechniques.com**	Air Techniques proudly introduces The Monarch™ line of hygiene protection products for Surfaces, Instruments, Skin & Hands, and Equipment. • 60 second kill times or less for TB, Viruses, Bacteria and Fungi • Packaging that reduces the amount of plastic waste • One-step cleaning and disinfecting method saves time and uses 50% less product • Clear color-coding by type of product	1012
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CDA JOURNAL, VOL 41, Nº8

Pediatric Dentistry Update

GARY D. SABBADINI, DDS

Dental schools do a very good job educating students on how to treat the adult dentition, but many spend very little time teaching aspiring dentists how to treat children in the primary and mixed dentition. While most general practitioners treat both adults and children, some may not feel comfortable providing comprehensive care to children because of their limited experience. Our goal is to provide general dentists with some practical, clinical knowledge to help them feel more comfortable treating children in their practices.

GUEST EDITOR

Gary D. Sabbadini, DDS, a diplomate of the American Board of Pediatric Dentistry and a fellow in the International College of Dentists, practices pediatric dentistry in Pinole, Calif. He is the editor for the California Society of Pediatric Dentistry. *Conflict of Interest Disclosure: None reported.*

It is important for practitioners to have at least a basic understanding of pediatric dentistry for a variety of reasons. First, they may not be able to refer them to a pediatric dentist because of geographic or insurance limitations. Second, the pediatric dentist may not be able to see them right away. Most importantly, there may be more than one million additional children in California who will have dental insurance once the Affordable Care Act takes effect next year. Pediatric dentists will not be able to treat all of these additional new patients alone.

According to the American Academy of Pediatric Dentistry, the specialty of pediatric dentistry is "an age-defined specialty that provides both primary and comprehensive preventive and therapeutic oral health care for infants and children through adolescence, including those with special health care needs." While care for patients with special health care needs will not be discussed in this issue, many other topics pertaining to children's dental care will be covered.

In "A Review of Pediatric Radiology," I discuss when to take radiographs on

children, which radiographs should be taken, what to look for when examining radiographs and possible ways to treat the problems diagnosed from the radiographs. In "A Review of Pulp Therapy for Primary and Immature Permanent Teeth," Priyanshi Ritwik, DDS, MS, describes vital pulp therapy for primary and permanent teeth, including indirect pulp capping, direct pulp capping, partial pulpotomy and cervical pulpotomy. She also examines the various medicaments that can be used for these procedures. Apexogenesis, apexification and pulp revascularization are also examined.

The ability to communicate with children is critical to successfully treating them. In "Communicating With Parents and Children in the Dental Office," Oariona Lowe, DDS, describes the interactions between the dentist, parent and patient and offers suggestions on ways that the three parties can best communicate. If the dentist is unable to use conventional behavior management strategies to complete treatment, the child may require pharmacologic management through sedation. David Rothman, DDS, details the definitions, levels, techniques and pharmacology of typical drugs used for sedation in "Sedation of the Pediatric Patient." The protocols for safe management of children before, during and after sedation are also discussed.

Very few dental school students get a chance to treatment plan, impress and cement space maintainers. Consequently, once they graduate and begin practicing, many dentists opt to not place space maintainers after extracting a primary posterior tooth. In "Management of Premature Primary Tooth Loss in the Child Patient," Clarice Law, DMD, MS, reviews the consequences of premature tooth loss and discusses the appliances commonly used for space maintenance.

People today are very interested in appearances and want their dentistry to reflect that desire. More and more parents are looking for esthetic options to repair their children's teeth. In "Management of Dental Caries and Esthetic Issues in the Pediatric Patient," Elizabeth Gosnell, DMD, MS, and Sarat Thikkurissy, DDS, MS, review a multitude of restorations including open-faced stainless steel crowns, preveneered stainless steel crowns, resin (strip) crowns and zirconia crowns. They also cover pediatric partial dentures, microabrasion, vital bleaching, restoration of hypoplastic molars and how to rebond fractured teeth.

After reading this issue, general practitioners will have more confidence treating children and will be able to incorporate some of this information in their practice. I would like to thank the authors for their time, hard work and dedication in writing their articles. I am grateful for the opportunity to be guest editor for this issue. It has truly been an honor to work with all of the people at the California Dental Association. ■■■■

CDA JOURNAL, VOL 41, Nº8

A Review of Pediatric Radiology

GARY D. SABBADINI, DDS

ABSTRACT In most dental schools, the focus is on teaching students how to treat adults, with little emphasis placed on treating children. The goal of this article is to review some basic concepts in pediatric radiology to help general practitioners have a better understanding of when to take radiographs on children, which radiographs should be taken, what to look for when examining the radiographs and possible ways to treat the problems diagnosed from the radiographs.

AUTHOR

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Conflict of Interest Disclosure: None reported.

A typical "full-mouth series" on a child with no specific dental issues and who has a complete primary or mixed dentition is an upper and lower anterior occlusal film and two bitewing radiographs. This helps the clinician screen for dental caries, supernumerary or missing teeth in the maxillary and mandibular anterior area, anomalies in the size or shape of the maxillary and mandibular permanent incisors, detect impacted or ectopically erupting teeth and evaluate the amount of space available for the permanent dentition. Some reasons for taking additional periapical films include history of pain, swelling, trauma, mobility of teeth, unexplained bleeding, disrupted eruption patterns or deep carious lesions.[1] X-ray film and plates come in size 0, 1 and 2. Most pediatric dentists use a size 0 or 1 film for bitewings in young patients and a size 2 for anterior occlusal films to view the upper and lower incisors.

In 2012, the American Dental Association (ADA), in collaboration with the U.S. Food and Drug Administration (FDA), released updated recommendations for the prescription of dental radiographic examinations (**TABLE**). Dentists should use these guidelines, along with their professional judgment, to determine appropriate diagnostic imaging for each individual patient. This requires that the dentist review the patient's health history, note any dental complaint and perform a clinical examination of the patient prior to selecting which diagnostic radiographs are needed.

Limiting Radiation Exposure

Even though radiation exposure from dental radiographs is low, once a decision to obtain radiographs is made, it is the dentist's responsibility to follow the ALARA principle (as low as reasonably achievable) to minimize the patient's exposure. Examples of good radiologic practice include:

TABLE

American Dental Association Recommendations for Prescribing Dental Radiographs *(Revised 2012)*
(In the child with primary or transitional dentition)

Type of Encounter	Patient Age and Dental Developmental Stage	
	Child with Primary Dentition (prior to eruption of first permanent tooth)	**Child with Transitional Dentition** (after eruption of first permanent tooth)
New patient being evaluated for oral disease	Individualized radiographic exam consisting of selected periapical/occlusal views and/or posterior bitewings if proximal surfaces cannot be visualized or probed. Patients without evidence of disease and with open proximal contacts may not require a radiographic exam at this time.	Individualized radiographic exam consisting of posterior bitewings with panoramic exam or posterior bitewings and selected periapical images.
Recall patient with clinical caries or at increased risk for caries	Posterior bitewing exam at 6-12 month intervals if proximal surfaces cannot be examined visually or with a probe.	
Recall patient with no clinical caries and not at increased risk for caries	Posterior bitewing exam at 12-24 month intervals if proximal surfaces cannot be examined visually or with a probe.	

These recommendations are subject to clinical judgment and may not apply to every patient. They are to be used by dentists only after reviewing the patient's health history and completing a clinical examination. Once a decision is made to obtain radiographs, it is the dentist's responsibility to follow the ALARA Principle (As Low As Reasonably Achievable) to minimize the patient's exposure.

- Use of the fastest image receptor compatible with the diagnostic task (F-speed film or digital);
- Collimation of the beam to the size of the receptor whenever feasible;
- Proper film exposure and processing techniques;
- Use of protective aprons and thyroid collars when appropriate; and
- Limiting the number of images obtained to the minimum necessary to obtain essential diagnostic information.[2]

Switching from D to E speed can produce a 30–40 percent reduction in radiation exposure.[3] The use of F-speed film can reduce exposure 20–50 percent compared to the use of E-speed film.[4] Digital imaging provides an opportunity to further reduce the radiation dose by 40-60 percent.[5] In digital radiography, there are three types of receptors that take the place of conventional film: charge-coupled device (CCD), complementary-metal-oxide-semiconductor (CMOS) and photo-stimulable phosphor (PSP) plates. Systems that use CCD- and CMOS-based solid-state detectors are called "direct." When these sensors receive energy from the X-ray beam, the CCD or CMOS chip sends a signal to the computer and an image appears on the monitor within seconds. Systems that use PSP plates are called "indirect." When these plates are irradiated, a latent image is stored on them. The plate is then scanned and the scanner transmits the image to the computer.

While some pediatric dentists utilizing digital radiography are able to use the CCD or CMOS "hard" sensors on young patients, many choose to use PSP plates because they are very much like regular film and are less objectionable for young children.

Panoramic Radiograph

A panoramic film is one of the most useful films in pediatric dentistry. It is typically taken in the mixed dentition (between 7 and 9 years old) to screen for extra or missing teeth, eruption problems (e.g., ectopic eruption, impaction, transposition, ankylosis, primary failure of eruption), root resorption, cysts or any other anomalies that might have gone undetected with a routine periapical series of radiographs.

While panoramic radiographs provide a wealth of information, other radiographs may be necessary to help confirm the diagnosis. Ectopic eruption of incisors and canine impaction are often diagnosed from panoramic radiographs, but can be erroneously evaluated in this manner if only a panoramic radiograph is used.[6,7] Labial or palatal positioning of the canine is best determined using the panoramic radiograph in conjunction with an occlusal radiograph, particularly if the canines cannot be palpated on the facial aspect of the alveolus at approximately 9 to 10 years of age. The occlusal radiograph will provide a better estimate of the position of the canine to the lateral incisor.[8] Cone beam computed tomography is an incredible tool that can also be used to help diagnose all of these potential problems. While it is becoming more widespread, it is not commonly used in the pediatric population.

Impacted Teeth

One of the more commonly encountered anomalies when examining radiographs on children are impacted teeth. Dental impaction has been

reported to affect as much as 25-50 percent of the population.[9] The most commonly impacted permanent teeth in decreasing order of frequency are mandibular third molars, maxillary third molars, maxillary cuspids, mandibular second bicuspids, maxillary second bicuspids, maxillary central incisors and mandibular second molars.[10] Because third molar impaction isn't usually a problem until late adolescence, one of the earliest encountered impacted teeth in young children is the permanent maxillary canine.

Permanent Maxillary Canine Impaction

Maxillary canine impaction occurs in approximately 1-3 percent of the population with a 2:1 female to male ratio,[11,12] and they are more commonly impacted than the mandibular canine.[13] Other teeth may be impacted but much less frequently.[14] Of the individuals with maxillary impacted canines, it is estimated that 8 percent have bilateral impactions.[15] Approximately one-third of impacted maxillary canines are located labially and two-thirds are located palatally.[16-17] Potential factors related to impaction include arch-length deficiency, maxillary transverse deficiency, missing or peg lateral incisors, cystic lesions of the follicle, trauma, early loss of primary teeth, ankylosed or over-retained primary teeth and physical impediments such as mesiodens, odontomas or supernumerary teeth.[18-22]

Impacted canines are usually asymptomatic. Therefore, most patients and parents are unaware of the impacted canine's existence. An impacted maxillary canine can be diagnosed clinically through delayed eruption of the permanent canine, over retention of the primary canine, absence of a labial bulge, presence of a palatal bulge and distal crown tipping of the lateral incisor. It is important for the clinician to utilize both visualization and palpation.[23] A bulge in the canine buccal area will be palpable approximately 18 months before oral eruption.[24] Impacted canines can also be diagnosed through multiple periapical films (SLOB rule), occlusal radiographs, lateral cephalometry and panoramic radiographs. Localization of impacted teeth is important for surgical exposure and for planning of appropriate orthodontic force vectors. Eighty-five percent of all palatal impactions have sufficient space for eruption (no arch-length deficiency) and 83 percent of labial impactions are associated with an arch-length deficiency.[25]

Ericson and Kurol found that early removal of primary maxillary canines could result in normal eruption of ectopically displaced permanent maxillary canines. They proposed that extracting the primary canine before the patient is 11 years of age would normalize the erupting position of the permanent canine in 91 percent of the cases if the crown were distal to the midline of the lateral incisor root. However, the success rate decreases to 64 percent if the permanent canine crown is mesial to the midline of the lateral incisor root[26] (**FIGURE 1**). If this is unsuccessful, the patient will need to have the tooth repositioned orthodontically.

Bonetti et al. found that primary canine and first primary molar extractions were more effective as a preventive approach to promote eruption of permanent maxillary canines that were positioned centrally or palatally.[27] The decision to extract primary teeth unilaterally or bilaterally should be decided on a case-by-case basis. If there is a unilateral ectopic permanent canine and no arch-length deficiency, you may extract only the primary tooth or teeth on the affected side. If there is moderate to severe arch-length deficiency, extract primary teeth on both sides. You must have a minimum of one-half root formation on the premolar if you choose to extract the first primary molar or there may be a delay in the premolar's eruption.[28]

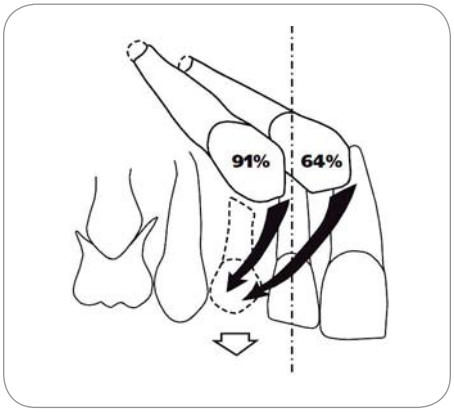

FIGURE 1. Illustration showing the normalization rates of the maxillary canine after extraction of the primary canine when the permanent maxillary canine is located mesially and distally to the midline of the lateral incisor.

Permanent First Molar

Ectopic eruption of permanent first molars occurs in 3-4 percent of children with the maxillary arch usually being affected.[29] Etiological factors include a sibling with ectopic eruption;[30] shorter, smaller maxilla;[31-32] larger mesiodistal width of the first permanent molar with increased mesial inclination;[33] cleft lip and/or palate[34] and association with other dental anomalies.[35]

They are usually identified between 5 and 7 years of age on a radiographic exam, with the first permanent molar impacted in the distobuccal root of the second primary molar (**FIGURE 2**). Of these teeth, 69.4 percent spontaneously correct and 14.3 percent result in pulpal exposure of the second primary molar.[36]

Early correction of ectopically erupting permanent molars is important for

FIGURE 2. Ectopic eruption of permanent first molars.

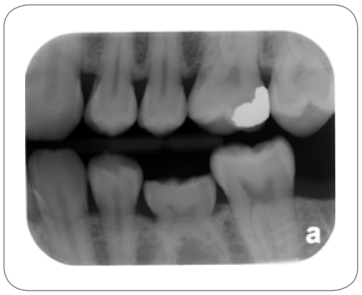

FIGURE 3. Ankylosed teeth are locked in position and cannot continue to erupt or be moved orthodontically.

development of a stable occlusion.[37] If left untreated, ectopic eruption of the first permanent molar may cause serious sequel, including early loss of the second primary molar, space loss, impaction of second premolars and super-eruption of the opposing first permanent molar. Treatment options for minimally impacted molars include disking the second primary molar, the brass wire technique,[38] a spring-type deimpactor[39] or elastic separators.[40] When the impaction is severe, options include extraction of the second primary molar and space maintenance or distal tipping appliances can be utilized, such as the Halterman appliance,[41,42] a removable appliance with a finger spring,[43] a sectional wire with open coil spring[44] or the Cetlin appliance/headgear.[45]

Ankylosis

Another common condition found in the pediatric patient, both clinically and on X-ray, is ankylosis. Ankylosis is defined as a fusion of dentin or cementum within the alveolar bone. These teeth are locked in position and cannot continue to erupt or be moved orthodontically (**FIGURE 3**). While the cause of ankylosis is essentially unknown, it is typically attributed to either a local disturbance in metabolism or from trauma, and can occur at any time during the lifetime of a tooth.[46] Evidence suggests that there is a genetic predisposition in primary molars.[47] The incidence of ankylosis in primary teeth is 1-14 percent of children and multiple primary teeth may be affected.[48-51] The following are the most commonly ankylosed teeth in the primary dentition:[52]

- Mandibular primary first molar.
- Mandibular primary second molar.
- Maxillary primary first molar.
- Maxillary primary second molar.

Diagnosis of an ankylosed primary tooth may include any or all of the following: decreased mobility compared to unaffected teeth; a positioning of the affected tooth apical to the plane of occlusion (infraocclusion) possibly without occlusal contact; altered percussion — giving a dull rather than a cushioned sound; radiographic obliteration of the periodontal ligament space suggesting direct approximation of tooth and bone; and the radiographs show a developing vertical defect between the primary and permanent tooth.[53]

Longitudinal studies indicate that most ankylosed primary teeth exfoliate normally and allow normal eruption of succedaneous teeth.[54] Ankylosed teeth should not be removed unless they are impeding the eruption of the succedaneous tooth or unless a large marginal ridge discrepancy develops between it and the unaffected adjacent teeth. If a marginal ridge discrepancy develops, the adjacent teeth may tip into the space occupied by the ankylosed tooth and cause space loss. In cases where there is agenesis of the succedaneous tooth, it must be decided whether to perform early extraction to allow mesial drifting of the posterior teeth or to place occlusal buildups to minimize super-eruption of the opposing tooth and to lessen mesial tipping of the tooth distal.[55]

When evaluating an ankylosed tooth, the clinician must take into account the presence of a permanent successor, the extent of submergence (and potential vertical defects), and the extent of the patient's remaining facial growth. Here are some possible scenarios:

- In a mature female with a missing second bicuspid and mild to moderate submergence of the ankylosed tooth, the tooth can be kept but it may need to be restored and/or reduced mesially and distally to idealize the occlusion.
- In a male with remaining facial growth and a missing second bicuspid, the ankylosed tooth should be extracted to allow the edentulous ridge to move occlusally as the adjacent teeth erupt.[56]
- In a 9-year-old with an ankylosed and submerged primary second molar with a permanent second bicuspid with a one-third root formation, the ankylosed tooth should be extracted and the space maintained. The potential for years of negative effects on the occlusion from the submerged tooth is too great to consider maintaining the tooth.
- In an 11-year-old with an ankylosed and submerged primary second molar with a permanent second bicuspid, the ankylosed tooth can be allowed to exfoliate on its own if the ankylosis is mild to moderate with minimal changes in the occlusion.

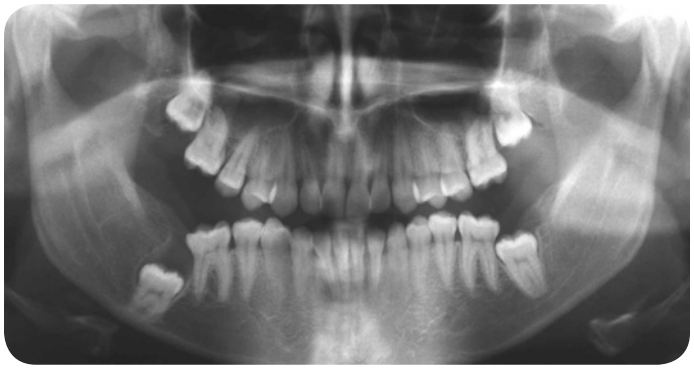

FIGURE 4. Primary failure of eruption or PFE.

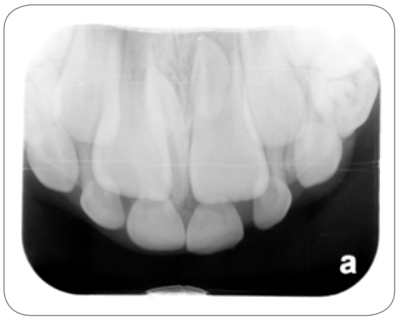

FIGURE 5. A mesiodens refers to a supernumerary tooth present in the midline of the maxilla between the two central incisors.

Primary Failure of Eruption

When teeth do not erupt normally, another possible cause is primary failure of eruption or PFE. Profitt and Vig described the condition as one in which "nonankylosed teeth fail to erupt fully or partially because of malfunction of the eruption mechanism" (**FIGURE 4**). This is an unusual eruption problem that affects the posterior teeth. It is diagnosed when a tooth fails to erupt despite the presence of adequate space and the absence of overlying hard tissue that prevents eruption. Furthermore, all teeth distal to the affected tooth also fail to erupt. The cause is unknown but appears to have a genetic component.

Profitt and Vig identified several key characteristics in their study:

1. Posterior teeth were more frequently involved and the teeth distal to the first affected tooth were also affected to some degree.
2. Capacity for eruption of affected teeth varied.
    a. Involved teeth may have erupted partially and then ceased to erupt and are relatively submerged but not ankylosed.
    b. Involved teeth may have completely failed to erupt with an uncoupling of the eruption and resorption mechanisms. In these cases, the resorption appeared to be normal but the tooth failed to follow the path created.
3. Deciduous molars were likely to be involved.
4. The condition was rarely symmetric and was frequently unilateral but it could be bilateral.
5. Involved permanent teeth tended to become ankylosed at some point.
6. Orthodontic forces led to ankylosis rather than normal tooth movement.
7. Patients did not seem to have similarly affected close relatives.[57]

The management of PFE is difficult, not least because diagnosis of this condition relies principally upon exclusion, where all possible causative factors have been considered and eliminated. Active orthodontic force will most likely result in localized ankylosis and failure to extrude an affected tooth into occlusion, a finding that is essentially diagnostic. Where the condition is a localized problem affecting only one tooth, management may include extraction of the affected tooth, followed either by orthodontic space closure or by prosthetic replacement. Alternatively, a localized bony osteotomy and orthodontic extrusion of the whole segment would seem to be the only option if an occlusal position of the tooth or teeth is to be obtained. If some eruption of the tooth has occurred, a coronal buildup may be the treatment of choice, in this case accepting the vertical position of the affected tooth but achieving occlusion via the restoration.[58] Cases where multiple teeth are involved are more difficult to manage; the only available method of bringing them into occlusion is a segmental osteotomy.[59] Careful planning in these cases is essential to ensure that no damage is caused to adjacent teeth. While surgical repositioning may not move teeth into an entirely acceptable position, it will certainly aid prosthetic management.

Mesiodens

A mesiodens refers to a supernumerary tooth present in the midline of the maxilla between the two central incisors. The incidence of mesiodens has been estimated at 0.15–1 percent of the population. It occurs more frequently in boys than in girls with the ratio being approximately 2:1. In one study, 66 percent of the mesiodens were conical in shape and 52 percent were in the upward (inverted) position (**FIGURE 5**).[60]

Mesiodens are usually found close to the crowns of the unerupted permanent central incisors in a palatal position but occasionally they erupt in the middle.[61] In children, 85 percent of anterior supernumeraries are unerupted and 65 percent interfere with the normal eruption of the maxillary permanent incisors.[62] Of the 15 percent that do erupt, most come in between the ages of 3 and 7. The mesiodens may emerge in the palate or may resorb the roots of the primary central incisors and erupt in their place.[63]

Common problems associated with mesiodens include over retention of primary teeth, impaction or delayed eruption of permanent teeth, dilacerations or abnormal root development, and abnormal crowding

FIGURE 6. Transposition of the maxillary right first bicuspid and canine transposed.

or spacing of the anterior teeth.[64] The accurate location of supernumerary teeth is critical in determining the proper treatment approach. Clinical examination, including labial and palatal palpation, along with proper radiographs, can be used with high accuracy to determine the mesiodens' location in the premaxilla. Both vertical and horizontal shift radiographic techniques using periapical films are helpful in localizing midline mesiodens. Panoramic and lateral occlusal films can also be used.[65]

Opposing views exist as to when supernumerary teeth should be treated, if at all. Some recommend early removal of supernumerary teeth especially if they are inverted or are unlikely to erupt.[66] This may prevent the need for orthodontic treatment and/or additional surgical procedures. Advocates of early treatment feel that this will improve the chance of spontaneous eruption of the permanent incisors and increase the potential for self-correction with the optimal time being 6 and 7 years of age.[67,68] Some believe that the best time for removal of mesiodens is 8 and 9 years of age when the upper incisors erupt. At this age, the child's behavior may be easier to manage and there may be less need for sedation.[69] Another treatment approach calls for late extraction of mesiodens when the adjacent permanent incisors have completed their root formation.[70,71]

Transposition

Transposition occurs when there is "a positional interchange of two adjacent teeth, especially their roots or the development or eruption of a tooth in a position occupied normally by a nonadjacent tooth."[72] While transposition is typically first observed in the late mixed-dentition stage, it can be diagnosed in the early mixed-dentition stage. This is usually a transposition of the mandibular lateral incisor and canine.[73] The lateral incisor will show distal tipping, resorption of the primary canine (and sometimes the primary first molar) and rotation as it migrates. Other transpositions that are observed later in the transitional years are likely to be the mature mandibular lateral and canine, and the more prevalent transpositions of the maxillary canine/first premolar and maxillary canine/lateral incisor[74] (**FIGURE 6**).

Serial Extraction

When children have little to no spacing in the primary dentition, they are almost assuredly going to have crowding in the permanent dentition. Radiographs can be very useful in determining whether there will be enough room to maintain all of the teeth or whether serial extraction should be considered. Serial extraction is a planned sequence of tooth removal to reduce crowding and eruption problems during the transition from the primary to the permanent dentition. While it may make later comprehensive orthodontic treatment easier, it is not viewed as a substitute for orthodontic treatment. Serial extraction is intended for severe dental crowding. It is best used when no skeletal problems exist and the crowding is greater than 10 mm per arch. If the initial discrepancy is smaller, more residual space should be expected.

Treatment begins in the early mixed dentition (usually between 6 and 8 years old) when the primary incisors are removed to make room for the permanent incisors. This may include the extraction of the primary canines as necessary. There is usually some lingual tipping of the lower incisors and overbite often increases.

In the middle mixed dentition (usually between 8 and 10 years old), it is advisable to take a panoramic radiograph. The goal of serial extraction is to influence the permanent first premolars to erupt ahead of the canines so that they can be extracted and the canines can move distally into this space. The maxillary bicuspids usually erupt before the canines so the eruption sequence is rarely a problem. However, the lower canines often erupt before the first bicuspids, which may cause the canines to erupt facially. One technique to avoid this is to remove the lower primary first molar when there is one-half to two-thirds the root formation of the first bicuspid. This usually helps speed up the eruption of the first bicuspid, allowing it to be removed before the canine erupts. One problem that can occur is when the lower primary first molar is removed and the permanent canine still erupts ahead of the first bicuspid. This can lead to impaction of the bicuspid that requires later surgical removal.

After the first bicuspid has been removed, the second primary molars should exfoliate normally. The first bicuspid extraction space closes by mesial drift of the second bicuspid and first molar along with distal eruption of the

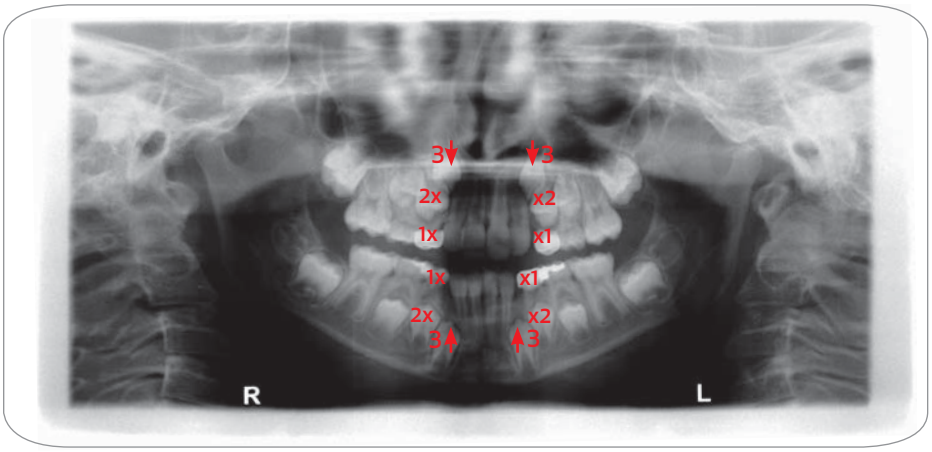

FIGURE 7. Here is an example of a serial extraction patient. The maxillary and mandibular primary incisors and cuspids have already been removed to accommodate the maxillary and mandibular permanent incisors. The sequence goes as follows: (1) Remove the first primary molars (2) Remove the first permanent bicuspids (3) Allow the permanent cuspids to occupy the space of the first permanent bicuspids and complete orthodontics as needed.

canine. Ideal alignment of the teeth is usually not achieved without subsequent orthodontic treatment[75] (see **FIGURE 7**).

X-ray Techniques for Young Children

The following are some techniques that may be useful when taking X-rays on children:

- Use a "tell, show, do" technique with an unexposed packet of film. You may want to use a camera analogy.
- Match the size of the film to the size of the child. Size 2 films are fine for anterior occlusal X-rays but size 0 or 1 films should be used to take bitewings on small children.
- Take the least difficult radiograph first to acquaint the child with the procedure. Anterior occlusal films are usually the easiest to take.
- Be sure that all settings are made on the machine and that the X-ray head is positioned before inserting the film. Some children can only hold a film for a short period of time because of their gag reflex, discomfort or short attention span.
- Consider placing alginate flavoring on the X-ray film to make it more fun and palatable for children.
- Work quickly with constant reinforcement.
- A Snap-a-Ray can be used as an anterior film stabilizer or to aid in taking bitewing radiographs.
- Be patient!

Conclusion

Because of the dynamic changes that occur in a child's developing dentition, it is very important for dentists to recognize when to take radiographs, which radiographs to take, how to evaluate them and how to treat the problems. Clinicians should be checking for anomalies such as extra/missing teeth, tooth impaction, ankylosis, primary failure of eruption, transposition and crowding. Early detection and treatment can help prevent larger problems as the child grows older. It is important for dentists to learn techniques enabling them to take radiographs on a child of any age. ■■■■

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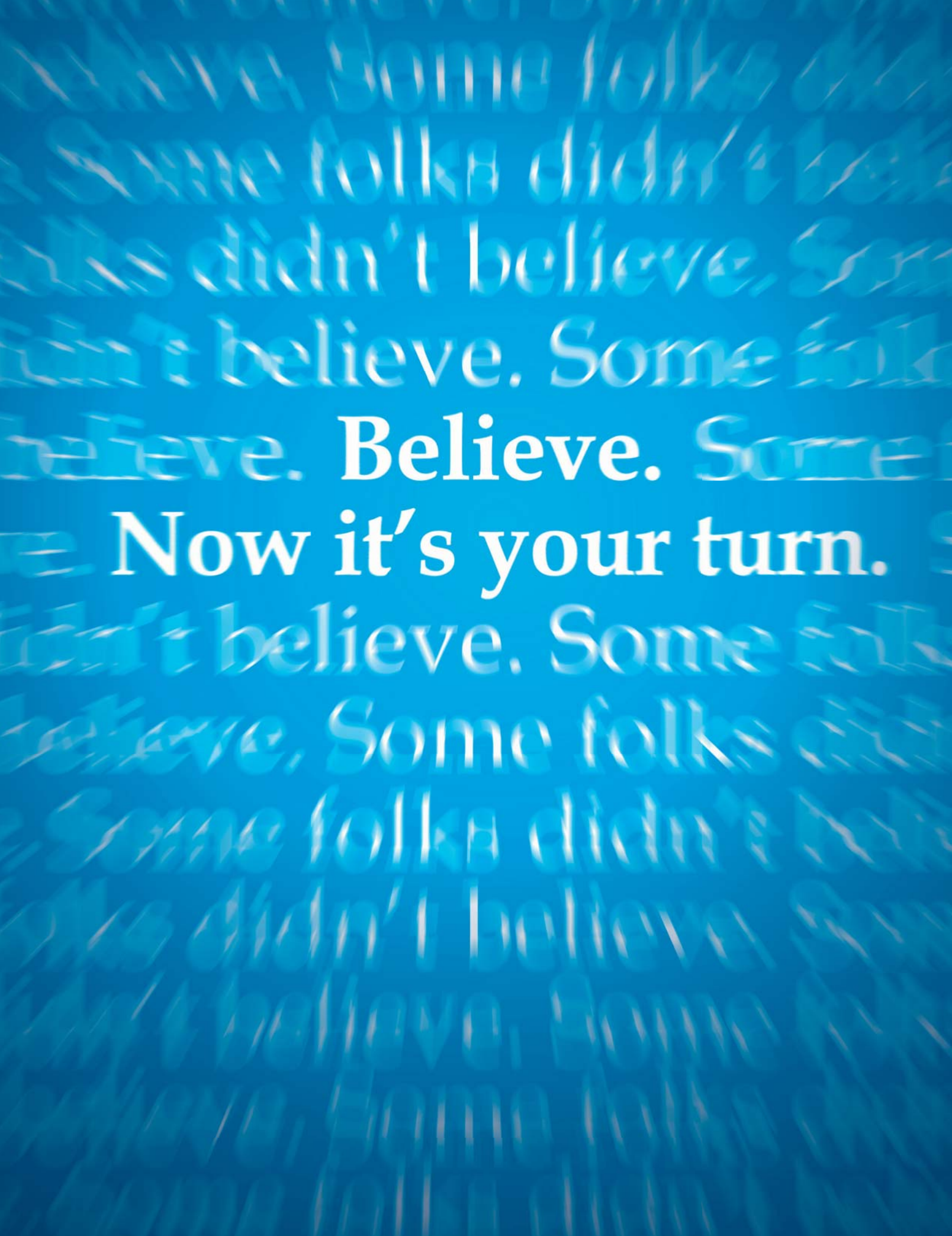
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A Review of Pulp Therapy for Primary and Immature Permanent Teeth

PRIYANSHI RITWIK, DDS, MS

ABSTRACT The aim of pulp therapy in primary and young permanent teeth is to maintain a functional tooth so that arch integrity is preserved in a growing child. History, clinical evaluation and radiographic findings should be integrated to arrive at pulp diagnosis. Vital pulp therapy should be attempted whenever the pulp is diagnosed to be vital. Nonvital pulp therapy should be performed for strategically important primary teeth. Revascularization is an emerging technique for immature necrotic teeth.

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Maintaining the integrity of the dental arch in the primary and mixed dentition is essential for establishing occlusion and function in the permanent dentition. The primary reasons for premature loss of teeth in children are either dental caries or dental trauma. Proximity of decay or trauma to pulp tissue may lead to pulpitis or even pulp necrosis. Whenever feasible, dental treatment should attempt to maintain pulp vitality, particularly in immature permanent teeth. Pulp vitality leads to development of a favorable crown-root ratio, apical closure and formation of secondary radicular dentin. The long-term survival of the tooth is also greater when pulp vitality is maintained (hazard ratio 7:1).[1] However, when irreversible pulpitis or pulp necrosis occur, nonvital pulp therapy procedures are required to alleviate patient symptoms and maintain a functional tooth in the dental arch. This review article presents the pulp therapy procedures commonly used in pediatric dentistry, their indications and the common therapeutic agents.

Pulp Diagnosis

The key to successful outcomes with pulp therapy is accurate pulp diagnosis. This can be particularly challenging in children, who are poor historians. Children either fail to report dental pain because of their fear of the subsequent treatment, or provide a hyper-responsive feedback to pulp evaluation because of anxiety associated with the dental visit. Young children may present with a draining parulis associated with early-childhood caries, but do not report a history of pain because, unfortunately, they have not experienced a pain-free oral cavity.[2]

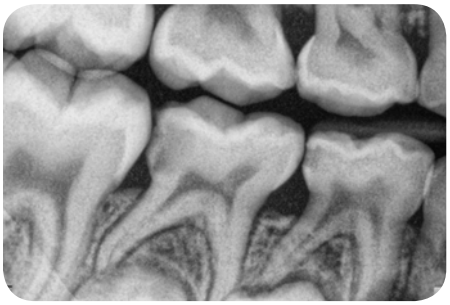

FIGURE 1. Deep decay on the distal surface of the mandibular right primary second molar without periapical or furcation pathology.

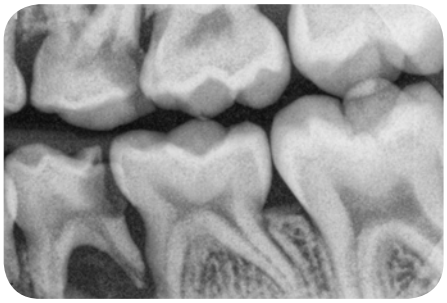

FIGURE 2. Dental caries extending into the pulp for the maxillary and mandibular left primary first molars. Pathologic bone loss can be seen around the mandibular primary first molar.

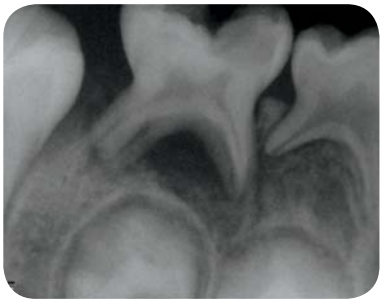

FIGURE 3. Pulp necrosis involving the mandibular second primary molar has lead to extensive furcation involvement but minimal periapical changes.

The history and characteristics of pain should be elicited in a review of symptoms with the child and the parents. A thorough clinical and radiographic evaluation, along with the clinical history, will help determine the extent of the pulpal involvement. Thermal and electrical pulp testing are seldom used in the primary dentition because of unreliable results with these techniques.[2,3] A history of provoked pain that is relieved by removal of the noxious stimuli is indicative of reversible pulpitis. Clinical examination of such teeth may reveal obvious dental decay or a dark shadow originating from the proximal surface. These teeth are not painful to percussion and do not exhibit pathologic mobility. Radiographs show decay close to the pulp and the absence of furcation or periapical radiolucency (**FIGURE 1**). Teeth with reversible pulpitis have inflammation confined to the superficial layers of the coronal pulp and are good candidates for treatment with vital pulp therapy techniques. In cases where interproximal decay occurs on the approximating surfaces of adjacent teeth, gingival pain from food impaction should be differentiated from pain of pulpal origin.

A history of spontaneous throbbing or constant pain is indicative of advanced pulpal degeneration or irreversible pulpitis.[2] Such teeth may elicit a painful response to percussion. In addition to large carious lesions, soft tissue swelling or erythema may be present if pulp necrosis has occurred. The mucobuccal fold should be palpated around teeth with deep carious lesions or trauma. The presence of swelling, parulis or pathologic mobility is indicative of necrotic pulp tissue. Radiographs of teeth with pulpal degeneration or irreversible pulpitis usually show decay extending into the pulp, along with radiographic bone loss such as in the furcation or periapical area (**FIGURE 2**). Internal root resorption or pathologic external root resorption may also be seen on the radiograph. When reviewing bitewing radiographs, the furcation area of primary teeth should be carefully assessed for any widening of the periodontal ligament space or pathologic bone destruction.[3] When possible, a comparison should be made with teeth on the contralateral side. The furcations of primary molars are porous and pathologic changes from a degenerative pulp may be seen in the furcation area before periapical changes are observed (**FIGURE 3**).[3] Although periapical radiographs are desirable for complete diagnosis, bitewing radiographs are often the only intraoral radiographs that can be obtained in young or uncooperative children. Management of teeth with pulpal degeneration or irreversible pulpitis requires utilization of nonvital pulp therapy techniques.

The commonly used vital and nonvital pulp therapy techniques for primary and immature permanent teeth are listed in **TABLE 1**. The subsequent sections of this article will discuss the individual techniques.

TABLE 1

Pulp Therapy Techniques Indicated for Primary and Immature Permanent Teeth

Technique/ Indication	Primary Teeth	Immature Permanent Teeth
Vital Pulp Therapy		
Indirect pulp capping	Yes	Yes
Direct pulp capping	No	Yes
Partial pulpotomy (Cvek Pulpotomy)	No	Yes
Cervical pulpotomy	Yes	Yes
Apexogenesis	No	Yes
Nonvital Pulp Therapy		
Pulpectomy	Yes	No
Revascularization	No	Yes
Apexification	No	Yes

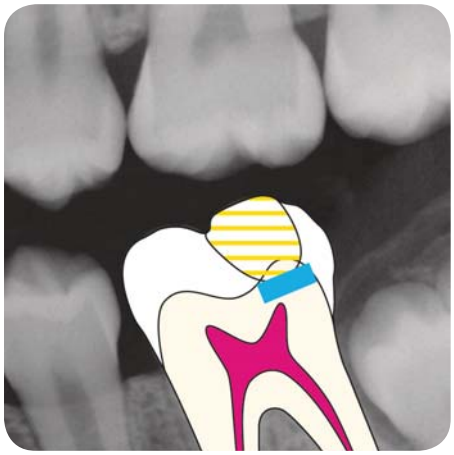

FIGURE 4. Schematic illustration of indirect pulp therapy for a permanent molar. The medicament for pulp protection is shown in blue. The pulp is vital.

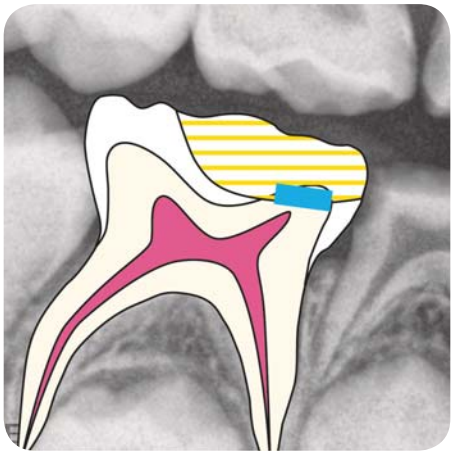

FIGURE 5. Schematic illustration of indirect pulp therapy for a primary molar. The medicament for pulp protection is shown in blue. The pulp is vital.

Indirect Pulp Therapy

Indirect pulp therapy should be considered when deep decay is in close proximity to the pulp but the tooth is asymptomatic and it is anticipated that complete removal of decay will result in pulp exposure. In such a situation, the infected dentin is removed but the affected dentin is left untouched.[3] It is important to completely remove the decay from the dentino-enamel junction along the axial walls of the cavity. A biocompatible material is placed on the floor of the cavity preparation close to the pulp and is followed by the final restoration.[2,3] Various medicaments have been used for indirect pulp therapy, ranging from calcium hydroxide to glass ionomer to none. The agent used does not significantly alter the success rate of the procedure.[3] Indirect pulp therapy is a clinically successful technique because the removal of the carious insult along with the placement of a biocompatible material and a well-sealed final restoration provide the pulp an environment conducive for healing.[4] The success rate of indirect pulp therapy for permanent teeth ranges from 74 to 99 percent.[3] Over time, the affected dentin is remineralized and reactionary dentin is laid down by the odontoblasts. While some practitioners may re-enter the cavity at this stage and replace the calcium hydroxide with the definitive restoration, the need to re-enter is considered unnecessary as long as a well-sealed final restoration has been placed over the pulp-capping medicament.[5,6] Some other materials that can be used for indirect pulp therapy are zinc oxide eugenol (ZOE), intermediate restorative material (IRM), glass ionomer cement (GIC), resin-reinforced glass ionomer cement (RRGIC), *mineral trioxide aggregate* (MTA) and composite resin. In particular, GIC has been shown to be a desirable material for indirect pulp therapy because of its ability to remineralize affected dentin, its antimicrobial effect and its ability to provide well-sealed margins.[7] Indirect pulp therapy is schematically shown in **FIGURE 4**.

Indirect pulp therapy has a long history of utilization in permanent teeth. In primary teeth, the preferred treatment was pulpotomy because it was considered a more definitive treatment.[8] However, recent literature has shown indirect pulp therapy to be a successful clinical technique in primary teeth as well, with success rates ranging from 93 to 96 percent.[9,10,11,12] Its success rates are comparable to that of pulpotomy in primary teeth. The ability of the primary pulp to heal after the removal of the noxious source has been shown in histological studies.[13,14] The success rate of indirect pulp therapy in primary teeth has been shown to increase seven-fold if the final restoration is a stainless steel crown.[11] This underscores the importance of a well-sealed final restoration to eliminate inflammatory insult to the pulp and facilitate its healing. Indirect pulp therapy in a primary molar is schematically shown in **FIGURE 5**. In the recent clinical guidelines by the American Academy of Pediatric Dentistry, the use of indirect pulp therapy in primary teeth has been taken a step further from just pulpal management to caries control and interim therapeutic restorations (ITR).[15] The atraumatic restorative technique (ART) utilizes the removal of gross decay with hand instruments without anesthesia and placement of an interim restoration (GIC, RRGIC or IRM). This reduces the oral bacterial load, delays progression of the carious lesion and provides the primary pulp the opportunity to heal. It also provides the practitioner the time to schedule definitive care for an uncooperative child by utilizing sedation or general anesthesia.

Direct Pulp Capping

Direct pulp capping (DPC) should be considered when a pinpoint exposure of healthy pulp occurs during operative procedures or as a result of dental trauma. The procedure is most successful if the pulp has been asymptomatic. Ideally, DPC should be performed under rubber dam isolation. The materials traditionally used for DPC are calcium hydroxide or mineral trioxide aggregate (MTA). The definitive restoration should be placed over the pulp-capping agent. DPC for

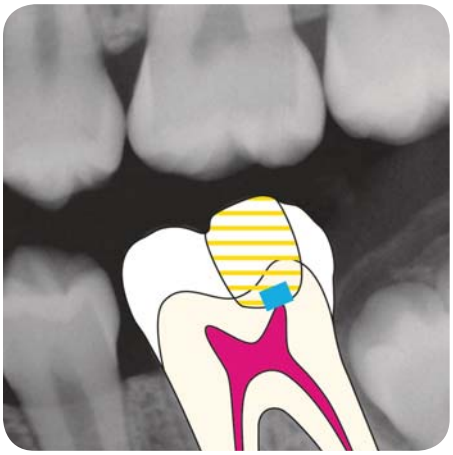

FIGURE 6. Schematic illustration of direct pulp cap in permanent molar. The pinpoint pulp exposure is covered with a biocompatible material (shown in blue).

TABLE 2

Comparison of Calcium Hydroxide and Mineral Trioxide Aggregate (MTA) as Pulp-capping Agents

	Calcium Hydroxide	MTA
Histology	Inflammation	Minimal inflammation
Dentin bridge	Dente with tunnel defects	Normal dentin
	Inconsistent	Consistent
PDL architecture	No effect	Favorable
Setting time	Quick (with hard setting type)	Prolonged
Coronal discoloration	Unlikely	Likely

a permanent molar is schematically shown in **FIGURE 6**. Although DPC is not a recommended technique for primary teeth, it should be considered for immature permanent teeth.[8,15]

The histological response of dental pulp to calcium hydroxide and MTA differ. Calcium hydroxide is alkaline (pH=11.5) and causes a zone of liquefaction necrosis at the site of application.[16] Beyond the zone of necrosis, it induces a low-grade inflammatory response from the pulp, which stimulates formation of a dentin bridge.[3] Over a six- to eight-week span, the formation of a dentin bridge is anticipated in the pulpal area beyond the location of the calcium hydroxide. The histological analysis of the dentin bridge formed with calcium hydroxide has shown several tunnel defects communicating with the underlying pulp.[17] This usually results in recurrent pulp inflammation and necrosis in one to two years.[17] MTA, like calcium hydroxide, is also alkaline (pH=12.5) and is a biocompatible and bioactive material.[18] It leads to formation of hydroxyapatite at the site of application.[18] When compared to calcium hydroxide, the dentin bridge formed in apposition to MTA is thicker and faster and exhibits superior structural integrity.[3,19,20] There is significantly less inflammation within the pulp tissue in response to MTA.[21] Some differences between calcium hydroxide and MTA are listed in **TABLE 2**. The clinical success of DPC has been reported to be 82 percent with calcium hydroxide[22] and 93-98 percent with MTA.[23,24]

The use of acid-etch technique for direct pulp capping has been investigated, based on the rationale that it is not just the biocompatibility of the pulp-capping medicament but the ability of the material to provide a hermetic seal, that leads to the success of pulp capping. Short-term clinical success has been reported with the use of the total-etch technique.[25-27] However, histological evaluation has shown the lack of dentin bridge formation and persistent mild inflammation.[28-30] Due to these negative findings, acid-etched dental adhesives cannot be recommended as the material of choice for direct pulp capping at this time.

Partial Pulpotomy/Cvek Pulpotomy

If pulp exposure occurs in a mature permanent tooth, conventional endodontic treatment can be successfully performed. However, when pulp exposure occurs in an immature permanent tooth, the thin radicular dentin, short roots and open apices decrease the success rate of conventional endodontic treatment and compromise the long-term retention of the tooth. Therefore, preservation of pulp vitality should be attempted in immature teeth with vital pulp exposure in an attempt to allow continued root development. Partial pulpotomy, also called a Cvek pulpotomy, should be considered when carious or traumatic pulp exposure occurs in a tooth without a history of spontaneous pain and clinical evaluation confirms the absence of sensitivity to percussion and/or soft-tissue swelling. There should also be no radiographic bone loss or pathologic root resorption.

Partial Pulpotomy Technique

After local anesthetic administration and rubber dam isolation, gross decay and sharp fracture margins should be removed and the exposed pulp should be flushed with sterile saline. The superficial pulp and adjacent dentin are surgically excised to a depth and width of 2 mm with either a high-speed diamond bur or No. 330 carbide bur with copious water spray. The surgical site is again flushed with sterile saline or sodium hypochlorite and a light application of pressure with sterile cotton pellets should achieve hemostasis. Ideally, hemostasis should be achieved within five minutes of pulp amputation. If hemostasis is not achieved in this time frame, the size of the surgical excision should be progressively increased until hemostasis is achieved. A biocompatible material such as calcium hydroxide or MTA is applied directly on the pulp

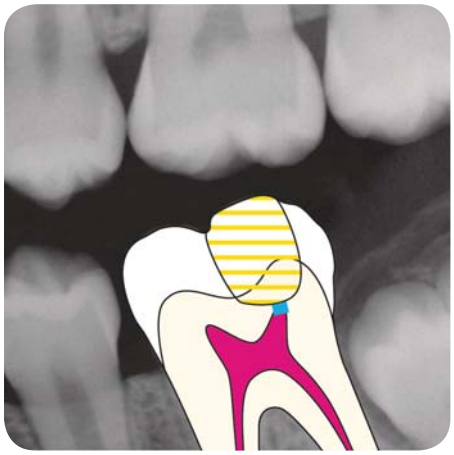

FIGURE 7. Schematic illustration of Cvek pulpotomy. Approximately 2 mm of the exposed pulp tissue is surgically removed and a biocompatible pulp medicament is placed over the pulp tissue (shown in blue).

TABLE 3

Contraindications to Pulpotomy in Primary Teeth

Clinical Findings
Swelling
Fistula
Pathologic mobility
Uncontrolled hemorrhage from radicular pulp
Radiographic Findings
Internal root resorption
Pathologic external root resorption
Periapical radiolucency
Furcation radiolucency

FIGURE 8. Schematic illustration of cervical pulpotomy in a primary molar. Pulp tissue is surgically removed up to the orifices of the root canals. Pulp medicament is applied to the radicular pulp stumps and the chamber filled with IRM or ZOE (shown in black).

tissue, followed by the final restoration. Cvek pulpotomy in a permanent molar is schematically shown in **FIGURE 7**.

The success rate of the partial pulpotomy or Cvek pulpotomy technique is higher than that of DPC. It is reported to range from 91 to 96 percent.[31-36] Its success rate is higher in immature teeth and in younger patients and does not depend on the size or duration of pulp exposure.[31,32] Successful outcome with Cvek pulpotomy has been reported up to three weeks after traumatic pulp exposure.[37] Both carious and traumatic exposures have similar rates of success.[33] The time needed to achieve hemostasis has been shown to be a predictor of success, while the color of the bleeding at the surgical amputation site is unreliable in determining the status of the pulpal health.[35,38,39] The biggest determinant in the success of this technique lies in the ability of the pulp to heal itself after the removal of the noxious stimuli. Further, the preservation of the cell-rich zone of the coronal pulp enables repopulation of the amputation site by odontoblasts, which lay down the dentin bridge. Partial/Cvek pulpotomy is a technique reserved for permanent teeth and should not be used for primary teeth.

Pulpotomy

Pulpotomy refers to the surgical removal of the coronal portion of the pulp. The most common pulp therapy procedure for vital primary teeth is pulpotomy. It is used when the coronal pulp is inflamed but the radicular pulp is deemed to be healthy (consistent with the diagnosis of reversible pulpitis). A pulpotomy is contraindicated if there are any signs of radicular inflammation. A summary of the contraindications for pulpotomy in primary teeth is listed in **TABLE 3**.

Pulpotomy Technique

After local anesthetic administration and isolation with rubber dam, gross decay should be removed to ensure that infected debris is not introduced into the pulp chamber. The location of the pulp horns should be assessed and the pulp chamber can be unroofed by connecting the pulp horns with a No. 330 carbide bur on a high-speed handpiece.[2] Alternatively, a No. 4 or No. 6 round bur on a high-speed handpiece can also be used to unroof the pulp chamber. When using this technique, the clinician should assess the distance between the roof and floor of the pulp chamber on the radiograph to avoid perforation of the floor by the bur. After unroofing the pulp chamber, the coronal pulp tissue should be removed with a sharp spoon excavator or a No. 4 or No. 6 slow-speed bur. When using the slow-speed bur for removal of pulp tissue, the bur should move in a scooping motion out of the pulp chamber, taking care to avoid touching the floor, furcation or canal orifices. The extent of surgical removal of coronal pulp tissue in a primary molar pulpotomy is shown in **FIGURE 8**. For primary incisors, the pulp should be amputated to the cementoenamel junction (CEJ). When preparing the access opening for a pulpotomy, the entire roof of the pulp chamber is removed so that there is direct access and visualization of the canal orifices. Care must be taken to ensure that there are no tissue tag remnants in the pulp chamber, as these tissue tags will continue to ooze blood into the pulp chamber and confound accurate pulp diagnosis. Bleeding from the pulp tissue at the root canal orifices should be controlled with mild pressure and cotton pellets. After hemostasis is achieved, cotton pellets moistened with formocresol should be placed over the pulp stumps for five minutes.[2] Excess formocresol from the pellets

FIGURE 9. Chemical burn of gingival tissue along the lingual aspect of mandibular right primary first molar due to leakage of formocresol from oversaturated cotton pellet used for pulpotomy.

should be blotted. Accidental leakage of formocresol into the oral cavity can lead to a chemical burn of the mucosa or gingiva (**FIGURE 9**).The formocresol pellets are then removed from the pulp chamber and either IRM or ZOE is placed over the pulp stumps and used to fill the coronal pulp chamber. The final restoration of choice for a pulpotomized primary molar is a preformed stainless steel crown. It is preferable for the pulpotomy and the stainless steel crown restoration to be performed at the same appointment.

Formocresol is a commonly used medicament for pulpotomy in primary teeth and is the standard against which the success of other agents or techniques are compared.[8,40] It is a compound consisting of formaldehyde, cresol, glycerin and water. It has a success rate ranging from 55 to 97 percent.[8,41,42,43,44] The wide range reflects studies evaluating success based on differing clinical and radiographic criteria as well as varying durations of follow up. Formocresol is a tissue fixative as well as a bactericidal agent. Histological evaluation of a formocresol pulpotomy shows that fixation occurs in the coronal third of the radicular pulp, chronic inflammation occurs in the middle third and the apical third remains vital.[45] These histological changes occur only if formocresol contacts pulp tissue; therefore, it is imperative to ensure that the formocresol pellets are compressed into the pulp chamber to contact the pulp tissue at the canal orifices. When the formocresol pellet contacts vital pulp tissue, the tissue and the cotton pellet will turn a dark brown color. Periodically, there is a resurgence of concerns regarding the mutagenic and cytotoxic effects of formocresol. While these concerns have not been validated in investigation of formocresol for therapeutic pulpotomies in primary teeth,[46,47] the quest for a successful alternative pulpotomy agent is ongoing. Some alternatives to formocresol as a pulpotomy medicament are ferric sulfate, MTA and sodium hypochlorite. Lasers and electrosurgery have also been evaluated for therapeutic pulpotomy of primary teeth.

Ferric sulfate is an acidic hemostatic agent (pH=1), used at 15.5% concentration. Cotton pellets soaked in ferric sulfate are applied to the pulp stumps for 15 seconds followed by a rinse. The chamber is filled with IRM or ZOE and the final restoration is placed. Ferric sulfate causes agglutination of the blood proteins to form a physical plug that occludes the capillaries.[48] The advantages of ferric sulfate are that it is easily available, relatively inexpensive and the duration of application is shorter than that of formocresol. The success rates of pulpotomies with ferric sulfate are comparable to that of formocresol. The clinical and radiographic success rates range from 43 to 100 percent.[41,49-54] The main disadvantages of ferric sulfate as a pulpotomy agent are internal resorption and shortening of roots.[41] Internal resorption can be a clinical dilemma. When static, nonprogressive internal resorption is noted on the radiograph after a ferric sulfate pulpotomy is performed, no further treatment is indicated. However, progressive internal resorption may be an indication for extraction. Histological evaluation has shown that the pulp remains in an inflamed state in a ferric sulfate pulpotomy, which can lead to internal resorption.[21]

MTA is a bioactive and bioinductive material that enables formation of hydroxyapatite at the site of application.[18] When used as a pulpotomy agent, a thin layer of MTA is applied on the pulp stumps, the pulp chamber is filled with IRM or ZOE and the final restoration is placed. The clinical and radiographic success rates with MTA range from 96 to 100 percent.[55-58] The advantages of MTA are that it is a biocompatible material, it helps form a dentin bridge and does not elicit an inflammatory response from the pulp.[21] The main disadvantage is that the material is very expensive compared to formocresol and ferric sulfate. Histological evaluation of an MTA pulpotomy shows dentin bridge formation, normal pulp tissue without inflammatory infiltrates and continued secondary dentin formation.

Sodium hypochlorite has been reported as a successful pulpotomy agent for primary teeth. After achieving hemostasis, cotton pellets soaked in 5% sodium hypochlorite are placed on the pulp stumps for 30 seconds followed by a water rinse. IRM or ZOE is used to fill the pulp chamber and the final restoration is placed. The clinical and radiographic success rates with sodium hypochlorite range from 74 to 100 percent.[59,60] The advantages of sodium hypochlorite are that it is easily available, relatively inexpensive and has a short application time. The disadvantages are that external root resorption, internal resorption and radicular bone destruction have been noted with its use.[59,60]

Lasers are now being used for various dental procedures, and their outcomes

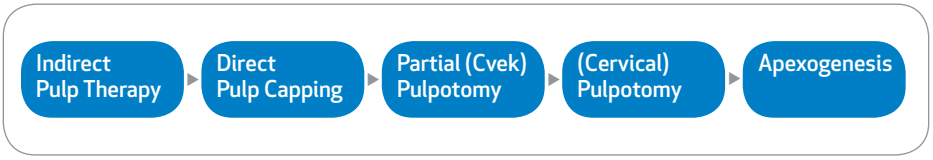

FIGURE 10. Continuum of vital pulp therapy techniques for immature permanent teeth.

with primary teeth pulpotomies have also been investigated. Current evidence shows that the clinical success rates of carbon dioxide laser for primary teeth pulpotomy is comparable to that of formocresol pulpotomy.[61] Reports have also shown clinical and radiographic success of pulpotomies in primary teeth with the Nd:YAG laser.[62,63] Histological analysis of Nd:YAG pulpotomies shows an initial inflammatory response that decreases with time.[63] Future research should be directed toward investigation of the ideal energy levels of lasers for optimal pulp response and evaluation of the response of cariously exposed primary pulp tissue to laser therapy.

Pulpotomy for Permanent Teeth

Vital pulp therapy for immature vital permanent teeth with reversible pulpitis can be viewed as a continuum ranging from indirect pulp therapy, direct pulp capping, partial pulpotomy (Cvek), cervical pulpotomy and apexogenesis (**FIGURE 10**). Using clinical judgment, inflamed coronal pulp tissue should be removed up to the cervical line and the radicular pulp covered with a pulp medicament (such as calcium hydroxide), followed by a well-sealed final restoration.[3] Preserving the vitality of radicular pulp in immature permanent teeth enables continued root length formation, apical closure and secondary dentin formation in the radicular portion of the tooth. It is important to place only calcium hydroxide and not MTA over the orifices of the canals. This is to ensure future easy access to the canals if the treatment fails. If the pulpotomy fails, the calcium hydroxide can be easily removed to access the root canals. A success rate of 92 percent has been reported for pulpotomy in immature permanent teeth with calcium hydroxide.[22]

Apexogenesis

Apexogenesis is a treatment modality for immature permanent teeth with inflamed coronal pulp. The surgical amputation of pulp tissue extends several millimeters into the root canal, usually leaving only the apical thirds of the radicular pulp.[3] After hemostasis is achieved, calcium hydroxide is placed over the vital pulp stumps and continued root and apex development is monitored. While a fast-setting calcium hydroxide (such as Dycal) can easily be used for direct pulp capping and Cvek pulpotomy, calcium hydroxide powder or a nonhard setting calcium hydroxide (such as Pulpdent) are usually easier to place in the root canals for apexogenesis. A permanent restoration should then be placed to ensure that the access to the pulp chamber is well sealed and the tooth should be periodically monitored both clinically and radiographically to assess radicular development.

Pulpectomy for Primary Teeth

Pulpectomy is defined as the complete removal of coronal and radicular pulp. It is performed in primary teeth which are either nonvital or have irreversible pulpitis to enable retention of a primary tooth which would otherwise need to be extracted. This can be a challenging procedure in primary molars because the root canals are narrow, ribbon shaped and have multiple accessory canals.[64] Complete removal of necrotic material is unlikely because of the anatomy of the root canal system in primary molars. This procedure is often utilized to save the primary second molars prior to the eruption of the permanent first molars or primary second molars with congenitally missing second premolars. It can also be performed on primary incisors and canines to enable

FIGURE 11. Schematic illustration of pulpectomy in primary molar. All the coronal and radicular pulp tissue is removed and the canal system is obturated with a resorbable filling material such as ZOE or Vitapex (shown in black).

retention of these teeth for esthetics. The procedure should be performed only when it is determined that the tooth is restorable. The restoration of choice is stainless steel crowns for molars or preveneered crowns for anterior teeth.

Pulpectomy Technique

After local anesthetic administration and rubber dam isolation, gross decay should be removed and the pulp chamber unroofed. The orifices are identified and the canals instrumented with the appropriate size of barbed broaches to remove as much pulp tissue remnants as possible. The working length is estimated from the preoperative radiographs and endodontic files are selected and the lengths adjusted to stop 1-2 mm short of the radiographic apex. The files are used to enlarge the canals 2-4 file sizes. An irrigant should be used intermittently to remove debris. While sodium hypochlorite is very efficient in dissolving organic debris, it can cause inflammation and swelling if expressed beyond the apex. Sterile saline or 2% hydrogen peroxide is a safer alternative. Upon completion of instrumentation, the canals are dried with sterile paper points and obturated. Pulpectomy is schematically shown in **FIGURE 11**.

The material used for obturation should resorb at a rate similar to the physiologic resorption of primary

roots and should not be harmful to the succedaneous tooth if extruded beyond the apex of the primary tooth. ZOE, Vitapex and iodoform-containing paste (KRI) paste are the most common materials reported in literature for obturation of primary root canals. When ZOE is used, a thin mix is carried into the canals and manually condensed into the canals with an endodontic plugger. After obturation of the canals, the pulp chamber can be filled with a thicker mix of ZOE and then followed by the final restoration. ZOE is the most commonly used material for obturation of primary canals. The reported success rate of ZOE pulpectomies is 77-82 percent.[65,66,67] Some of the reported problems with the use of ZOE for pulpectomy are as follows:

1. There is a 20 percent chance of ectopic eruption of the succedaneous teeth.[65]
2. If extruded from the apex, ZOE causes an inflammatory response and is unlikely to resorb. Unresorbed ZOE was found in 73 percent of exfoliated pulpectomies.[65]
3. The succedaneous teeth have a higher incidence of hypoplastic defects (18 percent),[65] although it cannot be ascertained from retrospective studies whether the hypoplasia occurred because of extrusion of ZOE or the infected primary tooth.
4. There is a higher incidence (35 percent) of over-retained primary teeth with ZOE pulpectomies.[65]

Vitapex, which contains a combination of calcium hydroxide and iodoform, is supplied in a premixed syringe with disposable tips (**FIGURES 12 AND 13**). The tips are inserted into the canals, the material extruded and the endodontic plugger used to condense the material. The material is soft to manipulate and easily condenses in the canal. The pulp chamber can then be filled with IRM or ZOE and followed by the final restoration. The reported success rate with Vitapex is 100 percent.[68] Vitapex resorbs faster than the primary root, and may appear to be washed out from the canals (**FIGURES 14 AND 15**). However, the canal remains sterile even if the material washes out.[69] Deleterious effects on the permanent successors, such as hypoplastic defects or ectopic eruption, have not been reported.

FIGURE 12. Vitapex in syringe.

FIGURE 13. Disposable tip for delivery of Vitapex in primary root canal.

KRI paste is a mixture of iodoform, camphor, parachlorophenol and menthol. While literature has reported its successful use, the material is unavailable in the United States.[70,71]

Clinical factors such as pre-existing internal or pathologic external root resorption and extrusion of material from the apex may reduce the success rate of a pulpectomy.[65] However, after a discussion of the risks and benefits with the child's parents, the procedure may still be performed on strategically important teeth to maintain arch integrity and functional teeth. In compromised teeth, it is imperative to discuss the guarded prognosis with the parents and explain the signs of failure so that the patient can be brought to the dentist in a timely manner should this occur.

While pulpotomies and pulpectomies are successful procedures, their use should be limited to healthy children. If the patient is immunocompromised or at risk for bacterial endocarditis, definitive treatment such as extraction may be more appropriate.

Revascularization/Regeneration

Revascularization or regenerative pulp therapy for nonvital immature permanent teeth is a technique that enables continued root length formation, radicular secondary dentin formation and apical closure.[72,73] The advantage is the long-term retention of teeth with a favorable crown-root ratio and adequate radicular dentin thickness. It is indicated only for necrotic immature permanent teeth (regardless of whether the etiology is caries or trauma) that have not had previous endodontic instrumentation or previous exposure to formocresol and/or calcium hydroxide.

Revascularization/Regeneration Technique

After obtaining adequate local anesthesia and rubber dam isolation, the pulp chamber of the affected tooth is unroofed. Sodium hypochlorite (5%) is used for chemical debridement of the pulp chamber and root canals. The irrigation should be done at a slow pace (10 ml over 15 minutes) to prevent forcing the sodium hypochlorite past the apex from excessive pressure.[74] A triple antibiotic paste is then delivered into the canals and sealed with a GIC or RRGIC. The antibiotic paste is allowed to disinfect the canals for approximately eight to 12 weeks. The tooth is then re-entered and sodium hypochlorite is used to wash out the remnants of the antibiotic paste. An endodontic file is used to irritate the periapical tissues to induce intracanal bleeding and clot formation. It is important to avoid cleaning or shaping the

FIGURE 14. Vitapex pulpectomy in traumatized primary incisor.

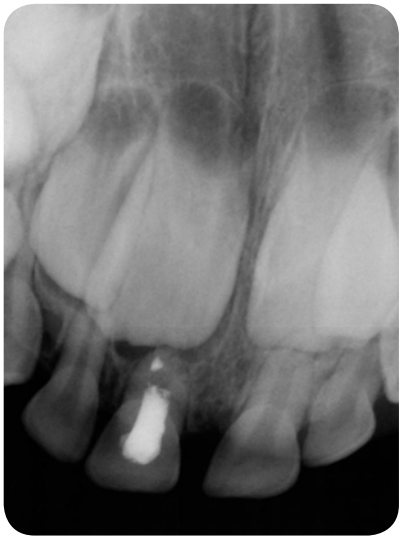

FIGURE 15. Same patient as in **FIGURE 14**, showing wash-out of Vitapex from canal and an accelerated resorptive rate of the treated tooth.

dentin in the root canals with the file. The bleeding is allowed to fill the canal up to the cervical third of the root canal. An MTA plug is placed over the blood clot up to the level of the CEJ. A layer of GIC or RRGIC can be placed over the MTA followed by the final restoration. The tooth is then monitored clinically and radiographically for root length formation, apical closure and eventual secondary radicular dentin formation. It may be 18 months before these changes are visible radiographically.

Different antibiotics have been proposed for the antibiotic paste used for this technique. Some authors have suggested minocycline, metronidazole and ciprofloxacin.[74] However, minocycline can lead to staining of the crowns.[73] For this reason, a bi-antibiotic paste or an alternative triple antibiotic paste comprising of metronidazole, ciprofloxacin and cefaclor can be used.[73] The paste can be constituted as a creamy mix by mixing with sterile saline and carried in to the canals with a lentulo spiral or a syringe. The blunt end of sterile paper points can be used to condense the paste into the canals.

In regenerative therapy, the antibiotic paste enables the establishment of an infection-free canal. The blood clot forms a scaffold for the ingrowth of progenitor cells, which are likely to arise from the apical tissue as well as cells in the blood clot. The growth factors required for the differentiation of cells into odontoblasts to lay down dentin are provided by the blood clot and the dentin wall.

Apexification

Apexification is a clinical technique for inducing apical closure of immature permanent teeth with necrotic pulps.[3] Pulp necrosis in an immature permanent tooth leaves the root short and the apex open (either a blunderbuss apex or an apex with parallel walls). Conventional endodontic technique makes it difficult, if not impossible, to obtain an apical seal. Inducing apical closure with apexification provides a barrier against which gutta-percha can be condensed. It should be reserved as the technique of last resort in an immature permanent tooth.

Apexification Technique[3]

After local anesthetic administration and rubber dam isolation, the pulp chamber should be accessed to enable visualization and instrumentation of the canal(s). The root canal(s) should be gently irrigated with 2.5% sodium hypochlorite or 0.2% chlorhexidine, so that the irrigant is not extruded beyond the apex. Minimal instrumentation with endodontic files should be performed because the dentinal walls are already thin. The canal(s) should then be dried with sterile paper points and a calcium hydroxide dressing placed in the canals. The calcium hydroxide paste can be introduced into the canals with lentulo spirals or with specially designed syringes, followed by compaction with endodontic pluggers. The pulp chamber can then be sealed with IRM. The canal(s) should be re-entered in two to four weeks to remove the previously placed calcium hydroxide, as well as any further tissue remnants denatured by the calcium hydroxide. A calcium hydroxide paste is condensed into the canals and the pulp chamber is sealed. The tooth should then be monitored clinically and radiographically at three-month intervals. When the apical barrier is seen on the radiograph, the tooth is re-entered and the old calcium hydroxide is removed. After the presence of the apical barrier is verified with an endodontic file, biomechanical preparation of the canals is completed and is followed by gutta-percha obturation. Apexification requires multiple patient appointments, extending up to a year or more, depending on the degree of apical development at the time of pulp necrosis.

An alternative to apexification with calcium hydroxide is using MTA to form an apical barrier.[3] The advantage to the apical barrier technique is the need for fewer appointments and faster obturation of the canal(s). For this technique, after securing anesthesia and rubber dam isolation, the canal(s) are accessed and thoroughly cleaned. Sodium hypochlorite (2.5%) may be used for irrigation and removal of organic matter. Sonic and ultrasonic instruments improve the debridement of the canals as well.[3] Sterile paper points should be used to dry the canals, a calcium hydroxide paste should be placed and the pulp chamber sealed. Initial placement of the calcium hydroxide changes the environment around the tooth from acidic to alkaline.[3] When the tooth is

asymptomatic, the previously placed calcium hydroxide is removed and the canal(s) are flushed and dried. A 4- to 5-mm apical plug of MTA should be placed in the apical portion of the canal(s) and compacted. The apical plug should be confirmed radiographically, and any residual MTA on the canal walls should be cleaned with paper points and cotton-tipped applicators. A wet cotton pellet should be left in the canal(s) to enable setting of the MTA and the pulp chamber access is then sealed. Once the MTA has set, the canal(s) are accessed again, and obturation with gutta-percha can be performed against the MTA plug. To increase resistance to root fracture, bonded composite resin can also be placed in the canal(s) directly over the MTA plug, without using any gutta-percha.[3] ■■■■

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Communicating With Parents and Children in the Dental Office

OARIONA LOWE, DDS

ABSTRACT Providing dental care for children can be challenging. Successful treatment is often dependent upon the effectiveness of the communication between the dentist, parent and patient. Effective communication should be developed by establishing rapport and trust during the initial visit. Few parents realize the disadvantage of the dentist who is introduced to a child who is anxious, afraid or resistant. They undoubtedly expect the dentist to provide care regardless of the child's reaction.

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For those dentists who treat children in their private practices, some important points need to be considered when providing treatment. Successful management of the child depends on the ability of the dentist to continue working with the parent and child who displays uncertainty and hesitancy about the proposed treatment plan. The dentist should approach treatment in a positive manner but should convey to the parent that the proposed work is extremely important and essential to the well-being of the child. The goal of any child's dental visit is achieving positive behavior and delivering safe, quality dental care. The most important component of any interpersonal relationship is communication. The manner in which we communicate with others determines the quality of the service we are trying to provide. This article will focus on communicating with parents and children in the dental office.

Working on kids can be difficult. Treating infants and young children has always been a challenge. Children frequently display behaviors that can make the delivery of dental care difficult and even dangerous. Many negative behaviors exhibited by children in the dental office are due to fear, anxiety and the manner in which the visit is conveyed to them. A child's visit to the dentist can be made more enjoyable if the parents foster a positive experience. It is generally agreed that the guidance of a child's behavior in the dental office is the prerequisite for completion of his/her dental care. In spite of their limited knowledge of child psychology, dentists are generally able to provide children's

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dental care at the same level of efficiency as that of adult patients. Many general dentists would be willing to treat children if they knew how to resolve their anxiety or behavior problems.

Few parents realize the disadvantage of the dentist being introduced to a child who is anxious, afraid or resistant to the initial examination. Parents undoubtedly expect the dentist to be the complete master of all situations and to provide health care services to the child regardless of the child's reaction. The dentist who limits his practice to children or the general practitioner who includes many children in his practice assumes that liking children is extremely important in managing them successfully in the dental office. While this is true to some extent, successful treatment of children is dependent on understanding their behavior. Practitioners must realize that a child's behavior can be unpredictable and they must be prepared to modify their behavior management techniques accordingly. Parents play an important and unique role in the child's oral care and overall well-being. The manner in which the parent promotes the visit to the dentist and the interaction between the dentist and the parent greatly affects the success of the appointment. Dentists who successfully guide children through dental experiences realize that children are constantly modifying their behavior. It is a fact that every child has a rhythm and a style of growth.[1] No two children have the same development or personality. The first objective in the successful management of the child is to establish communication and to make the child believe that the dentist and his team are his/her friends. This can be done by making the child and the parent aware of the importance of the dental appointment and the various procedures involved in the encounter (the classic "tell, show, do" technique). The parent is the child's first and most important teacher. Unfortunately, many parents do not view themselves as educators of their children. Parents "teach" the infant how to trust, rely on and depend on people and circumstances. Parents not only teach a son or daughter how to throw a ball, they also impart notions of sportsmanship and fair play. Parents who read to their children help foster a love of reading. Parents who take the time to explain things to their children foster language development and serve as models of a communicative style. Parents who display aggressive and temperamental outbursts in response to minor frustrations model a style of behavior and may find ready imitators in their children. In all these educational ventures, parents not only offer content, information and advice, but also transmit the values of their family and of their culture. Children as "students" may be willing, unwitting or resistant.[2]

DENTISTS WHO successfully guide children through dental experiences realize that children are constantly modifying their behavior.

The purpose of the child's initial dental examination is the exchange of information. This exchange occurs between parent and dentist, between child and parent and between dentist and child. In any social interaction, communication has two major features. One is the actual content or message and the other is the process or the manner in which content is exchanged within the relationship.[2] Even though the initial encounter or examination is the most common procedure in dentistry, the nature of the process is often poorly defined. It is recognized that preparing the child and parent prior to the first visit will result in a better experience in the dental office. The preparation begins at the time the receptionist calls to confirm the appointment with the parent. Some dentists prefer that the parents avoid preparing their child for the initial visit. It is important that the parents are told what to expect during the dental visit and what their role will be during the encounter.

Children are able to interpret nonverbal communication before they understand the meaning of words. Reciprocal communication of basic feelings and emotions between parent and child takes place through sounds, gestures and body language. Certain signals during the initial dental visit should be assessed for the effectiveness of communication. When parents do not appear assured by the diagnostic and treatment procedures, the dentist needs to look beyond hidden anxiety from unanswered questions. The dentist should make it comfortable for parents to ask "stupid" questions or for them to admit to ungrateful or angry feelings. One of the most important aspects of the initial visit is the simple collection of data, including psychosocial issues, medical history, diet, past dental history, behavior of the child during previous dental treatment, history of X-rays taken and past restorative treatment. Dentists need to find ways to assess the parent's and patient's emotional state, their typical reaction to stress, levels of self-awareness, their personal relationships and information about the demeanor of the patient (and parent) when undergoing treatment.

There are three important points that determine the success of treatment:

1. Goals — The most common deficiency during an initial examination is the failure of the dentist to clearly define the goals of the visit. "What is it that the parents want to accomplish?"
2. Time — An initial encounter with the parents and patients requires at least 30-40 minutes for a significant exchange of relevant information. This should include past dental behavior and a history of previous treatment.
3. Setting — Privacy is essential. The need for privacy is most likely overlooked with children. Treatment should be discussed with parents and children in private so they maintain their dignity and feel free to openly converse about their children's needs. If one or more of these points are lacking, the encounter almost always results in failure. Pediatric dentists are trained to recognize patterns of behavior and to adapt strategies to modify or accommodate behaviors in order to accomplish the desired treatment. Children are seen in all stages of life and they present with different moods and personality types.

Several factors are known to influence the child's behavior during the dental visit. One is the time of the appointment. The time of day at which the child is seen may influence the child's behavior. Early morning hours should be reserved for young children. Parents will usually accept bringing their children at the time suggested if it is explained that young children do better with dental treatment early in the day. The second factor is the length of the appointment. Appointments for a young, apprehensive or fearful child should be relatively short. A long appointment is considered to be 45 minutes or longer. Other factors relate to the parental state of mind or attitude toward dental care.[3]

FIGURE 1. Treatment plans should be presented in a positive manner and convey to the parent the importance of the proposed work while allowing for questions from the parent.

FIGURE 2. How patients and parents are greeted by front-office staff can set the tone for the entire office visit.

As stated earlier, parents play a key role in affecting a child's behavior. A parent who is anxious and fearful or mistrusts the dentist can influence the child's attitude and actions.[4] The key to successfully treating kids is having open communication with the parent and patient. Greeting the child is an important factor in influencing behavior. The dental team member should address the child by his/her first name and the parents should be invited into the treatment room with the child. Although many dentists may prefer to see the child alone at the initial visit, depending on the age of the child, it is often helpful if the parent accompanies the child because valuable information can be provided by the parent. The child is also more likely to cooperate for the dental team because he or she feels more comfortable and confident with the parent present.

Communication is the sharing or exchange of information and ideas.[5] The ability to connect with the child and parent verbally and nonverbally helps build a trusting relationship. Problems can arise when there is miscommunication or a lack of communication. One of the most powerful communication tools that can be used in relating to parents is asking the question, "What do you expect from the visit?"[6] Good verbal and listening skills are needed when dealing with parents and understanding what they expect from the dentist and oral health care team. Communication is often mislabeled as speaking to another. The communication process actually involves both speaking and listening. Listening is a skill that becomes a very effective part of communicating and is arguably the most effective and important tool of communication.[4]

Parents know their children better than anyone else. They have developed interactive dynamics that affect their behavior. Parenting styles play a major role in influencing the personality of children. Some of these styles have resulted in poorly developed coping skills with little or no sense of self-restraint or self-discipline.[2] Studies have shown that much of the anxiety that children experience is reflected from the parent. Effective communication from the dentist will help to downplay this anxiety.

How does effective communication take place with the parent when discussing future treatment? Different

FIGURE 3. Meeting the needs of patients and parents is a collaborative effort with staff.

FIGURE 4. Parents should be included on deciding the best method of treatment for their child.

options need to be assessed that are consistent with parental expectations. It is important to respect the thoughts and opinions of the parent. The perceived message from the dentist and the dental team will be received more clearly if it is shared in a polite and respectful manner. When discussing proposed treatment, it is important to reflect back and summarize the message of concern being communicated by the parents. This helps to validate their feelings and wishes by showing that you are engaged in the conversation. Providing nonverbal feedback like nodding the head or restating what was said not only helps to build the confidence between dentists and parents, but it also helps to communicate to the parents that you understand their wishes.[3,4] It is beneficial to ask questions to gain useful information and to clarify the message being portrayed. Treatment plans should be presented with confidence and clarity to allow for open-ended questions and answers (**FIGURE 1**). The information given must be organized and logical. Focusing on the proposed treatment and presenting it in a kind manner is critical to developing a good relationship. Further clarification about the suggested treatment should be given if needed. Messages that aren't implicitly clear can result in misunderstandings. A perceived lack of caring or effort can lead to unhappy and disappointed parents and family members.

Communication is also effective when it incorporates a collaborative effort from the dental team. Team members include the dentist, clinical staff and front office personnel. The dentist's behavior and how she or he relates with parents and patients is of utmost importance. This behavior plays a dominant role in patient and parent satisfaction. Dentist behavior that correlates to low parent satisfaction includes rushing through appointments, not taking the time to explain procedures, not allowing the parents in the examination room and being impatient. A stressful relationship and a feeling of discontent can result.[3] The receptionist and other front office personnel are integral members of the team and are usually the first contact the patient and family makes when they enter the dental office (**FIGURE 2**). The manner in which the family is greeted sets the pace of the day's visit. Communication techniques and a collaborative effort by the staff in meeting and serving the needs of the patient and their family are paramount (**FIGURE 3**).[6]

Effectively communicating with parents who are demanding represents an opportunity for the dentist to carefully review behavior guidance and treatment options. Parents who expect that their children will sit still and not cry during dental visits are not realistic. Some parents may try to dictate how treatment is delivered. The decision on the best method of treatment for the child needs to be a joint decision between the dentist and the parent (**FIGURE 4**).[3] Each practitioner has the responsibility to determine the communication and support method that best optimizes the treatment process. Some parents will request to be in the in the treatment room. This can be especially helpful for the initial visit. While there is currently no consensus regarding parental presence in the operatory during treatment, it is agreed that their presence may sometimes be effective in gaining cooperation for treatment.[7] Their presence also allows for an exchange of communication which can further promote a good relationship. The role of the parent must be clearly defined as supportive. The ultimate goal of parental presence is to minimize the child's anxiety toward dental treatment and to achieve a positive dental experience.[8]

Conclusion

Communicating with parents poses a special challenge to the dentist who treats children. It relates to the communicative behavior of the dentist, which is a major factor in patient satisfaction with both the parent and the child. Effective communication between the dentist and child requires focus from the parent. The dentist not only has to manage the child, but he or she must also communicate and develop a good relationship with the parent. Establishing rapport and trust should be attained at the first visit. Respect and confidence

is achieved when a good relationship is fostered through proper communication. Successful treatment results from understanding what parents expect from the dental visit(s) and their acceptance of future treatment. This is influenced by several variables. These include effective communication through collaborative efforts from the dentist and dental health care team, educating the parents on the proposed procedures and agreement from the parents on the method of behavior guidance with a clear understanding of the treatment to be accomplished. ■■■■

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DDS/BROKER

ASK THE BROKER

Why are some practice transitions better than others?

I recently experienced a practice transition that I could easily use as a case study of what NOT to do during a practice transition: firing most of the staff, discontinuing immediate use of the seller's name on the door, webpage, advertising or phone service and basically changing everything in the practice for whatever reason, based on the buyer assuming "they could do it better". Our standard advice to any buyer is to "ride the bike around the block" for a while before making any drastic changes. Most of us know that the "practice" of dentistry is about relationships with the staff as well as with the patients. These relationships foster trust and doctors who are capable of building trust quickly with their patients tend to have more successful practices. A new dentist in any practice must first concentrate on the staff relationships and the patient relationships will follow.

The new dentist may present EVERYTHING correctly during the first visit with a patient, but may overlook the fact that the patient will ALWAYS ask a staff member what they think of the new dentist. Of course this exchange usually occurs when the dentist isn't in the room. The point here is that even if staff changes or salary changes are inevitable, the new buyer needs to understand that this needs to be handled appropriately. Necessary changes should be done gradually, without making abrupt, sweeping changes from the very start.

"Trust builders" may not necessarily be the best clinical dentists. Obviously, dentists who possess outstanding clinical skills, communication skills and management skills will run the most profitable practices. However, the most important attribute that will usually define success is the ability to relate to people. Building trust will usually trump clinical skills as patients usually cannot judge the quality of dentistry they receive. Rightfully, our dental schools are geared toward producing dentists with a measurable clinical skill set, but may leave the interpersonal lessons to be learned at the "school of hard knocks."

The truth is that some dental students inherently will be better at interpersonal skills than others. After being subjected to four years of judgment based solely on their clinical skills, they are thrown into a world that will judge them mostly on their interpersonal skills. For buyers, hiring the best dental attorney and best dental accountant is certainly good advice, but it will not guarantee success as much as treating people right!

Timothy G. Giroux, DDS is currently the Owner & Broker at **Western Practice Sales (westernpracticesales.com)** and a member of the nationally recognized dental organization, ADS Transitions. You may contact ***Dr Giroux at*: wps@succeed.net or 800.641.4179**

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Sedation of the Pediatric Patient

DAVID L. ROTHMAN, DDS

ABSTRACT Children's behavior during dental treatment is often unpredictable. Many techniques for behavior management have been developed and include both pharmacologic and nonpharmacologic methods. Pharmacologic management with sedation has been shown to be an important adjunct in treating the fearful, uncooperative or precommunicative patient. This article reviews the definitions, levels, techniques and pharmacology of typical drugs used for sedation. The protocols for safe management of children before, during and after sedation are also discussed.

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Conflict of Interest Disclosure: None reported.

Sedation and pain management for dental or medical procedures has roots that extend back thousands of years. As long ago as 9000 BCE, the Sumerians used fermented beverages for both sedation and religious rituals.[1] In 1799, Sir Humphry Davy demonstrated the use of nitrous oxide in obstetrics. A German chemist, Justus von Liebug, synthesized chloral hydrate in 1832. Chloroform was used in 1847 by Sir James Young Simpson and his colleagues for surgeries, especially amputations, which often proved fatal. In 1845, after successfully using nitrous oxide in his private practice for more than a year, Horace Wells demonstrated the use of nitrous oxide for pain control during extractions to the Massachusetts General Hospital faculty, which is considered the basis of dental procedural sedation today. The famous rivalry between Wells and his student, William T.G. Morton, who demonstrated the use of ether in 1846, is well known. "Sleeping pills," or barbiturates, have their origins in the 1860s with the discovery of barbituric acid by Adolf von Baeyer. Derivatives of barbituric acid became the basis of sedation in the early 20th century. Their poor margin of safety, addictive nature and unpleasant side effects led to the exploration for better sedatives such as the sedative hypnotics, which includes the benzodiazepines.[2] The antihistamine diphenhydramine was first approved for use by the FDA in 1946 followed by promethazine in 1951, although it has since received a "black box warning" for children age 2 and under. Diazepam, the progenitor of all benzodiazepines, was introduced in 1965.

The use of sedation in combination with classical nonpharmacologic behavior management is an important adjunct in the treatment of anxious children or those who need extensive treatment. Referencing the American Academy of Pediatric Dentistry (AAPD) Clinical Guidelines — "Behavior Guidance for the Pediatric Dental Patient,"[3] "Use of Nitrous

TABLE 1

Levels of Sedation[5,8]

Intended Level	Responsiveness	Airway	Spontaneous Ventilation	Cardiovascular
Minimal Sedation	Normal response to verbal stimulation	Unaffected	Unaffected	Unaffected
Moderate Sedation	Purposeful response to verbal and tactile stimulation	No intervention required	Adequate	Maintained without intervention
Deep Sedation	Purposeful response after repeated or painful stimuli	May require assistance	May be impaired	Maintained without intervention
General Anesthesia	Cannot arouse, even with painful stimuli	Intervention often required	Frequently inadequate	Could be impaired

Oxide for Pediatric Dental Patients"[4] and "Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures"[5] — helps the doctor select a behavior management technique or combination of techniques that are appropriate for children. It is important to note that the use of any form of sedation does not supplant nor negate the concurrent use of nonpharmacologic behavior management. It is recommended that clinicians use the lightest possible level of sedation necessary to maintain the patient's vital protective reflexes.[5] Though not discussed in this paper, the administration of local anesthesia to alleviate procedural pain is the most important pharmacologic adjunct in achieving a successful sedation experience. When sedating a child, it is recommended to decrease the total amount of local anesthetic because of the potential for a synergistic effect of the multiple drugs leading to increased levels of sedation.[6]

Definition of Sedation

Pediatric and adult sedation is defined by a continuum of levels as recognized by the American Society of Anesthesiologists (ASA), American Academy of Pediatrics (AAP), American Dental Association (ADA) and AAPD (TABLE 1). Permitting and licensure in many states follows these levels because it is understood that sedation level risk is a factor of the drug, depth of sedation and stimulation rather than the route by which it is administered. The Dental Board of California defines both the level and route of administration when permitting or licensing, using the term "conscious sedation," which has appeared in prior versions of the ADA and AAPD *Guideline for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures* on the use of conscious sedation. The AAPD, in conjunction with the AAP and the ASA, developed and accepted new guidelines in 2006. In 2007, the ADA deferred to the AAPD guidelines for children age 12 and under. Available permits in California (dbc.ca.gov/licensees/dds/permits_index.shtml) include:

Oral Conscious Sedation for Minor Patients: allows "a minimally depressed level of consciousness produced by oral medication that retains the patient's ability to maintain independently and continuously an airway, and respond appropriately to physical stimulation or verbal command." This permit applies to patients both younger than 13 and older.

Oral Conscious Sedation: allows "a minimally depressed level of consciousness produced by oral medication that retains the patient's ability to maintain independently and continuously an airway, and respond appropriately to physical stimulation or verbal command. Oral conscious sedation does not include dosages less than or equal to the single maximum recommended dose that can be prescribed for home use." This permit is for patients age 13 or older.

Conscious Sedation: allows "a minimally depressed level of consciousness produced by a pharmacologic or nonpharmacologic method, or a combination thereof, that retains the patient's ability to maintain independently and continuously an airway, and respond appropriately to physical stimulation or verbal command. Conscious sedation does not include the administration of oral medications or the administration of a mixture of nitrous oxide and oxygen, whether administered alone or in combination with each other"[7] (see TABLE 1).

Levels of Sedation

In determining the type and level of sedation, it is important to assess the developmental stage of the child. Developmental stages can be divided into predetermined physical, behavioral and cognitive skill sets (Piaget and others) or by the precommunicative/communicative division. Precommunicative is understood as being younger than age 3 and unable to partially or fully comprehend the procedure. This child is more likely to require deeper levels of sedation to achieve the desired results because the combination of nonpharmacologic and

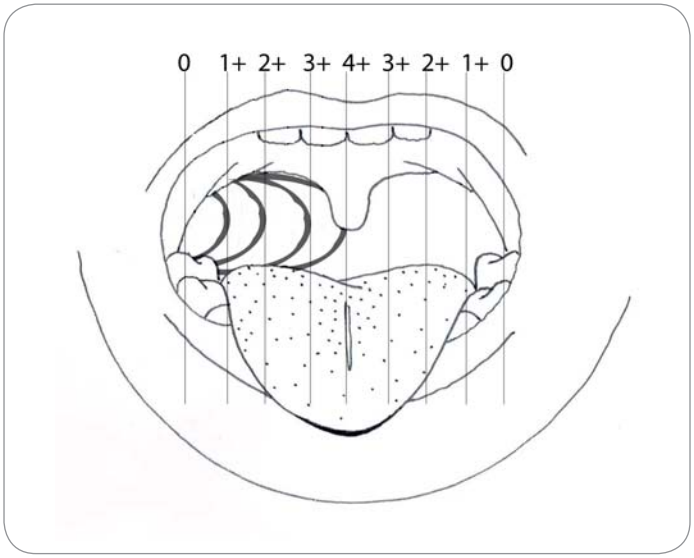

FIGURE 1. Brodsky Classification.[22]

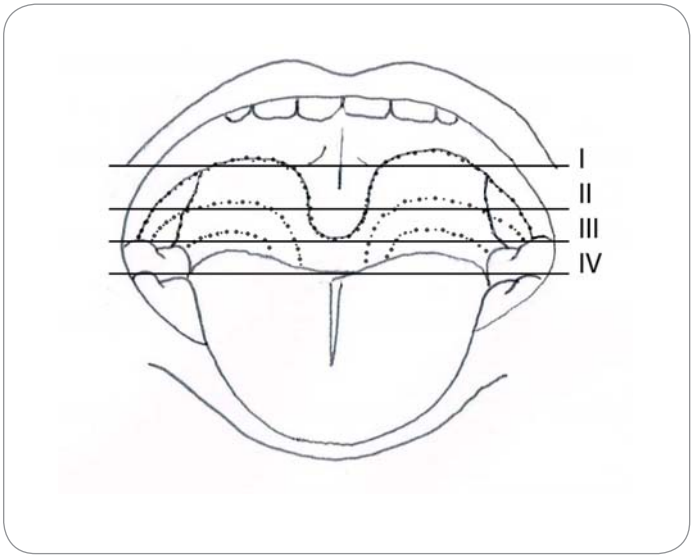

FIGURE 2. Mallampati Classification.[23]

pharmacologic modalities is unlikely to result in a more cooperative patient. Communicative is defined as the ability to partially or fully comprehend what is going on and this patient would benefit from a combination of pharmacologic and nonpharmacologic intervention. Practitioners tend to use larger doses of sedative medications because of metabolism and behavioral issues in the younger patient; however, the risk rises exponentially because of the potential loss of airway and protective reflexes.[9,10]

Pediatric dentists report a 30–70 percent success rate using all forms of sedation, although the definition of success varies amongst clinicians. Because children react differently to medications than adults, outcome predictability is never guaranteed and children cannot be expected to demonstrate a predictable pattern of behavior. Sedated children often show the signs of sleep deprivation, which can include increased activity levels, crying and inability to respond to commands.

Dentists performing sedation must be well trained in both sedation and emergency medical care and be prepared to rescue or manage the patient in the event of respiratory distress, cardiac failure or deeper levels of sedation until emergency care arrives. It is mandatory to have the appropriate medical equipment to deliver emergency care, and the doctor and staff members must regularly practice the skills necessary for rescue.[5,10,11] Factors that affect the risk of an adverse outcome include the level of training of the practitioner, the age of the patient, the choice of sedative medications, the type of monitoring, the ability to recognize deviations from normal and, for those in private practice, the distance from a primary or secondary medical care facility.[10,11]

Questions regarding the long-term effects of general anesthesia on the brains of developing children and potential future cognitive deficits were raised in a number of studies.[12-15] Rappaport et al.[16] reported the findings of a collaborative review effort which concluded that when a single anesthetic is administered in a healthy child, risk of cognitive deficit is minimal. Discussions with parents or caregivers are necessary about the risks and benefits of having or not having a procedure involving sedation or general anesthesia and doctors must stay informed of new developments in the discipline and recognize that anesthetics and sedatives are necessary for infants and children who require surgery or painful and stressful procedures.

All medications given for sedation in children 12 years old and under should be administered in the office under the direct supervision of the doctor or trained individual. Vital signs and sedation levels should be monitored and recorded preoperatively, intraoperatively and postoperatively in a time-based record with specific interval entries. Monitoring is useful in assessing the levels of sedation and pain control as well as the patient's cardiovascular and respiratory systems. Monitoring includes visual cues such as chest excursions and effort, mucosal coloring and skin turgor. Electronic and mechanical monitors include pulse oximetry to measure oxygen saturation of the blood, blood pressure monitors, electrocardiography and capnography to record expired carbon dioxide. Recommended monitors for specific intended sedation levels can be found in the AAPD guidelines, but state regulations dictate which monitors must be used for specific procedures, routes of administration and sedation levels. The reader is referred to the Dental Board of California[15] for appropriate state regulations. In California,

TABLE 2

American Society of Anesthesiologists Patient Physical Status Classification[25]

ASA Status	Preoperative Health Status	Organ System Status
ASA 1	Normal, healthy patient	All organ systems intact and functioning
ASA 2	Patient with mild systemic disease	No functional limitations Has well-controlled disease of one body system *Update medical history and crosscheck for drug interactions*
ASA 3	Patient with severe systemic disease	Some functional limitation Has controlled disease of more than one body system or major organ No immediate danger of death *Physician consult required*
ASA 4	Patient with severe systemic disease that is a constant threat to life	Has at least one severe disease that is poorly controlled or at end stage *Physician consult required, laboratory tests*
ASA 5	Patient not expected to survive >24 hours without surgical intervention	Multi-organ and system failure
ASA 6	Patient declared brain dead	Maintenance for organ harvesting
E	Emergency operation of any variety (used to modify one of the above classifications)	

the use of nitrous oxide/oxygen inhalation sedation in conjunction with local anesthesia does not require the use of monitors other than visual recognition of patient status. For all sedation, it is recommended that supplemental oxygen be administered to increase the margin of safety in the event of respiratory depression. With supplemental oxygen levels above the ambient level of 21 percent, the failure of pulse oximetry to recognize a drop in oxygen saturation may be prolonged.[20]

Recovery must occur in a facility or area supervised by trained personnel with appropriate monitoring and rescue equipment, including positive pressure oxygen. Discharge is determined by the patient's return to baseline vital signs and the ability to maintain protective reflexes (such as keeping the head erect) and respond to commands.[5,10] Children must be accompanied by at least one responsible adult who will be able to observe and stimulate the child during his or her entire trip home to help prevent resedation.[16,17] Children must be secured in a protective restraining device appropriate for the age group as specified by the California Department of Motor Vehicles[18] and should never be transported in an accompanying adult's lap.[19] The components of the discharge instructions should include the name of practitioner, a 24-hour emergency contact number, the contact number of emergency services and diet and pain control instructions. The clinician may opt to include the drugs and doses used for the procedure (including local anesthesia). These instructions must be reviewed verbally with the responsible adult and it is recommended that a follow-up phone call to check on the child be made shortly after the patient's discharge.[16,17]

A child's response to a specific drug and dose is often unpredictable. Children and adults may be hypo-responders who show less than an anticipated level of sedation or hyper-responders who achieve a deeper level of sedation than anticipated. The office and the practitioner must be prepared to maintain and potentially rescue the patient who slips into a deeper level of sedation. This may include stopping the dental procedure and observing/supporting the patient or administering reversal medications.

Evaluation of the Child for Sedation

The determination of whether sedation is appropriate for a child is based upon multiple factors:

1. The clinician must evaluate the severity of the disease and the complexity of the treatment.
2. The patient's age, developmental stage and anticipated cooperation will help determine the time necessary for the procedure and the number of visits.
3. The cost of single versus multiple procedures must also be considered. However, it is debatable whether time off from work for the parents or school for the child should be a mediating factor in the decision to use pharmacologic behavior management techniques.
4. It should be decided whether the treatment can be postponed or if a less invasive procedure may be performed to allow the child to mature and be more prepared to accept treatment. These preventive interventions include the use of multiple visits to apply fluoride varnish while educating the parent on better home oral health

TABLE 3

Fasting Guidelines for Elective Sedation[5]

Food	Time (hours)
Clear liquids	2
Breast milk	4
Formula, non-human milk	6
Light meal	6

care or placing glass ionomer or other similar dental materials. These intermediate therapeutic restorations are recognized by the World Health Organization as an acceptable treatment modality.[21]

5. It is critical to thoroughly review the patient's medical history with the parents to determine if the child is suitable for sedation. Frequent or recent upper respiratory infections will mean a delay of at least six weeks while the lung parenchyma heals. If there is a history of cardiovascular problems, a medical consultation from the child's pediatrician may help sort out significant findings. A family history of adverse sedation or anesthetic incidents is important to help decide your choice of procedures and medications. No discussion of sedation is complete without a warning about sleep disordered breathing, sleep apnea and sleep hypopnea, which may lead to respiratory complications such as obstruction and CO_2 retention. Any history of difficult and noisy breathing at night, snoring, frequent awakening, night sweats, night terrors, enuresis and ADD/ADHD-type behaviors are a red flag and warrants a referral to an otolaryngologist for an evaluation prior to proceeding with sedation.

The physical examination should include the vital parameters of heart rate and rhythm, blood pressure, oxygen saturation and weight, in addition to a standard head and neck exam. The Brodsky[22] and Mallampati[23] classifications of oropharyngeal and tonsillar size (**FIGURES 1 AND 2**) are important because they help determine the risk of obstruction during sedation.[24]

The American Society of Anesthesiologists has developed a risk-based scale for categorizing the medical status of patients (**TABLE 2**). Practitioners should only consider in-office sedation for ASA 1 and well-controlled ASA 2 patients.

The dental examination, though potentially difficult to perform if the child is uncooperative, must be done to give the practitioner an idea of the severity and complexity of treatment. A full discussion of the risks of treatment, options for treatment (including no treatment) and the benefits of completing treatment must be done and should be specific to the anticipated level of sedation. Verbal and signed confirmation must be received and recorded in the chart. Written instructions including NPO status, pre- and post-sedation instructions and 24-hour contact numbers must be provided and reviewed both at the screening and sedation visits. Forms should be customized for your office and practice and may include the drug or drugs used in case of emergency. Regardless of the level of sedation, fasting prior to the procedure is believed to be important in preventing aspiration of stomach contents in the event of regurgitation, but there are few studies that document aspiration risk in the sedated patient. Recent articles in the pediatric emergency literature show that sedated children do not have an increased risk of aspiration with a full or partially full stomach in an emergency facility,[26-28] but it is still recommended that the practitioner comply with the guidelines for fasting developed for the patient undergoing general anesthesia.[5] The recommended fasting times are outlined in **TABLE 3**.

Contraindications to Sedation

The following are some contraindications to sedation:

- Sensitivity or allergy to sedation drugs or drug combinations.
- Patients who are ASA 3 and above.
- Patients with special needs who may have problems maintaining cardiovascular or respiratory systems.
- Patients who may lack understanding or the ability to respond appropriately.
- Patients with anatomic airway abnormalities, extreme tonsillar hypertrophy or obesity who may have difficulty maintaining an airway during sedation.
- Patients who pose a risk to the safety or health of staff members.
- Patients who would have difficulty recovering safely and comfortably in the facility.
- Patients for whom resuscitation and transport would be difficult in the event of an emergency.

Drugs, Pharmacology and Metabolism

The drug categories commonly used in pediatric sedation include the benzodiazepines, the antihistamines, the opioids and nitrous oxide/oxygen inhalation. Other drugs falling out of favor because of the higher incidence of adverse effects include the sedative hypnotics chloral hydrate and promethazine. Drugs used for adult sedation may not be appropriate for pediatric sedation because of lack of clinical studies, FDA approval or inadequate dosage formulations to allow weight-based dosing in pediatric patients (**TABLE 4**). These include Triazolam and the nonbenzodiazepine gamma amino butyric acid (GABA) agonists Zaleplon and Zolpidem. Combinations of the drugs allow the practitioner to decrease dosages of the individual drugs and minimize adverse effects.[10]

TABLE 4

Drugs Commonly Used for Pediatric Oral Sedation

Drug	Proprietary Name	Route	Class (Action)	Dose (PO) mg/kg	Onset (PO) (min)	Working Time (PO) (min)	Half Life (PO) (hr)	Comments
Hydroxyzine	Vistaril, Atarax	PO	Antihistamine (H1 blocker)	1–2	30-45	30–45	2	Antiemetic Anxiolysis
Diphenhydramine	Benadryl	PO	Antihistamine (H1 blocker)	1–2	5-30	30–45	4–7	Antimuscarinic Antihistaminic Antiemetic Anxiolysis Emergency drug for anaphylaxis
Promethazine	Phenargan	PO	Anthistamine (H1 blocker)	0.5–1	15-30	60	2–8	Antiemetic Anxiolysis Antihistaminic Phenothiazine Black box warning for children ⩽ 2 Respiratory depression Extrapyramidal effects
Midazolam	Versed	PO	Benzodiazepine	0.3 –0.75	10–20	30-45	1.7–2.4+	Muscle relaxant Amnesia Anticonvulsant Best delivered in acidic base to improve uptake in ionized form Syrup or injectable form No active metabolite Inconsolable crying Dysphoria Respiratory depressant (high levels)
Diazepam	Valium	PO	Benzodiazepine	0.25–0.5	45-60	60	20-40+ (bi-phasic due to metab-olite action)	CNS depression with minimal cardiovascular or respiratory effect Amnesia Muscle relaxant Anticonvulsant Active metabolites with long half lives (desmethyldiazepam, oxazepam)
Lorazepam	Ativan	PO	Benzodiazepine	0.05	30-60	60	14–16	Limited pediatric data Half life shorter than diazepam but longer sedative effect because of lower lipid solubility
Meperidine	Demerol	PO	Narcotic	1–2	30-45	30-45	2	Cardiovascular and respiratory effects Lowers seizure threshold
Chloral Hydrate	Noctec	PO	Sedative Hypnotic	25	30–60	60	4–6	No longer available as suspension Significant risk for cardiovascular event by sensitizing myocardium to circulating catecholamines (epinephrine) Active metabolite: trichloroethanol Not an FDA approved drug Gastric irritant May cause respiratory and cardio-vascular depression at doses > 25mg/kg

Referenced to and modified from: Banks, D, Bernard, P, Cravero, J, et al. Sedation Provider Course Syllabus, The Society for Pediatric Anesthesia,2010; Pediatric Sedation for Diagnostic and Therapeutic Procedures. University of VA Children's Hospital. 2009; Pediatric Moderate Sedation. Illinois Emergency Medical Services for Children, 2008; Primosch, R, Kosinski, R, Wilson, S. Oral Sedative Agents,. Contemporary Sedation, AAPD course, 2011.

Benzodiazepines are the most commonly used oral agents for sedating children. They have a wide margin of safety that is mostly attributable to their mode of action. Benzodiazepines have the following properties: sedative/hypnotic, muscle relaxant, anxiolytic, amnesic and anticonvulsant. Flumazenil, a benzodiazepine receptor antagonist, reverses the benzodiazepines but may have a shorter half-life than the drug it is reversing (i.e., midazolam) and also lowers the seizure threshold.

Antihistamines are primarily used in the treatment of allergic reactions. However, they can be used as sedative-hypnotics because of their sedative effects. Additional benefits include antinausea, antisialogogue and antiemetic properties. They are not reversible.

Opioids are naturally occurring, synthetic and semisynthetic. Although their primary use is to decrease pain and anxiety, they can cause dose-related sedation. Adverse effects include depression of the respiratory and cardiovascular systems and unconsciousness. Naloxone, a competitive antagonist, reverses the opioids but may have a half-life shorter than the drug it is reversing.

For safe sedation, it is important to remember that when using multiple drugs in a combination technique, the quantity of each drug should be reduced because of the additive and synergistic effects of the drugs.[6]

The site of activity for most sedative agents is the reticular activating system (RAS), a cluster of cells in the cerebral cortex, basal ganglia, limbic system and cerebrum. The RAS controls the state of consciousness, cardiovascular control and respiratory and vomiting centers. In general, drugs used for sedation are in the GABA or n-methyl d-aspartate (NMDA) categories. The GABA system drugs either increase the amount of GABA remaining at a neuron after activation of the $GABA_A$ sites or prevent its metabolic breakdown or reuptake both of which add to the concentration of GABA at the neuronal junction. GABA is an inhibitory neurotransmitter, which opens the chloride channels within the cell membrane of the neurons preventing neural excitation resulting in muscle relaxation, anxiolysis and additionally anticonvulsant effects. The drugs work at the $GABA_A$ subtype of the GABA receptors that activate the benzodiazepine receptor site to enhance the chloride ion channel response to GABA when it is present. Nitrous oxide and the benzodiazepines affect the GABA system. It is believed that the benzodiazepines are able to achieve their relative level of safety because they do not act directly on GABA sites, instead only potentiating and enhancing the ability of GABA to open chloride channels. Alcohols, barbiturates and propofol have specific sites on $GABA_A$, which open the chloride channel independently of GABA.[17,29]

THE NARCOTICS DISRUPT both REM and non-REM sleep and bring about dose-dependent respiratory depression by acting on the pons and the medulla.

The NMDA system controls the transfer of electrical signals between neurons through Ca^{2+} movement intracellularly and is modulated by glutamate and glycine. Ketamine, nitrous oxide and the synthetic opioids work as either competitive antagonists or noncompetitive agonists to NMDA, glycine antagonists or as Ca^{2+} channel blockers, thus preventing transfer of electrical impulses between neurons. This class of sedative agents causes dissociative anesthesia marked by catalepsy, amnesia and analgesia.[2]

Synthetic, semisynthetic and natural narcotics work on the body's opioid receptors by inhibiting the release of excitatory neurotransmitters from the primary afferents of the spinal cord and by directly inhibiting dorsal horn pain transmission neurons of the spinal cord. The opioid receptors are a component of an inherent pathway, which blocks afferent pain transmission by blocking the release of substance P factor. Because pain consists of both sensory and affective (emotional) components, narcotics can also increase the pain threshold through euphoria by relieving anxiety and bringing on sedation and amnesia. The narcotics disrupt both REM and non-REM sleep and bring about dose-dependent respiratory depression by acting on the pons and the medulla.

Nitrous oxide has multiple modes of action in the central nervous system. It exhibits action on both the $GABA_A$ and NMDA receptor[30] and stimulates the release of endogenous endorphins that act directly on the opioid receptor[31] to provide analgesia. An excellent discussion of the use of nitrous oxide/oxygen analgesia is available in the *AAPD Clinical Guidelines* on the "Use of Nitrous Oxide for Pediatric Dental Patients."[4]

Drugs may be initially metabolized in the intestines and then transported to the liver by the cytochrome p450 family of superenzymes, a mixed-function oxidase system responsible for the synthesis of cholesterol and lipids. It is important to note that individuals

TABLE 5

Reversal Agents

Drug	Proprietary	Route	Class (Action)	Dose	Onset/Duration (minutes)
Flumazenil	Romazicon	IM, IV	Benzodiazepine reversal	0.01 mg/kg (First dose: 0.2 mg)	1-3 minutes/<60min Repeat doses to max 1mg
Naloxone	Narcan	IM, IV	Narcotic reversal for overdose	< 5 year– 0.1 mg/kg >5 year– 2.0 mg	<2min/20-60min q 2–3 minutes to max 5mg q 2–3 minutes to max 10mg

References: www.reference.medscape.com/drug/narcan-naloxone-343741; www.reference.medscape.com/drug/romazicon-flumazenil-343731; Banks, D, Bernard, P, Cravero, J, et al. Sedation Provider Course Syllabus, The Society for Pediatric Anesthesia, 2010.

TABLE 6

Absorption Rates by Route

Route of Administration	Absorption Time (minutes)
Intravenous	1
Inhalation	1 to 3
Sublingual	3 to 5
Intranasal	5 to 10
Subcutaneous	10 to 30
Intramuscular	10 to 30
Enteral (oral)	20 to 60

have variable enzyme expression that can lead to inconsistent drug sensitivity between patients. CYP3A4 is responsible for the metabolism of more than 50 percent of drugs, including the amide anesthetics and the benzodiazepines. Alcohol dehydrogenase, also found in the liver, breaks down alcohol-based drugs, such as chloral hydrate. Other drugs, such as ester anesthetics and synthetic opioids, may be broken down in the bloodstream by pseudocholinesterases and nonspecific tissue esterases.

Metabolized drugs can go through either deactivation or bioactivation. They either pass through the blood stream bound to plasma proteins or as a free compound in equilibrium prior to reaching the target organ. From there, they are carried to the kidneys for excretion. Impaired liver or renal function may prolong active drug metabolites (TABLE 5).

Routes of Administration

There are multiple routes of administration in pediatric sedation, each with specific onset and duration of action, indications and contraindications. Each state's licensure or permitting process determines the route of administration and the level of sedation. Many drugs are capable of all levels of sedation and are dose, not route, dependent (TABLE 6).

Inhalation

The inhalation route, specifically utilizing nitrous oxide/oxygen analgesia, yields the most consistent results and is the easiest to learn. It is the second most frequent type of sedation.[32] Dentistry uses an open nitrous oxide/oxygen system, which increases safety,[33] lowers the risk of hypoxia, helps block dental smells and the sight of dental instruments and requires no mechanical or electrical monitoring in California. Some negative factors include the initial cost of equipment, ongoing maintenance costs, the cost and storage of the nitrous oxide and oxygen tanks, increased risk of nausea and vomiting and environmental concerns with the exhaled and scavenged gases.[34,35]

Oral (PO)

The oral route is frequently used in pediatric patients. The benefits include the low cost, ease of administration and the relative safety because the slow drug uptake and first-pass effect limits the maximum effectiveness. Problems with this route include the inability to titrate or control the length of the sedation, occasional gastric upset, lack of an oral reversal agent, extended drug half-life and slow drug uptake because of delayed gastric emptying and pH incompatibility. Additional problems include the extended office time waiting for the onset of the drug and the postsedation recovery time prior to discharge and the increased costs and training necessary for monitoring.

Intravenous (IV)

The IV route provides the most reliable and consistent sedation. The IV line allows for a titratable and rapid sedation, which can be adjusted for the patient's level of pain and anxiety control. In the case of an emergency, the intravenous route provides a portal for rapid administration of emergency and rescue drugs. The factors that limit use are the need for advanced training, cost of supplies and equipment, advanced monitoring, potential venipuncture complications and difficulty with needle-phobic patients.

Intramuscular (IM)

The IM route offers the benefits of speed and ease of administration, reliable outcomes and the ability to potentially titrate doses. The negatives to IM sedation are muscle pain, potential nerve damage, difficult titration, defined sedation length with reinjection for additional sedation time and needle phobia.

Transdermal (TD)

The transdermal route is more commonly used in fields other than dental sedation and with drugs specially formulated for passage through skin either by increasing the blood flow or permeability of an area. The benefits of this route are that it is nonthreatening, easy to apply with little training, has few complications and is long acting; whereas, the negatives include inconsistent results and slow uptake.

Submucosal (SM)

The submucosal route has been used in pediatric dentistry for the administration of narcotic sedatives, analgesics and emergency medications. All dentists are trained in this route and the drug uptake profile mirrors that of the intravenous route. When used for sedation, this route is not allowed in California without a conscious sedation permit. The contraindications include pain in the injection area, unintentional intravascular access and interference with sedative uptake if the sedative medication is administered in the same quadrant as a local anesthetic with epinephrine.

Intranasal (IN)

The intranasal route is increasing in popularity in pediatric sedation.[36] It can either be used for anxiolysis to help the practitioner gain intravenous access or for very short procedures. It provides rapid onset, is inexpensive and has both oral and mucosal uptake. The negative factors are that it is an invasive and noxious technique, has variable uptake in nonpatent nares, may cause nosebleeds and can have an offensive taste. It is a parenteral technique and drug uptake mimics that of other parenteral routes.

Conclusion

Safe and effective sedation in the uncooperative or fearful child is an important adjunct in behavior management during dental procedures in young, fearful and uncooperative children. Protocols for its use and an understanding of sedation pharmacology and pediatric physiology are important for a successful outcome. It is vital to review and respect the established sedation guidelines as well as the state laws that regulate the practice of sedation in the dental office. ■■■■

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Management of Premature Primary Tooth Loss in the Child Patient

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ABSTRACT Premature loss of primary teeth can result in a loss of arch length and have a negative effect on occlusion and alignment, often increasing the need for orthodontic treatment. Use of space maintainers can reduce the severity of problems such as crowding, ectopic eruption, tooth impaction and poor molar relationship. This article presents a review of the consequences of premature tooth loss and discusses the appliances commonly used for space maintenance.

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The development of the primary dentition and the transition to the permanent dentition has a fairly predictable pattern in the typical child. The primary dentition of most children has interdental spacing throughout both arches. A smaller proportion of children have no interdental spacing, increasing the probability and severity of crowding in the permanent dentition. Prior to the eruption of the permanent first molars, the primary molars in children with spacing begin to develop interdental contacts, decreasing the space available in the arch. When the permanent incisors erupt, many children will exhibit transitional crowding because of the larger size of the permanent incisors (incisor liability). Some of this crowding can be resolved with the exfoliation of the primary molars, as the primary molars are larger than the permanent premolars (leeway space). Primary molar exfoliation can also result in the late mesial shift of permanent first molars, which can improve the molar relation of the average child from end-on toward Class I. Deviations from this typical pattern can have a negative effect on occlusion and alignment.

A major cause of deviation is premature loss of primary teeth, which can result from dental caries, infection, trauma or crowding. Premature tooth loss can increase the need for orthodontic treatment, making it very important to intervene in the event of extraction or premature exfoliation.[1,2] Use of space maintainers can counteract the effects of early tooth loss and reduce the severity of negative outcomes such as crowding, ectopic eruption, tooth impaction and poor molar relationship.[3]

Early loss of teeth in the primary dentition has different consequences depending on which teeth are lost and the child's existing alignment and occlusion. Potential consequences must be considered during the assessment of orthodontic problems to determine whether space maintenance is required and what type of space maintainer would be most appropriate.

Incisors

Premature loss of primary incisors is much more common in the maxilla than in the mandible. This loss is usually because of severe early childhood caries where multiple teeth are affected. One or more incisors may also be lost as a result of trauma. Space loss is usually minimal unless the tooth or teeth are lost at a very young age or if there is crowding, excess overjet or deep overbite.[4] Functionally, early loss of maxillary incisors has minimal impact on mastication, although incisive function is compromised.[5] If the child has not yet developed lingual-dental sounds, speech may be affected and an appliance may be indicated.[5] In most instances, space maintenance is not required. If multiple teeth are lost early, an appliance replacing these teeth may be offered for esthetic concerns.[4,5] Appropriate appliances for this type of tooth loss include bilateral fixed or removable appliances. Specific appliances will be discussed later in this article.

Canines

When a canine is lost prematurely, it is usually because of severe crowding in the incisor region with ectopic eruption of the permanent lateral incisors accelerating the resorption of one or both primary canine roots.[4] This can occur in both the mandibular and maxillary arches. Unilateral loss of a primary canine is usually accompanied by a shift of the incisors toward the affected side and a resultant midline discrepancy.[4] Bilateral loss reduces the lateral shifting, but can result in lingual tipping of mandibular incisors and a decrease in the space available in the arch.[6] Fortunately, early loss of canines rarely results in space loss in the posterior region.[1] An appropriate appliance for primary mandibular canine loss is a lower lingual holding arch. The appliance can be designed to include soldered spurs to resist distal migration of the incisors.[4]

First Molars

Primary first molars are commonly lost because of caries or infection — both unilaterally and bilaterally. The literature is controversial regarding the effects of early loss of primary first molars. Most studies report space loss within the first four to six months after extraction,[7,8] with migration of the primary canines and permanent incisors toward the edentulous space in both arches.[4,7,9,10] Some studies report minor mesial movement of maxillary primary second molars.[7,8] Space loss can result in blocked out permanent canines, more commonly occurring in the maxilla.[11] Other studies suggest that there is no statistically significant loss in arch width, length and perimeter following loss of the primary first molars.[7,8,10] Overall, reports suggest that patients in the full primary dentition[12] and those in the mixed dentition with good intercuspation of permanent molars are less susceptible to space loss.[8] Therefore, some authors question the need for space maintenance following early loss of primary first molars under these circumstances.[7,8,10] However, space maintenance is generally considered to be important for children during the mixed dentition stage.[12] An appropriate appliance for isolated loss of the primary first molar is the band and loop. In the event of loss of multiple teeth, fixed bilateral space maintainers or removable appliances may be considered.

Second Molars

Early loss of primary second molars is less controversial. There is a high probability of space loss, with a greater loss of arch length in the maxilla than in the mandible.[4] The effects are far worse when tooth loss occurs prior to the eruption of the permanent first molar, whose eruption into the oral cavity is guided by the distal surface of the primary second molars. Premature loss of primary second molars clearly requires space maintenance. If tooth loss occurs after the permanent molar erupts, a bilateral fixed appliance is the most appropriate, although a reverse band and loop may be appropriate. Prior to eruption of the permanent molar, a distal shoe or a removable appliance can be considered. In the event of multiple teeth lost, bilateral fixed appliances or removable appliances are appropriate options.

Space Maintenance Options

Space maintainers can be classified into three categories, described below along with indications and potential complications. An orthodontic assessment should be completed prior to determination of the most applicable appliance, as malocclusion and degree of crowding influence the success and appropriateness of space

FIGURE 1. Band and loop appliance to hold space for extracted mandibular right primary second molar. The band is cemented to the permanent first molar with the loop contacting the primary first molar.

FIGURE 2. Reverse band and loop appliance to hold space for extracted mandibular left primary second molar. In this case, the loop has been soldered directly to the stainless steel crown for the primary first molar with the loop extending distally to contact the mesial surface of the permanent first molar. As an alternative, the loop could be soldered to a band that would be cemented over the stainless steel crown.

FIGURE 3. Band and half loop appliance to hold space for extracted mandibular left primary first molar. The band is cemented to the primary second molar with the abutment contacting the primary canine. The bands are premade with wire soldered to the lingual surface. After the correct size band is selected, the wire is bent and the appliance can be delivered on the same appointment during which the band is fitted.

maintenance efforts. Some cases of early tooth loss may be better served with an immediate orthodontic referral for space regaining efforts or to address problems with occlusion.

Fixed Unilateral Space Maintainers

The band and loop is one of the most commonly used space maintainers. In its traditional design, it consists of a band around one of the teeth adjacent to the edentulous area and a 0.032 or 0.036 stainless steel wire loop that forms a cantilevered loop from soldered attachments on the buccal and lingual surfaces of the band to the tooth on the other side of the edentulous space (**FIGURE 1**). It is primarily used in cases with single tooth loss and is generally not recommended when multiple teeth have been lost. The band is usually placed on the tooth distal to the extraction space (e.g., on the primary second molar to contact the primary canine or on the first permanent molar to contact the primary first molar). Placement of the band and loop traditionally involves two appointments — one to fit the band and take an impression for a dental cast on which to fabricate the appliance and one to deliver the appliance. As with any of the space maintainers using bands or stainless steel crowns as abutment teeth, separators may be placed one to two weeks prior to the first appointment to facilitate the fitting of bands if there are adjacent teeth.

There are some problems with this appliance, with loss of cement being the primary reason for failure. Other complications include caries as a result of cement loss, appliance displacement with the wire embedding into the gingival tissues, and an inability to control for rotations or tipping of abutment teeth.[13] Other disadvantages are the lab cost and the chair time for the two appointments associated with fabrication and delivery.

As mentioned earlier, there are a few variations on the traditional band and loop. If used to maintain space after loss of a primary second molar and the permanent first molar hasn't erupted enough for band placement, the band may be placed on the primary first molar with the loop extending distally to contact the mesial surface of the permanent first molar. This is often called a reverse band and loop (**FIGURE 2**). This appliance has limited utility, as the first primary molar abutment may exfoliate prior to the eruption of the permanent second premolar. Other variations have been developed to allow chairside fabrication and delivery. The band and half loop (occasionally referred to as a "one-armed bandit") is a premade appliance with a 0.036 wire that has already been soldered to the lingual surface of the band (**FIGURE 3**). Once the correct band size has been selected, the wire is bent to contact the adjacent abutment tooth and cemented. Another variation is the prefabricated band and loop. Denovo and Appliance Therapy Group are examples of companies that carry this product (**FIGURE 4**). The band and loop come in two different pieces. Bands come in various sizes and include buccal and lingual tubes extending partially across the edentulous space. The wire attachments are designed to insert into the tubes and abut the tooth opposite the space. Once the proper size of band and wire are selected, the tubes can be crimped around the wires to finalize dimensions prior to delivery.

The distal shoe is another fixed unilateral space maintainer that is specifically indicated when the primary second molar is lost prior to the eruption of the permanent first molar. This appliance consists of a band or a stainless steel crown that is adapted to the primary first molar with a wire loop extending over the extraction space. There is an additional extension (of either wire or a metal guide plane) that extends subgingivally to contact the mesial surface of the unerupted permanent first molar (**FIGURE 5**). Without space maintenance, the permanent molar will drift mesially

FIGURE 4. Prefabricated appliances. Component parts for prefabricated band and loop and distal shoe appliances. These appliances are meant to be fitted and delivered chairside during a single appointment. *(Photo courtesy of Denovo Dental.)*

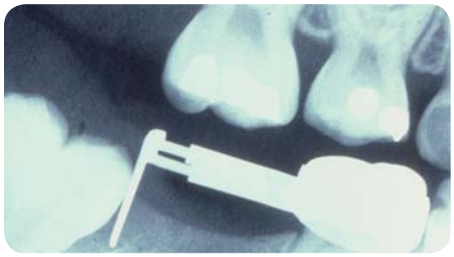

FIGURE 5A. Radiographic image of a distal shoe appliance to hold space for extracted mandibular right primary second molar. The band is cemented over a stainless steel crown on the primary first molar and extends subgingivally to contact the mesial surface of the unerupted permanent first molar. The two different wire dimensions in the loop demonstrate the pin and tube configuration of this prefabricated appliance.

FIGURE 5B. Distal shoe appliance to hold space for extracted mandibular right primary second molar. The band is cemented over a stainless steel crown on the primary first molar and extends subgingivally to contact the mesial surface of the partially erupted permanent first molar. The appliance in this case was lab-fabricated, with the loop soldered to the buccal and lingual surfaces of the band.

into the extraction space. Among all of the space maintenance options, the distal shoe has the greatest number of contraindications for use,[14] mainly because the subgingival extension involves continuous communication between the oral environment and the intra-alveolar space. Meticulous oral hygiene must be maintained and use is contraindicated for patients with systemic diseases that affect healing or cardiac anomalies requiring antibiotic prophylaxis.

Fixed Bilateral Space Maintainers

For the mandibular arch, there is only one passive bilateral space maintenance appliance — the lower lingual holding arch (**FIGURE 6**). This appliance consists of two bands, typically placed on the permanent first molars with lingual attachments to a round, stainless steel orthodontic wire extending along the lingual surfaces of the mandibular arch. Primary second molars can also serve as abutments. Fabrication is similar to that of the indirect band and loop. Bands are fit, an impression is taken and orthodontic separators are placed. The wire is adapted and soldered on the model. The appliance is cemented in place and can remain in use until all the permanent teeth have erupted. Resistance to the mesial movement of the permanent first molars comes through cross-arch stabilization between the two abutment molars and through contact with the lingual surfaces of the mandibular incisors.

The lower lingual holding arch has an advantage over the band and loop in cases with multiple missing teeth. Because it does not contact any primary teeth, it is less likely to interfere with the typical increase in intercanine distance that takes place as a child transitions from mixed to permanent dentition.[12,15] By resisting mesial movement of the permanent first molars, the lower lingual holding arch also has the capacity to relieve potential crowding by allowing incisors to drift distally into the leeway space.

There are also disadvantages to the lower lingual holding arch. If placed before the loss of the primary incisors, the lingual wire may interfere with the eruption of the permanent incisors, which typically migrate facially from a lingual position during development. It has also been suggested that the lower lingual holding arch causes proclination of the lower incisors, which has led some clinicians to suggest avoiding contact of the lingual arch with the mandibular incisors.[15] However, this retruded wire position is thought to reduce the ability of the arch to resist mesial movement of the permanent molars. Another disadvantage is that the preservation of leeway space may increase the prevalence of second molar impactions.[16]

The lower lingual holding arch also has design variations. The recommended wire size for the lingual arch varies between 0.032 and 0.036 inches in diameter.[15] In addition to the laboratory fabricated custom design, these appliances also come in premade forms. One variation consists of premade wires designed to fit in horizontal tubes welded to the lingual surfaces of the molar bands. Another variation has lingual arch wires designed to fit into vertical tubes.

For the maxillary arch, there are two options if a fixed bilateral space maintainer is indicated — the Nance appliance or the transpalatal arch. The Nance appliance is reported to be the more commonly used appliance.[17] This appliance consists of a 0.032 or 0.036 stainless steel wire soldered to the lingual surface of the two molar bands and extends to the anterior palate where it is embedded in an acrylic button to provide greater resistance to the mesial movement of the abutment teeth (**FIGURE 7**). As with the lower lingual holding arch, the bilateral options for the maxilla are intended for cases with multiple missing teeth and may utilize either permanent first or primary second molars as the abutment teeth. Although the acrylic button can be very effective at resisting mesial drift, it does make it difficult for patients to maintain good oral hygiene

FIGURE 6. Lower lingual holding arch appliance to hold space for extracted mandibular left primary second molar. Bands are cemented to the permanent first molars with the wire extending cross-arch to contact mandibular incisors.

FIGURE 7. Nance appliance to hold space for extracted maxillary primary first molars. Bands are cemented to the permanent molars with the wire extending anteriorly to an acrylic button in the anterior palate.

FIGURE 8. Transpalatal or Goshgarian arch to hold space for extracted primary first molars. Bands are cemented to the primary second molars with the wire extending across the arch. The adjustment loop allows for minor orthodontic movement such as expansion, torque and derotation.

because of the accumulation of food particles and plaque under the appliance. There is also the potential for tissue irritation and overgrowth of the tissues around the button.[17]

The transpalatal arch (TPA), also known as the Goshgarian arch, is similar to the other fixed bilateral appliances. Bands are placed on the permanent first or primary second molars with a 0.032 or 0.036 stainless steel wire extending between the two abutment teeth (**FIGURE 8**). The wire may extend straight across (transpalatal bar) or it may incorporate an omega loop in the center (Goshgarian or transpalatal arch). The wire should have no soft tissue contact and generally sits 3-5 mm from the soft tissue surfaces. As with other appliances, fabrication of the traditional appliance includes two visits. There is also a prefabricated removable option that inserts into lingual sheaths on the lingual surfaces of the bands. The TPA is not as common as the Nance appliance because of concerns about its efficiency. It resists mesial drift of the abutment teeth by coupling the movements together across the arch.[17] In order for one tooth to drift mesially, the contralateral molar would also have to move. The advantage of the TPA over the Nance appliance is reduced food impaction and plaque retention as well as improved soft tissue compatibility. The TPA also has some orthodontic benefits by providing some resistance to molar extrusion and allowing orthodontic tooth movement — mild dental expansion, derotation and some torque.

A variation on the fixed bilateral space maintainer is the pedi partial or Groper appliance (**FIGURE 9**). This also has a very specific indication as a replacement for missing maxillary incisors. The appliance consists of two bands or stainless steel crowns on primary first or second molars, a wire extending across the edentulous area and replacement denture teeth embedded in acrylic. Although used primarily for esthetic purposes, because the early loss of incisors results in minimal space loss, this appliance can also be used for cases in which posterior teeth are lost in addition to the incisors.

Removable Appliances

Removable appliances are less standardized than any of the other space maintainers. There is room for creativity in the design of each appliance. The only requirements are to have a mass of acrylic to fill the edentulous spaces and some type of retention system, with any combination of anterior labial bows, ball clasps, Adams clasps or C-clasps (**FIGURE 10**). These appliances are generally indicated for cases in which multiple teeth are missing. They are a good option when the permanent molars have not yet erupted. In this instance, the removable appliance can be designed to fill the saddle area and end just mesial to the unerupted permanent molar. Because they are removable, hygiene is easier to maintain. However, there is always the risk that the child will not comply with instructions for wear.

Types of Cements

Just as important as the design and construction of the space maintainer is the method of affixing the appliance in the mouth. The cement utilized should have a high retentive strength and minimize the chance of enamel demineralization. Historically, zinc polycarboxylate and zinc phosphate were the standard cements used in dentistry. But in contemporary practice, these have been replaced with the glass ionomer and resin reinforced glass ionomer cements, with no significant difference in bond strength.[18] And as an added benefit, the fluoride-releasing properties of these cements demonstrate less demineralization than the traditional cements, making them the most highly recommended cement for space maintenance and orthodontic purposes.[19-21]

Failure Rates

For each clinical situation in which early tooth loss is experienced, more than one space maintainer might be considered appropriate. Therefore, potential for longevity should be assessed when determining the best option for each situation. The first consideration is whether the abutment teeth will be present

FIGURE 9A. Groper or pedi partial appliance. Denture teeth are secured to the wire with acrylic.

FIGURE 9B. Groper or pedi partial appliance to replace extracted maxillary incisors. Bands are cemented to maxillary primary second molars, with the wire extending anteriorly to support the replacement denture teeth.

FIGURE 10. Removable appliance to hold space for extracted mandibular primary second molars. The appliance is held in place with C-clasps to the primary canines and first molars. The acrylic fills the edentulous saddle and extends distally to the bulge of the permanent first molars. Partial eruption of the molars behind the appliance is evident in this photo.

until the successors for the missing tooth or teeth erupt. Some appliances may need to be replaced by different variations as the dentition develops. As for failure of space maintainers, one of the most common reasons is cement loss.[22,23] Cement loss accounts for anywhere from 15 percent to 36 percent of failures[23-25] and is more common with the band and loop than with the lower lingual holding arch or Nance appliance.[26] The other common failure of space maintainers is breakage at the solder joint,[22,23] which has variable failure rates. Splitting of bands also occurs, with a higher incidence in the lower lingual holding arch than the Nance appliance or the band and loop.[25,26] Because the most common failure of the band and loop can be addressed by simply recementing the loose or displaced appliance as opposed to remaking a broken fixed bilateral appliance, many would conclude that the band and loop has less complications, making it a more common choice for space maintenance.[22,24,25]

Recent Innovations

In order to decrease the number of visits required to deliver space maintainers, some alternatives have been proposed. One recent innovation is the direct-bonded retainer. This consists of a 0.036 stainless steel wire formed on a stone cast, then bonded with flowable composite to the buccal surfaces of the teeth adjacent to the extraction space. As with the band and loop, this is only used to maintain a single extraction space. The survival rate is lower than the traditional band and loop.[13] Failure is usually the result of the wire debonding, which is a major disadvantage because of the risk of aspiration or swallowing.

Another innovation, which is mostly being evaluated overseas, is the fiber-reinforced space maintainer. This is also intended to take only one appointment with no laboratory procedures. The appliance consists of composite reinforced with polyethylene or glass fibers direct bonded to the buccal and lingual surfaces of the abutment teeth. Some studies have shown this alternative to be comparable in success rate to the band and loop.[27,28] Others suggest longevity of just five to six months.[13,29,30] Failures primarily involve debonding at the enamel composite interface.

Conclusions

- Space maintenance is generally not required for premature loss of primary incisors.
- Lower lingual holding arches can help prevent lateral and/or lingual drift of incisors and possible midline shifts in cases of premature loss of primary canines.
- Space maintenance helps prevent mesial migration of the permanent first molars when there is premature loss of primary molars.
- The band and loop is a safe choice for premature loss of a single primary molar.
- Fixed, bilateral space maintainers — lower lingual holding arch, Nance appliance, transpalatal arch — are recommended in cases with multiple missing teeth.
- Removable space maintainers can be used in cases with multiple missing teeth.
- Glass ionomer and resin-reinforced glass ionomer cements are the most effective cements for fixed space maintainers. ■■■■

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Management of Dental Caries and Esthetic Issues in the Pediatric Patient

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ABSTRACT Anterior pediatric restorations exhibit a unique treatment challenge. Factors to consider include the child's medical history, level of cooperation, dental age, caries risk, parental preferences and cultural norms regarding esthetics. The goal is to retain the anterior teeth with an esthetic result and allow natural exfoliation without the need to retreat. Anterior restorations are discussed. Rebonding traumatized fractured teeth, pediatric partial dentures, microabrasion, vital bleaching and enamel hypoplasia are also discussed.

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The restoration of children's teeth can be challenging for any dentist. While the vast majority of children can be managed with communicative behavior guidance techniques, some children require pharmacologic behavior management (such as sedation or general anesthesia) in order to complete treatment.[1] Additionally, parental expectations for their children's dental treatment has increased considerably over the past few decades. In many cases, "form" may be equally as important as "function."[2] Predoctoral training in pediatric dentistry typically focuses on basic management of caries in essentially cooperative children and often neglects training in esthetic anterior restorations. Some reasons for this educational paradigm:

- Dental students rarely spend a significant amount of continuous time in pediatric dentistry rotations.
- Younger and behaviorally complex/challenging patients are often referred to pediatric graduate programs.
- There is often a limited amount of clinical experience that makes tackling esthetics in a precooperative or uncooperative child patient a challenge that is reserved for those dental students who intend to treat pediatric populations.
- Posterior primary teeth serve a more strategic long-term purpose.
- In many dental schools, pediatric restorative dentistry is taught by general dentists and is subject to their comfort level and philosophy.

Despite the lack of pediatric esthetic restorative experiences in dental school, many general practitioners' offices will

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become the dental home for children in their community. From a practice management standpoint, this may involve the treatment planning and completion of esthetic restorations for children. While by no means exhaustive, this article aims to serve as a guide to basic esthetic restorative procedures in pediatric dentistry.

Esthetic expectations are directly influenced by the child, the family, the culture and the materials. As noted by Kupietzky, the ultimate goals of restoring severely decayed anterior primary teeth are the following:

- To allow patients to retain these teeth functionally with an esthetic result.
- To permit natural exfoliation of these teeth without any pulpal complications and to avoid the need for re-treatment of the restoration.[3]

The Child

The nature of dental disease in children is changing. The most recent Centers for Disease Control and Prevention (CDC) report from 2007 presented data in which most age groups demonstrated no appreciable rise in the prevalence of caries. The notable exception to this was the 2-5 age group, which saw the prevalence of dental disease rise from 24 percent to 28 percent.[4]

One possible reason for this is that children are coming in earlier for their first visit. Several years ago, the recommendation was that a child visit a dentist by the age of 3. The current recommendation by the American Academy of Pediatric Dentistry (AAPD) is that *"the establishment of a dental home begins no later than 12 months of age."*[5] This recommendation has been consistently supported for disease prevention by research in the following areas: health behaviors, acquisition of oral microflora, establishment of the oral microflora and sustained morbidity of disease.[6,7,8] The implication is because we are seeing children at a younger age, more early childhood caries (ECC) is being diagnosed.[9] In addition, children with ECC demonstrate significantly higher subsequent caries rates after treatment under general anesthesia.[10] This should be a consideration when treatment planning.

The Family

The child does not exist as a physiologically isolated entity, but rather is typically subject to the desires and expectations of his or her parents, caregivers and entire family. It has been noted that over the past four to five decades, there has been a fairly profound shift in parenting styles and habits.[2] In many cases, the family may act as a surrogate in making decisions regarding esthetics that will help the child assimilate into the community.[11]

The Culture

Just as the child is not an independent, isolated entity, the family similarly lives within the construct of the culture and the community. There is literature to support the fact that cultural beliefs can directly impact health behaviors — this is most evident with conditions such as diabetes and infectious diseases.[11,12,13,14] Today, the culture of America is inoculated with images of altered parental expectations of child beauty. From Honey Boo Boo, the child star of *Toddlers and Tiaras,* to the daily images of reality medical television with plastic surgery procedures and a "Botox-for-all" undercurrent, American parents and children are inundated with images of what society considers attractive. In 2010, Berenburg et al. noted that over the past 70 years there has been a shift in what is considered attractive in both male and female face structure. The most significant historical changes have been with respect to chin lengths, frontonasal angles and total face angles. There have been no similar studies performed on children.[15]

FIGURE 1. Caries risk versus esthetics: 3-year-old child with multiple teeth with anterior smooth surface decay. Child is classified as high risk with severe early childhood caries (S-ECC).

In 2009, Holan et al. surveyed more than 300 parents on their perspectives related to anterior esthetic restorations. The major cause of esthetic defects was due to caries (47 percent).[16] Despite many of these children requiring sedation or general anesthesia to complete their dental treatment, parental compliance for follow-up care and oral hygiene instruction was poor and recurrent decay rates were high.[17] By definition, these children present with severe early childhood caries (S-ECC), which is defined by the AAPD as "any sign of smooth-surface caries in children younger than 3 years of age. From ages 3 through 5, one or more cavitated, missing (due to caries) or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing or filled score of ≥4 (age 3), ≥5 (age 4) or ≥6 (age 5) surfaces also constitutes S-ECC."[18] In clinical practice, it is prudent to consider the caries risk and cooperation level of the child along with parental compliance in order to determine a treatment plan. For some children with S-ECC, who require treatment under general anesthesia because of behavior and extent of disease, it may be prudent to treat more aggressively with full-coverage restorations or anterior extractions (**FIGURE 1**).[9] However, as noted by Holan, 87 percent of parents wanted to save the tooth even when given an overall

50/50 prognosis.[16] For the purposes of this paper, we are going to suspend our views on cariology and parental compliance with home-going instructions and focus on the techniques themselves.

Stainless Steel Crowns (Modified)

For the purposes of this article, which is focused on esthetic restorations, we will not be discussing unaltered stainless steel crowns in the anterior. This is despite the finding by MacLean in 2006 that the failure rate of anterior stainless steel crowns is only 8 percent.[19] Furthermore, this is not accounting for the fact that in certain cultural communities, unaltered stainless steel crowns in the anterior may represent a truly esthetic restoration. Within the scope of this paper, we will discuss two distinct types of anterior stainless steel crowns — the open-faced stainless steel crown (OFSSC) and the preveneered stainless steel crown (PVSSC).

Open-faced Stainless Steel Crown

The open-faced esthetic option was succinctly described in the literature in the 1980s but had already been in use for decades.[20] In reviewing the literature, the OFSSC has primarily been described in case reports with very little long-term data.

This option is used largely in instances where the anterior stainless steel crown (unmodified) is deemed unesthetic and extraction is not a favorable option for practitioner or parent. The advantages of OFSCC are a more esthetic restoration than an unmodified stainless steel crown coupled with durability. The disadvantage is the possible loss of the facial composite, which requires reapplication and unacceptable metal margins.[19] In addition, this technique requires extra chair time, and hemorrhage control is important when applying the resin facing.[10] Carrel and Tanzilli reported the clinical success of resin-veneered crowns after one year as 32 percent intact, 41 percent debonded and 27 percent partially retained.[21]

Technique: Following cementation of the stainless steel crown and initial set of the luting cement, a bur is used to cut out a facial window and composite resin is then placed. When preparing the facial aspect, it is recommended to tuck the window prep into the interproximal area so as to avoid a noticeable silver outline. When preparing the window, care must be taken so as to not leave the metal frame so thin that it might tear and be unable to retain the composite resin. One might consider using retraction cord/paste to allow a better preparation of the window at the gingival margin. Another option is to cut the window prior to cementing the crown and then do some adjustments once the crown is actually cemented. The disadvantage of this is the possibility of salivary contamination as the cement is setting. The finishing and polishing of the prepared window can be done with burs, disks or a white stone. The science behind the placement of the resin in these situations is poorly represented in the literature. The operator may consider placing a flowable composite as the first layer for better marginal adaptation followed by a hybrid resin for strength and polishability.[20]

THE ADVANTAGES of OFSCC are a more esthetic restoration than an unmodified stainless steel crown coupled with durability.

Preveneered Stainless Steel Crown (PVSSC)

Preveneered anterior stainless steel crowns were first introduced in the 1990s. They are stainless steel crowns with resin chemically or mechanically bonded to the facial surface.[22] There are numerous manufacturers (NuSmile Pediatric Crowns, Houston; Cheng Crowns, Exton, Pa.; and Kinder Krowns, St. Louis Park, Minn., are some well-known examples) all with varying methods of bonding and different baseline crown characteristics. The literature behind PVSSC has largely consisted of small group studies and/or case reports. One retrospective analysis from 2001 examined both clinical characteristics and parental satisfaction. Roberts et al. noted that of the 38 crowns evaluated, 24 percent had full-facial veneer loss and 32 percent had partial-facial veneer loss after an average time of 20 months postplacement.[23] Another study by MacLean reported a 91 percent good-to-excellent clinical appearance of NuSmile crowns after an average postplacement time of one year. In this study, 83 percent reported a lighter color than natural tooth, 14 percent reported a bulky appearance, 86 percent resisted fracture of the facing for at least six months and 12 percent had fractured facings after six months.[19] In a retrospective, cross-sectional study of PVSSC after an average time of 17 months, 19 out of 25 parents were satisfied. They were most satisfied with the crown size and least satisfied with the appearance.[24]

Technique: Because PVSSCs require a passive fit in order to minimize the risk of the resin facing debonding from the metal, the teeth need as much as 25-30 percent circumferential reduction. This increases the chance of pulpal exposure. The incisal edge needs to be reduced by at least 1.5 mm.[25] The retention for these crowns is primarily from the luting

FIGURE 2. Follow-up photo of anterior preveneered stainless steel crown.

FIGURE 3. Completed tooth preparation for resin strip crown.

FIGURE 4. Resin strip crown form placement.

FIGURE 5. Resin strip crown final restoration (No. D-No. G) immediate postoperatively.

FIGURE 6. Preoperative and postoperative photos of resin strip crown.

cement because the crowns cannot tolerate aggressive crimping or marginal contouring. Flexure of the crowns may create craze lines or microfractures within the facing itself.

In 2010, Oueis et al. conducted a survey of the AAPD membership to assess the use of PVSSC. They found that while 51 percent of respondents utilized PVSSC and 41 percent considered them to be their first choice for anterior restorations, nearly three-quarters (73 percent) were concerned about the durability of the restoration. More than 50 percent of the respondents recommended that the manufacturers improve the esthetics and more than 60 percent suggested improving the resin/crown bonding interface.[26] One distinct advantage of the OFSSC to the PVSSC is in the event of failure (**FIGURE 2**).

Failure may occur because of trauma or parafunctional bruxism, which is a common and often transient occurrence in the pediatric population. The restorations can be repaired if the facings come off; however, it is a challenge because silane couplers must be used to facilitate the bonding between composite and metal. The long-term stability of these repairs is questionable. Because of the difficulty in repairing the facing, some practitioners may choose to replace the crown if esthetics is a concern. The steel-veneer bond is extremely important to the success of the crown. A study by Waggoner investigated the failure strength of four brands of PVSSC. The Whiter Biter crown (White Bite Inc., LaGrange, Ky.) required significantly more force for failure than NuSmile, Kinder Crowns or Cheng Crowns (none of which were statistically different from each other). The NuSmile, Kinder and Cheng crowns all showed a mixed adhesive (separating at metal/resin interface)/ cohesive failure (veneer chipped off).[27]

Resin (Strip) Crowns (RSC)

According to Kupietzky (2002), RSC are "perhaps the most esthetic of all the restorations available to the clinician for treatment of severely decayed primary incisors."[28] Studies have demonstrated an overall retention rate as high as 88 percent.[29] Higher failure rates have been correlated with an increased number of carious surfaces being restored. Irrespective of color, size or appearance deficiencies, parents rated the overall treatment and appearances of these restorations as very high (**FIGURES 3–6**). In 2005, Kupietzky reported an 80-percent retention rate after an average of 31 months with 92 percent demonstrating healthy pulps clinically and radiographically. No discernible color difference was noted after this time and crown contour was rated as very good or acceptable.[3]

There are several key considerations when treatment planning for RSC.

Remaining tooth structure — It has been well documented that because of decreased mineral content and varying tooth morphology, bonding strengths are reduced in the primary dentition. The more tooth structure that is removed, the more retention is dependent on the physical properties of the composite resin restoration. If the caries removal results in insufficient tooth structure remaining for bonding or a subgingival margin, PVSSC may be considered instead of RSC because of moisture concerns as well as potential bonding problems.[3]

Occlusal relationships — The relationship between the maxillary and mandibular teeth (overbite and overjet) can play a significant role in the decision to use the RSC. Dental material literature has reinforced that composite resin has poor compressive strength and is less resilient when

FIGURE 7. Aluminum chloride retraction paste. (3M ESPE, St. Paul, Minn.)

FIGURE 8. Immediate postoperative placement of strip crowns after resin cure and crown form removal.

subjected to lateral shear forces. When a child presents with an anterior cross bite, edge-to-edge anterior occlusal relationship or other significant loss of vertical dimension prior to restoration, careful preoperative consideration must be given to the use of composite resin. This may involve shaping the final restoration or the occlusion to remove excursive interferences and/or open the bite. One advantage of composites in these situations is their ability to be easily and readily modified to fit an occlusal scheme, unlike stainless steel crown-based alternatives.

Gingival health — When restoring carious anterior teeth with composite, the gingival health of the surrounding tissues is a key determinant to long-term success. If the gingival tissues are friable, edematous or susceptible to bleeding, the quality and final cure of the composite restoration may be compromised from the moisture contamination. In addition, the resulting restoration may be discolored if there is excessive bleeding during the curing process.[28] In instances where gingival hemorrhaging is not overwhelming, some clinicians may use hemostatic agents to help with moisture control. Caution must be taken when using agents such as ferric sulfate (Astringedent 15.5%), which can retard the cure of the composite resin. Newer retraction pastes using aluminum chloride (**FIGURES 7 AND 8**) provide gingival retraction without affecting resin cure.[30] Inflammation has also been noted postoperatively around crown margins as a result of accumulated plaque on less than ideal crown margins.[3]

Pulpal involvement — As with any restoration, the correct pulpal and periradicular diagnosis is critical to long-term success. In 2003, Kupietsky et al. noted that 91 percent of teeth restored with resin strip crowns had healthy pulps with less than 1 percent showing radiographic evidence of pulpal necrosis. An additional 10 percent had some radiographic evidence of pulpal necrosis, but still demonstrated clinical success.[29] Esthetic restoration of teeth requiring pulpal therapy may be challenging because incomplete removal of pulpal debris or use of resorbable materials such as iodoform calcium hydroxide may show a color shadow through the restoration.

Technique considerations — When preparing teeth for strip crowns, the operator needs to ensure that the preparation does not have sharp line angles that may propagate stress fracture points within the restoration. Care must be taken to ensure adequate tooth reduction so that the resin is thick enough to resist fracture — especially on the lingual surface. A two-plane reduction may be beneficial to represent anatomic tooth form and to ensure adequate bulk of material. When parents evaluated the final restoration, they found that the contour of the restoration was more critical than the color.[28] Care must be taken when filling the crown form with resin so as to not have air bubbles present in the final restoration. Also, when removing the crown form, it is recommended to use a sharp, hand-held instrument, such as a cleoid/discoid carver to avoid damage to the cured restoration. A rotary instrument to remove the crown form may cause damage to the underlying restoration.[28]

Zirconia Crowns (ZC)

As parental expectations of pediatric esthetics have increased, the need to explore materials previously unused for pediatric dentistry has also increased. Chief among these in recent years has been zirconia, a metal-free alternative to traditional restorative dentistry. There have been some case reports and in vitro studies describing the esthetic qualities of zirconia in conjunction with osseointegrated implants and other fixed prostheses.[31] Zirconia is noted to be the strongest and toughest ceramic material available to the practitioner and has demonstrated clinically outstanding performance in areas of high stress.[32] While the pediatric dental arch is not typically a load-bearing, high-stress area, the practitioner needs to consider the unpredictable behavior of young children. According to the NuSmile ZR literature, zirconia is nine times stronger than enamel.[33]

Technique for the ZC does require some additional preparation. The EZ-Pedo (EZ-Pedo Inc., Loomis, Calif.) technique guide recommends 1.5-2 mm incisal reduction, 3-plane facial reduction of 0.5-1 mm extending 1-2 mm subgingivally with a featheredge margin, approximately 1 mm lingual reduction and parallel mesial and distal walls for added retention.[34] When evaluating the preparation from the incisal, it should be ovoid in shape. The Try-In crown (advocated by the NuSmile system) prevents unnecessary sterilization of the actual ZC, which can affect esthetics and durability (**FIGURE 9**). Adjustment of ZC must be done with extreme caution, as this may result in microfractures if not performed according to the manufacturer's instructions. A passive fit is paramount — excessive force will result in fracture of the ZC. Adequate isolation from heme or saliva contamination is necessary, as it is for RCS.

FIGURE 9. On the left, preoperative radiograph, try-in of zirconia crown and final cementation. On the right is the follow-up presentation two weeks after cementation.

Several manufacturers recommend the use of a resin, resin-modified glass ionomer or glass ionomer cement. It should be noted that the NuSmile ZR clinical guide as well as the EZ-Pedo technique guide states that if all four anterior teeth are being restored, the centrals should be cemented followed by the laterals. Consistent, firm-finger pressure should be applied until the cement is hardened (**FIGURE 10**). The sizing labels can be removed with coarse prophy paste.[33,34]

These crowns have also gained some popularity in the posterior primary dentition. One favorable feature is a thin margin, which reportedly enhances and promotes optimal gingival health. The zirconia crown preparation must remove height of contour of the posterior tooth so that the crown fit is passive. ZC have a high compressive strength, but weaker flexural strength, enhancing the importance of the passive fit. Reduction should be completed in two steps: supragingival, then subgingival using diamond burs for preparation. The crown system may come with recommended burs for each step of the preparation. Crown retention results from grooves inside the crown and the luting cement (glass ionomer cement); glass ionomer cement does not bond to the inside of ZC. When seating the crown, cement should fill the crown and careful cleaning should be done so that cement is not removed from underneath the crown margin.[33,34] To date, there are no clinical trials assessing the impact of poor oral hygiene on tissue in teeth restored with ZC. In addition, while there is a CDT code for ZC (D2929 — prefabricated porcelain/ceramic crown — primary tooth), what is actually

FIGURE 10. Zirconia crown in primary anterior teeth.

reimbursed will depend on the payer's guidelines. However, with the increased parental demands for esthetics, ZC represent the "new frontier" of pediatric esthetic dentistry (**FIGURES 11–20**).

Rebonding Fractured Teeth

Of nearly 300 children examined with esthetic defects, dental trauma represented 37 percent that required restoration.[16] In 2011, Badami noted that there was "no single dental disturbance with greater psychological impact than the fracture of an anterior tooth."[35] When treatment planning the restoration of an uncomplicated fracture, rebonding the fractured segment may represent the most conservative therapy (other than no treatment) and can be the most natural looking postoperatively.[36,37] While some authors have cited this technique as the preferred method for restoration, others have noted that the technique does require dexterity and can be technically challenging.[38] In 1999, Farik noted that a fragment that "has been dry for more than one hour will have resultantly lower bond strengths."[38] In addition to compromised bond strengths, another challenge for the successful rebonding of a fractured tooth fragment is the esthetics. A fragment that has been stored dry is at risk for desiccation and can result in a white, chalky appearance. It has been recommended that if a tooth fragment is to be reattached, it should be rehydrated for 30 minutes prior to reattachment.[36] The literature on in vivo tooth reattachment has largely been limited to case reports and/or technique-specific papers.

FIGURE 11.

FIGURE 12.

FIGURE 11 and **FIGURE 12.** Preoperative radiograph and image of primary anterior caries.

FIGURE 13. Postoperative image of anterior zirconia crowns (No. D-No. G).

FIGURE 14.

FIGURE 15.

FIGURE 14 and **FIGURE 15.** Caries in first primary molar, preoperative photograph.

FIGURE 16. The posterior zirconia crown preparation consists of 2 mm occlusal reduction, 1 mm buccal and lingual reduction extending 1-2 mm subgingivally. Careful preparation to ensure no undercuts remain is important so that the crown has a passive fit. Mesial and distal preparation is more aggressive than a stainless steel crown preparation to ensure a passive fit.

FIGURE 17. Final preparation extends subgingivally 1-2 mm resulting in a featheredge margin. All line angles should be smoothed and no undercuts present prior to crown try-in.

FIGURE 18.

FIGURE 19.

FIGURE 20.

FIGURES 18, 19 and **20.** Final crown cementation. Light occlusal contact should result.

Rebonding Technique: The most successful results occur when the fragments are well approximated with minimal preparation required. Different rebonding techniques are presented in the literature and include enamel beveling, v-shaped enamel grooving, internal fragment groove and circumferential chamfer preparation.[39] Many clinical papers have recommended the use of bevels to increase bonding surface area and increase retention. However, Worthington et al. demonstrated that beveling did not significantly contribute to bond strength.[40] Reis et al. disputed this by suggesting that an internal preparation in the fracture segment may aid by regaining up to 90 percent of the original tooth's fracture strength.[39] One common thread that all authors seem to agree on is that violation of the biologic width by a reattached fragment will significantly lower the long-term prognosis of the tooth.[41] Loguercio et al. showed that a fragment bonded with no additional preparation has lower fracture strength than various types of preparation prior to bonding the fragment (**FIGURES 21–25**).[42]

When considering rebonding fractured fragments, note that voids in the fractured fragments may be filled with composite to allow for a "dowel" type of retention. Instances of complicated crown fracture with pulpal involvement should be evaluated for pulpal therapy prior to rebonding of the fractured segment.[35] The Cvek technique has been demonstrated to have a success rate approaching 95 percent.[43] In more recent years, capping with mineral trioxide aggregate (MTA) has been suggested; however, it should be noted with caution that there is a steadily growing body of literature suggesting coronal discoloration associated with both gray and white MTA usage.[44]

FIGURE 21. Uncomplicated crown fracture of No. 9.

FIGURE 22. Uncomplicated crown fracture of No. 9 — incisal view.

FIGURE 23. Tooth fragment No. 9.

FIGURE 24. Internal fragment groove No. 9.

FIGURE 25. Final rebonded fractured tooth No. 9.

Pediatric Partial Dentures (PPD)

In today's society, some parents have higher esthetic expectations when their child has extracted or missing maxillary anterior teeth. In order to meet this need, PPD (often referred to as pedi-partials) can be used to replace the missing anterior teeth. PPD can be removable or fixed. The removable variety has pediatric denture teeth attached to an acrylic framework with clasps used to attach the retainer to the posterior teeth. Ball clasps, C-clasps or Adams clasps are commonly used for retention. While these are easier to fabricate than fixed pedi-partials because they only require an alginate impression, they are not commonly used because children often lose or break the appliance.[45]

The fixed PPD is more commonly used. It is made by fitting orthodontic bands or crowns on the maxillary first or second primary molars. An alginate impression is taken of the maxillary and mandibular arch to ensure correct occlusion. The appliance is made with a stainless steel wire that supports the acrylic framework and pediatric denture teeth. The appliance is cemented with either a glass ionomer cement or resin-reinforced glass ionomer cement.[45]

While esthetic, there are a few contraindications. Fitting bands/crowns and taking alginate impressions requires the cooperation of the child. The wire and/or teeth are prone to fracture. If the child has a malocclusion, consideration should be made for treatment deferment. The child's dental age must be carefully considered to avoid impingement of the erupting permanent incisors. The success of pedi-partials is often documented by case reports rather than longitudinal long-term reports. Good oral hygiene and recall visits to monitor the appliance and to make necessary adjustments are important to the success of this appliance.

An alternative method for an esthetic result is the application of Ribbond (Ribbond, Seattle), an adhesive material with reinforced polyethylene fibers. This material is bondable and has high fracture strength, which lends itself to several potential applications in dentistry. Case reports have demonstrated clinical use of Ribbond in fixed prosthodontics.[46]

FIGURE 26. Fluorosis staining preoperative presentation.

FIGURE 27. Postoperative photo after enamel microabrasion, at-home vital tooth bleaching and restoration completed.

Enamel Microabrasion (EM) and Vital Tooth Bleaching (VTB)

Aside from caries and trauma, staining is another potential source of esthetic defect in a tooth. Staining can be classified as extrinsic or intrinsic based on the underlying etiology.[47] Fluorosis is a classic example of intrinsic staining that affects the enamel matrix. Classification of fluorotic stains may be categorized as Grade 0: normal, translucent, smooth and glossy teeth; Grade I: white opacities, faint yellow line; Grade II: changes as in Grade I and brown stains; Grade III: brown line, pitting and chipped-off edges; and Grade IV: brown, black and/or loss of teeth.[48]

Enamel microabrasion (EM) is a technique that uses an acid (often hydrochloric acid) with varying grits of silica carbide to remove the surface layer of enamel where staining may be contained.[49,50,51] The use of EM requires careful treatment planning and informed consent. In some of the brown stains with areas of opacity (such as the Grade II stains), abrasion can actually expose more intense areas of discoloration. From a practical treatment standpoint, it is advisable to sketch out areas of discoloration on a lab form or have high-quality imaging, which will allow the practitioner to carefully evaluate areas of discoloration and improvement. For intense stains, the practitioner needs to establish with the patient and parent that several treatments may be required. Because EM may lead to increased sensitivity, some advocate the use of fluoride varnish as a desensitizer and to help replenish the fluoride-rich outer enamel layer. Prema (Premier Products Co., Plymouth Meeting, Pa.) and Opalustre (Ultradent Products Inc., St. Louis) are two examples of microabrasion kits.[52]

It is not uncommon for practitioners to pair EM with vital tooth bleaching (VTB) in the treatment of unesthetic stains. Celik et al. showed that the combined therapy of EM followed by VTB results in significantly higher esthetic scores than EM alone.[49,53] However, Price et al. showed that EM alone did improve appearance and color uniformity when evaluated by multiple practitioners.[50] The EM eliminates surface irregularities and forms a more uniform color; VTB reduces the contrast between the white opaque areas and the surrounding tooth surface.[49] EM is a conservative first treatment of choice for removing superficial enamel stains.

For nearly three decades now, the at-home bleaching protocol using 10 percent carbamide peroxide has been used. There has been a steady stream of FDA and ADA recommendations, which have reinforced the safety of at-home products.[54] The major adverse effect associated with VTB is tooth sensitivity, which has been reported to be as high as 67 percent.[55,56] Hydrogen peroxide, at concentrations above 10 percent, is potentially corrosive to mucous membranes and can cause a burning sensation and tissue damage.[54] A potential disadvantage of at-home VTB is that it does require patient compliance. Dietary factors such as use of coffee, tea or tobacco products may influence the outcome or stain relapse.

The literature is replete with improved patient esthetic outcomes with VTB.[57,58] In-office bleaching materials such as Zoom! (Discus Dental, LLC, a Philips company, Playa Vista, Calif.) often contain high-dose carbamide or hydrogen peroxide (as much as 40 percent), and should be used according to manufacturer instructions and the AAPD guidelines.[59] At these higher concentrations, the bleaching material and the resulting free radicals may pose more problems to mucosal and pulp tissues; thus, careful attention to barrier protection is required.

Thorough informed consent should be obtained after reviewing each patient's health history. Possible risks and benefits should be discussed with the parent/guardian. If VTB is done on children in the primary and mixed dentition, it must be done under the strict supervision of the dentist and parent (**FIGURES 26 AND 27**). The AAPD guidelines discourage full-arch cosmetic bleaching for the patient in mixed dentition.[59,60] The ADA has accumulated good data over the past two decades suggesting that there is minimal risk from 10 percent carbamide peroxide (3.5% hydrogen peroxide). However, there is no good, long-term data on the effect of in-office, high-dose bleaching materials on the primary dentition.

Hypoplastic Permanent Molars

Enamel hypoplasia (EH) is a qualitative and quantitative defect in enamel formation that results in areas of opacities or areas more susceptible to caries. A disruption in the secretory phase of enamel development causes a deficiency in the tooth substance.[61] While there is no single etiology for EH of permanent teeth, it has been attributed to both environmental and genetic factors. Examples include trauma or infection of the primary predecessor,

systemic metabolic disturbance or neonatal infection.[61] In many cases, it is often difficult to pinpoint the exact cause of the hypoplasia. One of the most commonly and severely affected teeth is the first permanent molar. Restorative treatment will depend upon the severity of the defect, cooperative ability of the child and the age of the child. Restoration of hypoplastic teeth can be an extreme challenge for several reasons, including the reduced bond strengths to resin as a result of the decreased mineralization. In addition, local anesthesia has been documented as being more difficult for hypoplastic teeth because of chronic pulpitis.[62]

Due to the compromised tooth structure, an adhesive restoration is the best material choice in order to preserve tooth structure and maximize retention. Glass ionomer cement (GIC) or resin-reinforced glass ionomer cement (RRGIC) is a good restorative material for mildly to moderately affected hypoplastic teeth. GIC and RRGIC release fluoride and chemically bond to the enamel and dentin, allowing for minimal tooth preparation. It has been recommended in literature that GIC or RRGIC be used as an interim restoration because of inferior, long-term success to other dental materials. However, this material may prove ideal if cooperation is limited. Composite resin is another restorative material that can be considered. However, this material should only be considered if there is a sound cavosurface margin of unaffected enamel. The adequacy of the bond strength to hypoplastic molars is not well documented in the literature.

Full-coverage restorations are the treatment of choice for moderate to severe hypoplastic teeth. For children in mixed and early permanent dentitions, preformed stainless steel crowns are recommended for posterior restorations. The goal of this restoration is to create proper occlusal relationship, establish interproximal relationships and decrease symptoms. It is important to note that even though full coverage may conserve tooth structure, stainless steel crowns may demonstrate increased gingival irritation. Further, a violation of the biologic width may result in periodontal disease and decreased long-term prognosis of the tooth.[63,64]

One must also consider the long-term retention of a compromised hypoplastic tooth. "If single or multiple first permanent molars with severe hypoplasia are present, consideration of timely extraction may be advantageous. The suggested best time to extract a permanent molar is between the age of 8.5 and 10.5 years, which should coincide with the calcification of the bifurcation of the second molar."[61] If done in a timely manner, the second permanent molar will erupt in its place. If extractions of first permanent molars are considered, it would be prudent to consult with an orthodontist to also consider facial growth pattern, degree of crowding, occlusal classification and other orthodontic considerations.

Conclusion

Esthetics in restorative pediatric dentistry continues to increase in clinical significance. Parental expectations and peer-based values continue to drive the need and desire for highly esthetic restorations at all ages. Dentists who look to esthetically manage caries in children have several challenges. There are multiple options for esthetic management of the primary and young permanent dentition, and the final treatment must consider dental materials, the family's ability to maintain esthetic restorations, the child's caries risk and the cooperative ability of the child. With all of these options, informed consent is essential with a discussion of the alternatives, risks and benefits of the planned treatment. ■■■■

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A look into the latest dental and general technology on the market.

Dental Trauma *(Dental Trauma AB, $1.99)*
This simple new application, available in the iTunes app store and Google Play (Dental Trauma First Aid by Ulf Glendor), is endorsed by the International Association of Dental Traumatology. The Dental Trauma First Aid app offers a readily available, quick-reference guide to assist dentists and patients in the event of acute dental trauma. The app cites the best available evidence-based literature and expert professional judgment, as stated in its disclaimer. Once on the main page, you are directed to care instructions immediately following dental trauma or at-home care instructions following a dental visit relating to dental trauma. The app recommends a visit to the dentist within varying time frames in order of severity for avulsed, displaced, mobile and fractured permanent and primary dentition. A bulk of the information is, however, focused on completely avulsed teeth. A concise how-to guide is listed in bullet-point form with the pictures, laying out instructions for an individual's proper handling, cleansing and preservation of root surface using available appropriate mediums. An informative section titled "public health aspects of dental trauma" is found under the care at home heading. It includes data relating to prevalence and incidence of dental trauma for children and adults, as well as most common injury risk and types of injuries sustained. The app's description says it will help parents, teachers and sports coaches. The prognosis for a fair amount of dental trauma often depends on addressing the trauma as quickly as possible. This app serves as an added adjunct to aid dentists, patients and parents, if and when dental trauma first takes place.
— Darien E. Hakimian, DDS

Office Mobile for Office 365 Subscribers
(Microsoft Corporation, free to download, subscriber prices vary)

Microsoft has finally released the much-anticipated Office Mobile for the iPhone, an app that complements many of the Office desktop apps that users have been accustomed to for years. Users may be disappointed to find that an active Office 365 subscription ($99.99 annually for Home Premium) that includes desktop applications is required for the app to work. After logging in with valid Office 365 credentials, users are taken to a file browser that contains locally stored and recently accessed Word, Excel and PowerPoint files. Although this app does accept file imports from other iOS apps, Microsoft has clearly designed Office Mobile to access files stored in the cloud. Users can add SkyDrive accounts and SharePoint sites easily from the file browser. The app can also create new Word documents and Excel spreadsheets. Files can either be saved locally or on SkyDrive or SharePoint. Users also have the option of emailing their saved files.

Users looking for fully featured Office desktop counterparts will be frustrated. This app allows for viewing and editing of Word, Excel and PowerPoint files while maintaining their existing content and formatting. However, there are few options for creating new custom content and formatting. When working on Word documents, there are only simple file, editing, formatting and viewing tool options. The formatting tool option includes bold, underline, italicize, strikethrough, color underline, highlight (limited to red, green and yellow) and font size. When working on Excel documents, the same tool options exist with small additions. The editing tool additions include simple cell content formatting (date, currency, percentage and text), the ability to create a chart and an autosum function. The viewing tool adds a simple sort function and the ability to apply a filter. When working on PowerPoint documents, the same tool options are present, but the editing tool is limited to altering text and moving or hiding slides. Users needing to create custom content or formatting beyond these basic editing tool options must create

them on Office desktop apps before viewing them with this app. Users wanting to access their Word, Excel and PowerPoint files on the go while only making minor changes will find Office Mobile extremely useful. Users looking to replace their desktop Office apps will most likely find this app marginally useful. — *Hubert Chan, DDS*

Virtual Dentist *(ModiFace Inc., free/upgradable)*

Practitioners often use before-and-after pictures to show patients what to expect from treatment they may receive in the office. Predicting results of patient cases prior to treatment is a considerable challenge that only technology can solve. Virtual Dentist is an app that takes an interactive and personal approach to patient education, using actual photos of the patient to provide simulated treatment results.

Users take photos of patients' smiles directly from the app or import them from the photo library on their device. Once a smile photo has been selected, users are taken through a photo preparation process that involves marking mouth boundaries, specifying center points of each tooth and masking of the areas surrounding the teeth. Users may find specifying tooth center points somewhat difficult and tedious, as it is sometimes difficult to get the placement exact.

Once the photo preparation has been finalized, users can easily simulate a variety of patient treatment, including braces, whitening, veneers, fillings, gum bleaching and gum reshaping. The free version only includes braces and whitening. In-app upgrades include a Premium Edition ($4.99), which unlocks all the patient treatment options or a Professional Edition ($99.99), which in addition to the Premium features, offers more options for practitioners to customize the look and feel of the app for their practice.

When simulating braces and veneers, the app superimposes a subset of images based on the center points specified on each tooth, allowing the patient to see what his/her teeth would look like if those treatments were done. Each bracket or veneer can be dragged if adjustments are needed. The whitening, gum bleaching and gum shaping treatments use a variety of white balancing and masking to produce the simulated treatment result. Users can toggle between the original photo and the simulated treatment. Simulated treatment photos can be saved locally or shared via email, Facebook and Twitter.

Virtual Dentist provides a fairly inexpensive method for practitioners to simulate a limited set of treatments for their patients. The interactive and personal approach of this app provides a unique experience for the patient in the wide array of patient education tools available to dentists. — *Hubert Chan, DDS*

DDS GP *(Kick Your Apps Inc., $399)*

Practitioners in the digital age have invested large amounts of money to computerize their offices. Patient education is just one of the areas where a practitioner is faced with a plethora of choices to make in deciding what to use in their practice.

DDS GP is a patient education app available for the iPad that has an all-inclusive solution for demonstrating diagnoses or treatments to patients chairside. Users are able to access a library of more than 230 demonstrations ranging from simple diagnoses such as interproximal decay to more complex treatments such as sinus lifts. These demonstrations are organized in basic categories, or through a searchable library, and contain beautiful, patient-friendly illustrations made by the author. Each demonstration is a video that can be played or manually scrolled through frame by frame. A floating toolbar appears over each demonstration, allowing users to make illustrations with their fingers directly on the demonstration itself. Users can save these custom illustrations within each diagnosis or treatment demonstration. Users can also import photos or digital radiographs from their iOS device's photo library, Dropbox account or through taking pictures from the app itself. Imported photos and/or radiographs are stored within each specific diagnosis or treatment demonstration.

In addition to providing valuable demonstrations to patients, DDS GP can also assist in creating illustrative patient treatment plans. The demonstration frame of any diagnosis, a series of frames for any treatment demonstration,and imported photos and/or radiographs can be added to a treatment plan for a specific tooth or area. When an entire treatment plan has been created, users obtain signature consent from the patient, and a treatment plan is formalized. Treatment plans are complete with a customizable formal letter from the office along with all demonstration illustrations that were added to the plan during the demonstration to the patient. Users can either print treatment plans to any AirPrint-compatible printer or send them via email.

When looking at the extensive library of demonstrations and features, along with an easy-to-use interface, DDS GP saves chairside time by providing patients a valuable educational experience into the diagnoses and treatments involved in their dental care. This app easily replaces the paper sketches that practitioners are familiar with. — *Hubert Chan, DDS*

Would you like to write about new technology?

Dentists interested in contributing to this section should contact Tech Trends Editor Blake Ellington at blake.ellington@cda.org.

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LOS ANGELES COUNTY

BURBANK (Ortho) - 45 yrs gdwll. Consists of 2 chairs in open bay w/ Pano/Ceph in 1,221 sqft ste. Grossed ~$292K in 2012.ID #4047.
COVINA - Leasehold & Equip Only! 3 eq op office located in 1 story med building. Reasonable rent with excellent terms. ID #4355.
CULVER CITY - Leasehold & Equip Only! 10 eq op office in a single story bld. In residential area. Heavy traffic flow. ID #4261.
HUNTINGTON PARK (GP) Established in 2008. In a 2 story free stranding bldg near residential area. Has 4 eq ops. ID#4295.
LOS ANGELES (GP) - Well designed practice w/ 5 eq op in a strip shopping center. 20 years of goodwill. Some Denti-cal. ID#2771.
LOS ANGELES (GP) - Three operatory office located on a 13 story prof blfg. Fee for service. 14 yrs of goodwill. Net $209K. ID#2831.
LOS ANGELES (GP) - Turn-Key office located in busy small shopping center. 3 operatories. Some Ortho. Near residential area. ID#4367.
MOORPARK - Leasehold & Equip Only! Modern office w/ 4 eq ops, 1 plmbd not eq in a 1,346 sqft ste. Reasonable rent. ID # 4343.
PACOIMA - Leasehold &Equipment Only! Two eq op w/ 1 plmbd not eq office in small strip mall. Charts included. ID #4361.
RESEDA - GP located on a single story bldg w/ heavy traffic flow. 18 year of gdwll. 5 eq operatories. Some Ortho. Net $235K. ID#4333.
TARZANA (GP) - Fee for service practice w/ over 28 yrs of goodwill. Consists of 8 eq ops and 2 plmbd not eq. ID #4313.
VALENCIA - Leasehold Improvements Only! Beautiful office w/ 6 plmbd not eq ops in 2,400 sqft. suite. Busy shopping center. ID#4321.

ORANGE COUNTY

COSTA MESA - Three (3) eq ops office w/ over 19 yrs of gdwll in busy strip mall. Fee for service. Revenues of $38K/mo. ID#4365.
HUNTINGTON BEACH (GP) - Modern designed practice w/ 3 eq ops & 1 plmbd in a 1,280 sqft ste. Grossed $246K in 2012. SOLD
HUNTINGTON BEACH (GP) Located in a 2 story prof bldg w/ 3 eq fully eq ops, Dentrix software in a 1,650 sqft ste. SOLD
LAKE FOREST (GP) - Turn key practice w/ 3 spacious eq ops, 1 plmbd not eq in a 1,200 sq ft ste. Busy shopping center. ID #4123.
MISSION VIEGO (GP) - Well designed turn-key practice w/ 3 eq op & 3 plmbd is located in a prestigious shopping center. ID #4303.
NEWPORT BEACH - Leasehold & Equip Only! On a 2 story med/dent bldg w/ 3 eq ops in a 1,000 sq ft suite. Reasonable rent. SOLD
ORANGE - Turn-key office w/ 42 yrs of goodwill. Has 2 eq ops, 1 plmbd not eq in 1,200 sq ft office. Not computerized. ID #4353
TUSTIN - Leasehold & Equip Only! Beautiful state-of-the-art off. Great for GP or Spec. 5 eq ops/3 plmbd not eq for expansion. ID #4225.

RIVERSIDE / SAN BERNARDINO COUNTIES

APPLE VALLEY (GP) - Well established practice w/ 5 eq op, 3 plmbd not eq, Dentrix software and digital x-ray. Net $214K. ID #4349.
BARSTOW(GP) - Long established office w/ 4 eq ops in a single story bldg. Easy freeway access. Fee for service. ID #4241
FONTANA (PEDO) - State-of-the-Art office w/ 2fully eq ops & 3 chairs in open Bay. 15% Insurance & 85% Denti-cal. ID #4301.
MURRIETA (GP) - Beautiful office w/ 3 eq ops surrounded by major anchor tenants. Some Capitation. 4 day/wk office. ID #4247.
PALM DESERT (GP) - Well established practice w/ 5 eq ops in 1 story bldg w/ ample parking & excellent signage. Net $119K. ID#4331.
RIVERSIDE - Fee for service practice w/ over 50 yrs of gdwll. Modern office w/ 4 eq ops in corner single prof. blfg. ID #4351.
UPLAND - Leasehold & Equip Only! All active pt charts included. Located in 2 story med bldg (ground level) w/ 3 eq ops. ID #4323.

SAN DIEGO C OUNTY

CHULA VISTA (GP) - Located in downtown. Store front. Consists of 4 eq ops 1 plmbd not eq. Some Cap. Net $152K. # 4279.
ENCINITAS (GP) - Corner location w/ excellent signage and street visibility. Consists of 2 eq ops. Fee for service. ID # 4315.
RAMONA (GP) - Established in 1979 and located in single strip mall. Busy area. Fee for service. Consists of 3 eq op. ID #4305.
SAN DIEGO (GP) - In free standing bldg w/ private prkng. Consists of 5 ops w/ Dentrix software. Monthly revenues of ~$40K. ID #4279.
SAN DIEGO (GP) - Beautiful Turn-Key practice with 8 eq ops in a modern designed shopping center. Absentee owner. ID #4335.

VENTURA & SANTA BARBARA COUNTY

SANTA BARBARA (GP) - Well established practice in busy shopping center w/ 3 eq ops in a 1,220 sq ft suite. ID #4311.

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How to Place a Free Classified Ad

The *Journal* has changed its classified advertising policy for CDA members to place free classified ads online and publish in the *Journal*. CDA members can place any classified ad. Non-CDA members can post employment classifieds or place display ads in the *Journal*.

All classified ads must submitted through cda.org/classifieds. Fill out the blank fields provided, including whether the ad is to appear online only or online and in the *Journal*. Click "post" to submit your ad in its final form. The ad will post immediately on cda.org and will remain for 90 days. Space permitting, your ad will run one time in the next issue of the Journal following the posting of your online ad. After 90 days, you will need to repost your ad if you wish to continue running it online. Note that CDA reserves the right to modify your classified ad for CDA style and to correct typographical errors.

Classified ads for publication in the *Journal* must be submitted by the fifth of every month, prior to the month of publication. Example: Jan. 5 at 9 a.m. is the deadline for the February issue of the *Journal*. If the fifth falls on a weekend or holiday, then the deadline will be 9 a.m. the following workday. After the deadline closes, classified ads for the *Journal* will not be accepted, altered or canceled. Deadlines are firm.

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Nonmembers are welcome to place display ads. For information on display advertising, please contact Corey Gerhard at 916-554-5304 or corey.gerhard@cda.org.

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AVAILABLE POSITIONS

DENTIST — Part-time Associate Dentist position available at Dental Spa of West Covina, a PPO multispecialty dental office. Must have experience working in a multispecialty environment; 3 years work experience required; proficient in molar endo. Must be available to work every third Saturday of the month. Submit CV to sdpartners346@yahoo.com.

DENTIST — Dear Doctor, We are a private dental office in Watsonville, located in the beautiful Monterey Bay area between Monterey and Santa Cruz. We are a general and multispecialty dental group. We invite you to join our team as an Associate Dentist. We require that you have at least 5 years experience. Experience with simple extractions and simple anterior root canals preferred. If you reside in San Jose, the Watsonville/ Monterey area is only about an hour drive and it's against the traffic. It takes less time to get here than to go from San Jose to Oakland during rush hour. If you are serious about this excellent opportunity, please email your resume to bayareadentist2009@gmail.com. Please do not hesitate to call us at 408.656.4567.

CONTINUES ON 634

CLASSIFIEDS, CONTINUED FROM 633

DENTIST — Hello! We are a multidisciplinary group practice in beautiful Sonoma County. We are starting a pediatric dental practice and are looking for an enthusiastic Pediatric Dentist or General Dentist who enjoys working primarily with children. We are a start-up so this is not a full-time position, but we fully expect it to be a full-time position in the future. Although experience certainly is desired, it is not required. Most importantly, we seek an individual who is compassionate and is truly looking for a long-term position. Please contact us at scpedo12@gmail.com for more info.

DENTIST — Kids Dental Kare is a leading provider of Pediatric Dentistry to the underserved population in California. We are looking for GPs with experience treating children in high-volume clinics for Ventura and Los Angeles counties. GPs with practice limited to pedodontics are preferred. Email resume to hr@kidsdentalkare.com.

DENTIST — New dental office in San Jose, Calif., is looking for a part-time or full-time Dental Associate. Must be gentle and able to communicate clearly with patients. Please email resumes to vunvhuy@yahoo.com.

DENTIST — Associate Dentist opportunity available in a growing, established practice with a comfortable, modern design. State-of-the-art-equipment, digital panoramic, CAD/CAM, laser and much more. Doctor must be ethical, have a positive, outgoing chairside demeanor and be a participating team player with our fantastic, supportive staff. Ability to perform full-dental services including extractions, molar endo and have an interest in cosmetic dentistry. This is a wonderful opportunity for the right candidate. Benefits include an assistant, medical, 401k, vacation and a

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BAY AREA

AC-187 SAN FRANCISCO: Near Union Square in the heart of the City! 950 sf w/4 ops **$225k**

AN-182 SAN FRANCISCO: Outstanding! Near Pacific Heights. 800 sf w/3ops **$395k**

BC-162 PLEASANT HILL Facility: Updated office, large windows & views of the outdoors. Open floor plan. 1,852 sf w/6 ops **Reduced! $150k**

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DN-186 SUNNYVALE: Beautiful , state-of-the-art practice. 1,214 sf w/4 ops **$400k**

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EN-167 SACRAMENTO: One of the most desirable, affluent areas. 2,400 sf w/5 ops. **$450k**

FN-181 NORTH COAST: Well respected FFS GP. Stable patient base. 1,000 sf w/3 ops **SELLER MOTIVATED! $150k (25% int. in bldg. avail.)**

FN-087 LAKE COUNTY: Quality practice, friendly staff & Cerec 2,400 sf w/3+ ops **$699k**

FN-148 MENDOCINO CO: "Gateway to the Redwoods!" Quality care in 4 ops **$325k**

FN-185 UKIAH: Street-level office/desirable area. 900 sf w/ 3 ops **$275k**

GG-140 CHICO VICINITY: **Selling for less than 50% of gross!** 1,200 sf w/4ops. **Reduced! $195k**

GN-058 YUBA CITY: Known for quality dental care. 1,704 sf w/ 4 ops Reduced! **$359k**

GN-103 CHICO: Successful, highly esteemed practice! 3,500 sf w/ 8 ops + 2 add'l **$850k**

GN-134 REDDING: Stellar reputation, quality care and location! 2,264 sf w/4 ops. **$500k**

GN-149 YREKA: Quality FFS, Warm & Caring. 900 sf w/ 3 ops **$200k/Real Estate $110k**

GN-166 CHICO: Well Respected Practice, loyal patient base. 1,800 sf w/4 ops. **$395k (or $450k w/Cerec)**

GN-177 CHICO/OROVILLE: Spacious and spectacular! 2,500 sf w/6 ops **$399k**

CENTRAL VALLEY

HN-059 LASSEN CO: Quality, well-established, family-oriented. 1,600 sf w/3 ops **$120k**

HN-169 SONORA AREA: Nestled in Pines East of Sonora. 1,800 sf w/3 ops + 1 Add'l **$250k**

I-9721 STOCKTON: Prof. complex. 1,450 sf w/ 3 ops & plumbed for 1 add'l **$75k**

IG-067 STOCKTON: Fully computerized, paper-less, digitalized. 5,000 sf w/10 ops **Now $425k**

IG-165 TURLOCK: Well established Shared/Solo Group Practice. 10 ops (shared) **$428k**

IN-176 TURLOCK: Mother Lode, SF Bay & Sierras nearby! 2,500 sf w/3 ops **$120k**

J-1000 TULARE: Highly visible location! 1,650 sf w/4 ops **$465k /Real Estate: $249k**

JG-137 FRESNO: Own the Building too! 3,500 sf w/ 5 ops **Now Only $425k/ Real Estate $350k**

JG-188 FRESNO: Loved, respected, Established! Net Profit over $350k! 1,452 sf w/4 ops **$390k**

JN-157 FRESNO: Comprehensive care and comfort . 1,470 sf w/3 ops **$200k**

JC-178 SAN JOAQUIN VALLEY: Historical Building in thriving area! 2,206 sf w/6 ops **$495k**

SPECIALTY PRACTICES

AC-119 MILL VALLEY Prostho: State-of-the-art equipment including: digital charting and x-ray. 1,100 sf w/ 3 ops. Plumbed for 4th **$450k**

CG-105 VACAVILLE Ortho: Strong, loyal, wide-spread referral base. 30+ pats/day. 5-6 new starts/mo. 2,000 sf 4 chairs/bays **$280k**

EG-131 ROSEVILLE/AUBURN Ortho: 2 practices within ½ hour of each other! **$175k**

I-7861 CENTRAL VALLEY Ortho: 2,000 sf, open bay w/ 8 chairs. Fee-for-Service. **$370k**

I-9461 CENTRAL VALLEY Ortho: 1,650 sf w/5 chairs/bays & plumbed for 2 add'l **$180k**

IC-163 CENTRAL VALLEY Perio: Well-respected FFS. 2,300 sf w/5 ops **$175k (Bldg: $250k)**

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stable patient base. Contact Dr. Denise Riemer via email at denise_riemer@yahoo.com or Tiffany (practice administrator) at tiffany@lemooredentalcare.com to learn more. You can call the office Mon-Fri at 559.924.2520.

ORTHODONTIST — Growing specialty practice with multiple locations in Santa Barbara and Ventura counties is looking for an experienced Orthodontist, two to four days a week. Please fax cover letter, CV and references to 805.682.8899 or call 805.682.4800 x 204 for more information.

DENTIST — New dental office in San Jose, Calif., is looking for a part-time or full-time Dentist. Spanish speaker is a plus. Must be able to communicate clearly with patients. Email resumes to vunvhuy@yahoo.com.

LAB TECHNICIAN — New dental office in San Jose, Calif., is looking for a Lab Technician for crown and bridge and removal of partial denture. Email resumes to vunvhuy@yahoo.com.

ORTHODONTIST/PERIODONTIST/ ENDODONTIST — New dental office in San Jose, Calif., is looking for a specialist (Orthodontist/Periodontist/Endodontist) to work 3 to 5 days a month. Email resumes to vunvhuy@yahoo.com.

ENDODONTIST — We're a modern, private general dental office with friendly staff and patients located in the East Bay. We are looking for an Endodontist for one day every other week. Compensation is negotiable. Please contact Rosie at 510.651.8479.

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• **BAKERSFIELD and SMALL FARM COMMUNITY Practices:** *For Sale* - two Practices 30 minutes apart from each other, staff and doctor work both practices – Strong patient base in both locations, room for growth, communities underserved. Rare opportunity to own two practices.

• **BISHOP:** *For Sale* - General Dentistry Practice & Building. Collections were $1,000,243 in 2011 with $387,000 Adj. Net Income. 5 op., 1,800 sq. ft. building. #14390

• **CENTRAL COAST:** *For Sale* - Pedodontic Practice. 4 operatories. Gross Receipts of over $775,000. #CAM546

• **CENTRAL COAST:** *For Sale* - Prosthodontic Practice. 4 operatories, full in-house lab. $1.1M in Gross Receipts in 2011. #CAM535

• **CHICO:** *For Sale* - General Dentistry Practice. 2012 Collections of $1,385,222. Free-standing building with 2,464 sq. ft. Buyer can purchase or lease building. #14392

• **COASTAL ORANGE COUNTY:** *For Sale* - General Dentistry Practice/Implant Practice. 2011 Gross Receipts were $1.2M 1,800 sq. ft., 4 op office with implant systems in every op. #CA520

• **COASTAL ORANGE COUNTY:** *For Sale* - Perio Practice. 5 Operatories, retiring doctor works 3 days with 4 days of hygiene. 2011 Gross Receipts were $400,000. #CAM533

• **COASTAL ORANGE COUNTY:** *For Sale* - General Dentistry Practice. 4 Operatories with modern, new equipment and high-end finishes. 2012 Gross Receipts of over $690,000 #CAM529

• **DANVILLE:** *For Sale* - FACILITY ONLY. Office has 5 fully equipped & furnished ops. Digital X-ray, Digital Panoramic X-ray, and central Nitrous Oxide/ Oxygen. Seller relocating after 27 years of practice. #CA548

• **FRESNO:** *For Sale* - General Dentistry Practice: $935K in collections in 2011, w/Adj. Net Income of $337K. Office is 2,300 sq. ft. with 6 equipped operatories. #CA502

• **GRASS VALLEY:** *For Sale* - General Dentistry Practice. Collections of $491K with an Adj. Net Income of $130K. Office is 1,555 sq. ft., 4 equip. ops, 5 available. #14379

• **GRASS VALLEY:** *For Sale* - General Dentistry Practice. 2012 Gross receipts of $442,736. 1,950 sq. ft. office with 6 operatories. Office condominium available to purchase. #14372

• **GREATER SACRAMENTO:** *For Sale* - General Dentistry Practice. 2012 Gross Receipts of $879,000 and Adj. Net Income of $446,218. 1,400 sq. ft. office with 5 operatories. #CA525

• **HAWAII (MAUI):** *For Sale* - General Dentistry Practice. Gross Receipts of $636K. Office has 4 equipped operatories in 1,198 sq.ft. #20101

• **INDIAN WELLS:** *For Sale* - General Dentistry/TMJ Practice. 4,000 sq. ft. suite, 6 ops. 2011 Gross Receipts over $350,000 on just one doctor day/week. #CAM530

• **LANCASTER:** *For Sale* - General Dentistry Practice. This 4 operatory office is located in 2,360 sq. ft. Gross Receipts were $676,000 with $174K Adj. net income. #14376

• **MERCED:** *For Sale* - General Dentistry Practice. 2011 gross of $878K with Adj. Net Income of $294K. 4 treatment rooms in 1,550 sq. ft. office. #CA512

• **MURRIETA:** *For Sale* - General Dentistry Practice. 4 operatories in 1,300 sq. ft. 2012 Gross Receipts were over $530,000 with $213,000 Adj. Net Income. #CAM544

• **LINCOLN-ROSEVILLE:** *For Sale* - General Dentistry Practice. 2012 Gross Receipts of $787K with Adj. Net Income of $358K. 4 operatories in 1,268 sq. ft. #CA545

• **NEWPORT BEACH:** *For Sale* - General Dentistry Practice.3 operatories, newer, high-end equipment. 2012 Gross Receipts of $350,000 on 3 1/2 days per week. #CAM534

• **NORTH OF SACRAMENTO:** *For Sale* - General Dentistry Practice. 2012 Gross Receipt of $521K with low overhead of only 52%. 1,650 sq. ft. with 4 operatories. #CA528

• **NORTH SAN DIEGO COUNTY:** *For Sale* - Large legacy practice. 12 equipped operatories, HMO practice with large CAP check. Desirable area in North County.

• **ORANGE:** *For Sale* - General Dentistry Practice. 5 operatories. 2012 Gross Receipts of over $830,000. #CAM543

• **ORANGE COUNTY:** *For Sale* - Periodontal Practice. 6 operatories available, 5 fully equipped. 2012 Gross Receipts of over $450,000 on a 4 day week. #CAM536

• **PALM SPRINGS:** *For Sale* - General Dentistry Practice. 4 operatories. PPO/Fee For Service, no HMO with 2012 Gross Receipts of $348,000 #CAM538

• **RIDGECREST:** *For Sale* – General Dentistry Practice and Dental Building. 4 operatories in 1,536 sq. ft. office building. This small practice grossed about $175K in 2012. #CA523

• **SACRAMENTO:** *For Sale* - General Dentistry Practice. Owner retiring. 2012 Gross Receipts of $642,507 with low 54.2% overhead. 8 available ops with 7 equipped in 2,400 sq. ft. office/building. #CA549

• **SAN GABRIEL VALLEY:** *For Sale* - General Dentistry Practice. 4 operatories. 2012 Gross Receipts of $950,000. #CAM537

• **SAN GABRIEL VALLEY:** *For Sale* - General Dentistry Practice. 4 operatories. 2011 Gross Receipts of over $590,000 on a 3 1/2 day week. #CAM541

• **SAN JUAN CAPISTRANO:** *For Sale* - General Dentistry Practice. 4 fully-equipped operatories. Gross Receipts of $650,000 in 2012. #CAM539

• **SAN RAMON:** *For Sale* - General Dentistry Practice. 2012 Gross Receipts of $926K with Adj. Net Income of $340K. 5 ops (6th plumbed) in approx. 2,000 sq. ft. #CA547

• **SAN RAMON:** *For Sale* - FACILITY ONLY. Great location, equipment, leaseholds & furnishings only. 1,400 sq. ft. with 4 equipped treatment rooms (2 additional plumbed) #CA511

• **SAN FRANCISCO:** *For Sale* - General Dentistry Practice. 3 operatories plumbed with NO2 in 648 sq. ft. 2012 Gross Receipts of $314,000. #CA527

• **TURLOCK:** *For Sale* - General Dentistry Practice. Doctor's gross receipts in 2012 were over $950,000 with $443,777 Adj. Net Income. #CA506

• **WALNUT CREEK:** *For Sale* - Prosthodontic Practice. Three fully-equipped operatories and lab. 2012 Gross Receipts of $530,000. #CAM540

• **WEST LA:** *For Sale* - Periodontal Practice. Four operatories, well established, seller may be willing to work back as an associate. Beautifully appointed office, highly desired location.

• **WESTWOOD:** *For Sale* - Amalgam-free General Dentistry Practice. Five operatories, near UCLA. $672,000 in Gross Receipts in 2012. #CAM542

• **YORBA LINDA:** *For Sale* - General Dentistry Practice. Five well-appointed operatories in a central location in this family community. #CAM531

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CLASSIFIEDS, CONTINUED FROM 636

ORTHODONTIST — Orthodontist needed for busy office one day a week in the Modesto area. Great patients, friendly team, wonderful pay. Email us at happybraces@gmail.com.

PEDODONTIST — Kids Dental Kare is now hiring for the most in-demand area in health care — children's dentistry. The Affordable Care Act makes children's dental the ideal place for you to be if you have the skills and desire to help others. Minimum 3 years experience. We've just opened three new offices and are opening three more for a total of 16 offices. Oxnard, Baldwin Park, Crenshaw adds to the 10 we already have. We are adding Fresno and San Jose along with Norwalk. Be a part of something really big and "do well by doing good." We work with GPs who limit their practice to pediatrics. This is not a "sometimes" vocation; too intense for that. If you think you qualify, please email resume to HR@KidsDentalKare.com. Visit us at kidsdentalkare.com.

DENTIST — General Dentist needed. Please call 818.988.9482 or email resume to smile4me0627@yahoo.com.

ORTHODONTIST — Orthodontist needed to start/take over an orthodontic practice within a general practice office in Arcadia, ideally 6 days per month. Compensation from $1,200 to $1,400 per day. Please email your CV to perfectteeth11@yahoo.com.

DENTIST — Dear Doctor, We are a private dental office Watsonville, located in the beautiful Monterey Bay area between Monterey and Santa Cruz. We are a general and multispecialty dental group. We invite you to join our team as a part-time General Dentist. We require that you have at least 3 years experience in a private office. Experience placing implants a plus. Experience with simple extractions and simple anterior root canals preferred. If you reside in San Jose, the Watsonville/ Monterey area is only about an hour drive and it is against the traffic. It takes less time to get here than to go from San Jose to Oakland during rush hour. If you are serious about this excellent opportunity, please email your resume to bayareadentist2009@gmail.com or call 408.656.4567.

DENTIST — General Dentist opening in a modern health center serving the Native American population of northwestern California. Ten-operatory clinic, four dentists and two hygienists. Located on the beautiful Redwood Coast of Humboldt County. Health insurance, malpractice insurance, paid holidays and generous vacation package, CDA and ADA dues paid, CE allowance and a lively and diverse working environment. Call Megan Warren in HR at 707.825.4036 for more details.

OFFICE MANAGER — Dear Office Manager: We have an excellent, long-term opportunity for a high-performance Office Manager in our Santa Clara office. The job is for 4-5 days per week. You must have a track record of growing a dental office and must have worked in a large, private dental practice managing the entire staff. Ideal candidate must have at least 2 years of recent Dentrix experience and

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4004 LOS GATOS GP

Seller retiring from a high quality cosmetic general practice in upscale neighborhood w/well-educated and loyal patient base & long term dedicated staff. Currently working equivalent of 2+ doctor-days with hygienist working 3 days per week. Seeks to transition practice to an experienced buyer with a passion for dentistry. Modern 1,200 sq. ft. office w/4 fully-equipped ops., digital x-ray & 7 fully networked computers running Dentrix. 5 year avg. GR $408K. 2013 GR on target for $360K.

PENDING

3092 SF FACILITY

1,600 sq. ft. street-level dental facility in Marina/ Cow Hollow neighborhood across from Presidio with excellent visibility and signage for foot traffic plus easy diagonal parking in front of building. Move in ready with 4 ops., 2 labs, kitchenette, reception and 2 desk areas plus 2 pvt. offices, 2 bathrooms, 1/2 basement & backyard with deck.

4003 SAN JOSE ORTHO

Owner passed away. Practice available immediately contact us for more information. Asking $295K.

SOLD

3096 NORTH BAY PERIO

Step into quality practice with established referral base. 2,200 sq. ft. office w/6 fully-equipped ops. Modern facility kept updated with recently purchased chairs, lights, Pano & lasers. Seller will grant a fair market lease and would consider selling the office space. 5 year avg. GR $1.2M+

3099 LOS GATOS GP

Well-est. general, restorative & cosmetic practice available in very desirable neighborhood. Gorgeous 1,530 sq. ft. office in single story dental complex w/4 ops. Asking $580K.

SOLD

3098 SALINAS GP

Well-known GP specializing in restorative dentistry retiring from 28 year practice located in highly visible downtown office. 4 fully-equipped ops., Panorex, digital x-ray & recent equipment upgrades. 2 year avg. GR $331K+ w/approx. 152 doctor days/yr.

3995 SAN CARLOS

Seller well-known for quality patient care retiring from established practice with loyal patient base, in highly desirable neighborhood. Asking $515K.

SOLD

3085 MODESTO GP

State-of-the-art practice in approx. 2,800 sq. ft. facility w/7 fully-equipped ops. This practice is for an established dentist or 2 dentists w/experience & who will appreciate a high quality practice. Asking $745K.

SOLD

4002 SANTA CRUZ AREA GP & BLDG

Well-est. practice in modern 1,250 sq. ft. office w/ 4 ops. 5 year avg. GR $630K+ w/ just 4 doctor days. Selling building & practice together. Practice asking price $430K, building to be determined.

4000 SONOMA COUNTY GP

Practice in a relaxing small town community located in the Sonoma wine country. Owner retiring from well-established practice in charming, fully-equipped, 3 op. turn-key facility. Approx. 400 active pts. Asking $110K.

4001 NORTHERN SONOMA COUNTY GP

Approx. 1,059 sq. ft. facility w/3 fully-equipped ops and dedicated parking in downtown area. Practice & building for sale. Great opportunity. Practice Asking $311K, building to be determined.

PENDING

3094 NORTH BAY PERIO

North Bay Perio now available. Seller retiring from well-est. practice with seasoned staff and active referral base. 1,300 sq. ft. very nice office with 4 fully- equipped operatories. 2012 GR $450K+ with just 3 1/2 doctor days and 5 days of hygiene per week. Great upside potential since owner does few implants. Asking $271K.

Contact Us:
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2055 Woodside Road, Ste 160
Redwood City, CA 94061

Phone:
650.403.1010

Email:
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should be top notch in selling small and big dental cases. We offer a competitive salary plus a performance-based bonus for the right candidate. If you think this is you, we invite you to email your resume to us at bayareadentist2009@gmail.com.

SURGICAL SCHEDULER — Part-time dental Surgical Scheduler is needed for a busy dental office in the Sacramento area. This position is responsible for scheduling outpatient dental surgeries at multiple facilities for various doctors. Responsibilities include, but not limited to: Obtain required medical, demographic and insurance information and collect out-of-pocket costs and POSs. Call patients, families and care providers to schedule appointments, recalls and return messages in a timely manner throughout the day. Maintain excellent communication and relationships with facilities and external clients. Demonstrate courtesy and helpfulness at all times toward families, caregivers and patients. Coordinate processes and route all paperwork as required to meet physician and facility requirements. Qualifications: 2 years surgery scheduling or dental experience; detail oriented; ability to multitask; team player; strong interpersonal skills; ability to work well under pressure; experience with insurance verification; customer-service oriented; familiar with insurances, POSs and Medi-Cal computer experience; bilingual preferred. $12 - $15 an hour, 30 hours a week, 10:00 a.m. – 4:00 p.m. Monday through Friday. If interested, please submit resume to kpirotto@rbughaodds.com or call the office at 916.941.0323.

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2012 collected $1.9 Million. Available Profits topped $1 Million. Collections thru 6/30/13 were $1.2 Million. Performance realized by One Dentist. After you get past "Wow!" reaction, there is nothing special. As well as this practice is performing, it is not close to realizing its potential. With right Successor who tweaks the practice where it needs to be tweaked, then this shall be Something Special. Paperless and digital. Ambitious SoCal Dentist who is not averse to commuting should consider this opportunity. Phenomenal opportunity for Periodontist. "Husband & Wife Team" would hit Grand Slam. Little competition with phenomenal upside. **Full Price $1.2 Million.**

Contact Ray Irving at 415.899.8580 or Ray@PPSsellsDDS.com.

6048 **SALINAS** Great opportunity for ambitious. Ideal for Husband and Wife. 9.5 days of Hygiene per week. 6-Ops. 2012 collected $1.1 Million.

6047 **STOCKTON** Best location outside Brookside Community on West March Lane. Annualized revenues of $500,000. Attractive 3-Op office. Package sale includes condo.

6046 **PINOLE** Collected $500,000 in 2012. 4-days of Hygiene produced $178,600. Beautiful office. Refers Endo. Lots of Goodwill here.

6045 **MANTECA - MODESTO AREA** Great location. 3 Ops, 2 more wired & plumbed. $180,000 invested here. Practice did more when Owner worked harder. 2012 collected $327,000 on 3-day week with 5-weeks off.

6044 **MODESTO** Best location. New development occurring nearby. Collects $380,000. Digital with computers in Ops. Very attractive office.

6043 **EL SOBRANTE** 3-day practice collected $170,000 in 2012. 3-Ops. Building optional purchase.

6042 **BERKELEY** 2012 produced $1.3 Million and collected $1.23 Million. Available Profits totaled $465,000. Owner works 3-days a week. 6-days of Hygiene per week. Very strong foundation. SOLD

6041 **PLEASANT HILL** Collected $365,000 with Profits of $142,000 in 2012. Owner slowing down. Previous 3-years averaged collections of $415,000 and Profits of $180,000.

6040 **SANTA ROSA** Beautiful 4-Op office. Paperless and digital. Collected $480,000 in 2012. Should have done more! Prior year did $625,000. Package includes condo.

6039 **CALIFORNIA'S LAKE TAHOE** Long established. 2012 collected $515,000 with 2-months off. Realized Profits of $230,000+. Attractive 3-Op office.

6038 **FREMONT** On part-time schedule due to other responsibilities, collects $300,000 per year. 2-days of Hygiene.

6029 **NORTHEAST CALIFORNIA – ALTURAS** Trade in smog and congestion for soaring mountains and close-knit communities. 2012 collected $514,000 on 3-day week. 3+ days of Hygiene. Beautiful office.

6008 **MENDOCINO COAST'S FORT BRAGG** Cultural haven offers attractive lifestyle. 2013 trending $800,000. 4-days of Hygiene. Digital radiography. Computers in ops.

3368 **SMALL TOWN NEAR LAS VEGAS** $600,000 invested here. Does $660,000 part-time. 4-to-5 days should do $1 Million.

3367 **IRVINE - ABSENTEE OWNER** 2013 tracking $1.4 Million. Beautiful 1,860 sq.ft. 5-Op suite with reasonable rent. Cash paying patients with one PPO. Interested in treating patients able to afford the best dentistry? Contact PPS.

3366 **INDIO** First Dental Building in Indio. New campus for 3,000 students being built 2 blocks away. Hi Identity.

3365 **YUCCA VALLEY** Hi Identity. Small practice needs TLC. On major Highway. Full Price $165,000.

3364 **RIALTO** Dental/Medical Building 18,000 sq.ft.. Room to build self-storage center in back. $1,200,000 or make Offer.

3363 **LAMONT/ARVIN – GP/ORTHO** Grossing $30K/month on 2 days. Beautiful 4 Op office. RE For Sale as well. 3,000 sq.ft. includes apt. Full time DDS will do $40K+/month.

3362 **BALDWIN PARK** Established 20+ years. 3 Ops in 1,000 sq.ft., Lady DDS Retiring. Conservative Seller needs to sell. Eager Buyer will gross in excess of $500K in this hi Identity Dental Building.

3361 **FONTANA – SUPER HI IDENTITY** Shopping center. 4 Ops. All Hispanic, next to McDonald's. Part time DDS. FP $285,000.

3360 **PALMDALE – BARGAIN** Shopping center. 4 Ops, grossing $15K-to-$25K part time by Absentee DDS. Full time DDS will do up to $600K like prior Owner. Asking $185,000.

3359 **ONTARIO** Stater Brothers Center. Hispanic patients. 5 Ops plumbed, 3 equipped. Rent less than $3,500/month. Needs marketing to do $500K+/year.

3358 **TEMECULA** Seller busy with young family and two thriving practices. Can take in Partner for one with option to buy all once Buyer bonds with patients. Buyer should Gross minimum of $500K.

3357 **CUCAMONGA** Shopping center on 210 Freeway. 50-to-70 new patients/month. 2013 projects $1.2 Million. Beautiful 5 Ops.

3356 **APPLE VALLEY – VICTORVILLE** Grossed $675,000. Modern Hi Identity shopping center. 8 Ops. With little marketing, will do $800K next year. Great Profits.

3355 **SAN FERNANDO PRACTICE & VALUABLE RE** Hispanic Market. 60-to-70 NPs/month. Store front. $40,000 Digital sign changeable with Dental Ads to 1,000's of passing cars daily in Front of High Traffic intersection. 7 Ops. Practice and RE $3.3 million.

3354 **GRANADA HILLS –** BEST PRACTICE – NO PPO's – NO HMO – NO MEDICAL Cash and Insurance. Established 45 years. Hi identity building. Property could be purchased. Grossing $1.1 Million. 7 Ops. FP $.1.2 Million for Practice.

3353 **EAST SAN DIEGO** DDS in a pickle will assist Buyer to Gross average $50K/month. FP $300,000. Unusual opportunity. Seller would sell half @ $165,000.

3352 **BAKER/VISTA – LAKE SAN MARCOS** Established 20+ years. Recently moved to prestigious Hi-Traffic location. 4 Ops with 10 plumbed. State of Art. Collections $50K/month. FP $550,000.

3351 **CARLSBAD** 4,000 sq.ft. Freeway Visibility. Grossed Million+, Absentee Seller. 12 Ops. Develop Solo Group. Specialists will pay for your investment. FP RE $1.5 Million and Practice $685,000.

3350 **ANAHEIM HILLS** Partner with Lady DDS who will sell all in 3 years. Purchase half now for 50% of Gross. Beautiful Hi Tech office.

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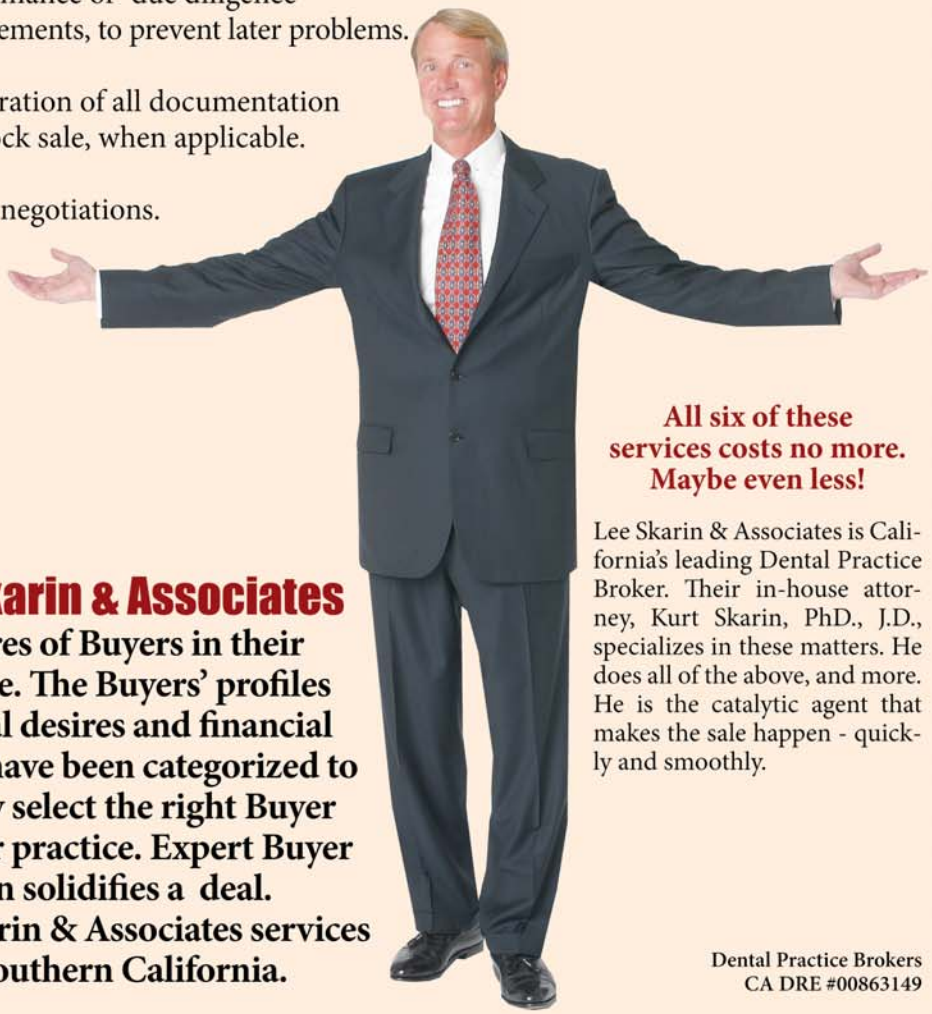

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successfully challenged by *cool* in all of its manifestations.

Cool was a handy word — cooler when spelled with a "k" — that could easily indicate complete agreement, a judgment call, admiration, a parenthetical phrase or a dangling participle, especially when accompanied by *Dude!* with a capital D. A whole generation of individuals yearning to appear coolized in public wearing malpositioned baseball caps, baggy, semi-detached pants and embryonic facial hair bathed (figuratively) in the glow of hyper coolicious dudeness.

If their quintessentialized dudeosity survived long enough to accumulate a 10-bathroomed estate in a gated area subject to annual landslides, floods and periodic SWATical summons, it was sure to proresonate with the under-30 aficianados and alert Internal Revenue Service personnel.

Fab and rad youngsters obtaining iconichoodness by age 17 bereft of properly tuned synapse grids, supercharged the paparazzied media. The result was the frequent totalization of the kids' Maserati/Lamborghini transport systems. Awesome! Even better, you didn't have to be *into* anything as long as you were *down* with it.

Well, chill! Superdude's hairdo and guitar are celebrated icons. Imagine that! George Washington didn't become an American icon until well after the cherry tree incident; wasn't even cool until he crossed the Delaware standing up in the boat. Michael Jackson introduced the iconic Moon Walk between surgicalized interventions, during which, or maybe before or shortly afterward, he and a hole in Wyoming became viralish icons at the same time.

In medieval times the Black Plague, a bubonic unpleasantness, viralized, killing about 75 million people worldwide. Today your cat can flatline from feline leukemia, your canary can pitch off the perch with avian encephalomyelitis without a mention. Converselywise, in less than four hours, they could both go viral on YouTube as 15 million viewers gawk at their doing something as epochal as tweeting the first bars of *Yellow Bird* or challenging a mirror to a cat fight.

Even viruses have been superactivated virally with the intent of destroying your computer. This is bad in the old sense of the word, the direct result of the unbridledness of superhackability! As a result, the mother tongue and the King's English are seriously unwell and will abdicate in favor of upsized flexibilityment.

English teachers and lovers of the language internalize with disaffectionism as they ponder the bastardization of their era when things were what they were, back when politicians would state their prevarications clearly with unforked tongues. "Let us all join together singly," they would pontificately verbalize, "in seeking a bipartisan transparency to the wellness of a new world order as we deputize a strategical forwardness to the iconic resonation of carefully massaged diversity."

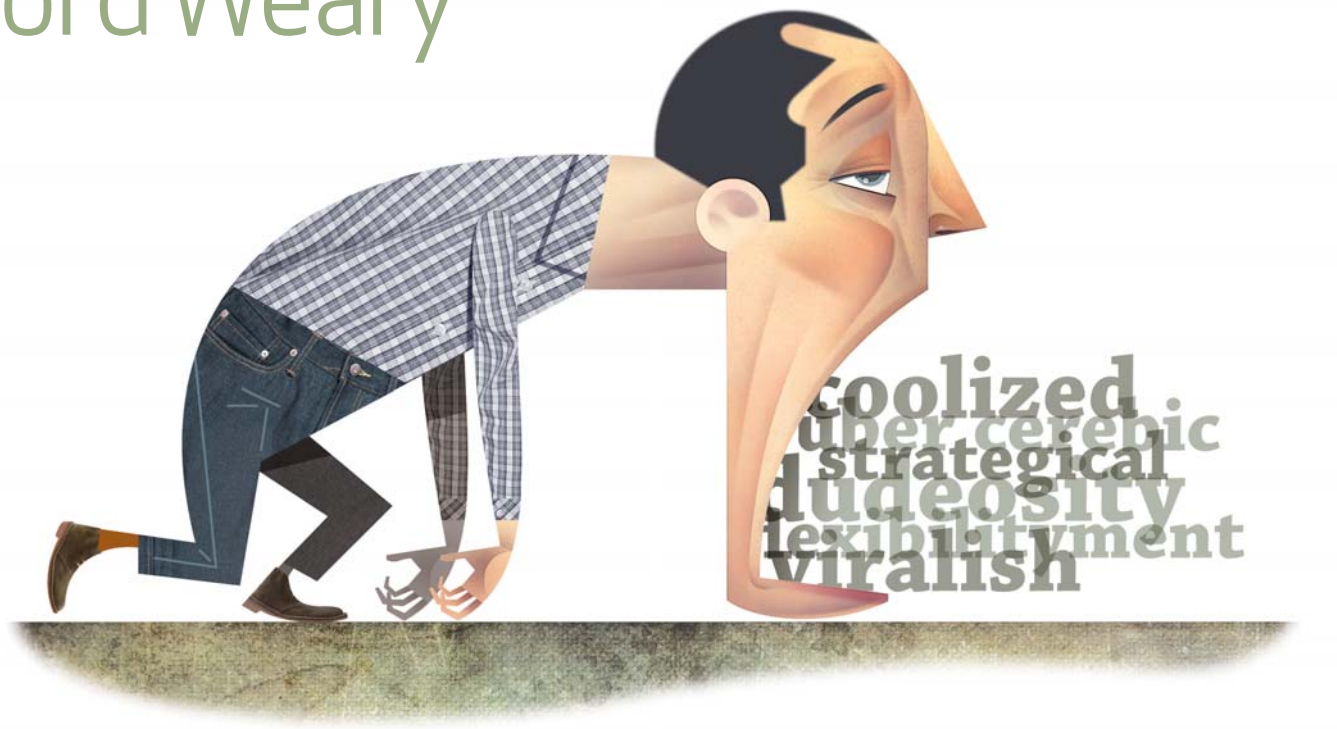
Norman Hicks could not have put it better. Noah Webster revolves in his grave, probably counterclockwiseably. ■■■■

We're taking your requests

If you have a favorite Dr. Bob column you want to see again, email Publications Specialist Andrea LaMattina at Andrea.LaMattina@cda.org. We will oblige by reprinting those requested favorites interspersed with any new Dr. Bob submissions.

CDA JOURNAL, VOL 41, Nº8

Word Weary



Fortunately, Norman didn't live to witness the amazing adaptability of the English language when super was successfully challenged by cool in all of its manifestations.

Robert E. Horseman, DDS

ILLUSTRATION BY VAL B. MINA

Norman Hicks was short. Hundred and thirty-five soaking wet, but sharp as a newly stropped razor, keen as mustard, bright as a new penny and knew more about electricity than George Westinghouse and Tom Edison put together.

While the girls at Frances E. Willard Jr. High School in 1934 were learning to make cupcakes and pasta fagioli in home economics, preparing for a lifetime of drudgery in the kitchen, Norman Hicks was enthralling us boys in electric shop with the mysteries of ohms, volts and heterodynes. We could blow bubblegum and fuses with equal ease and if something was in, we were into it. Unless girls were into it, then we were out. All of a sudden, at some point, girls were in, ultimately evolving into more fun than kilowatts and milliamperes. The learning curve steepened and Mr. Hicks was no more help than my grandfather.

Possibly because he wasn't all that into coeds who never got within a half mile of his class, Mr. Hicks had time to compose the prefix "super" and added it to the word heterodyne. We never learned exactly what a superheterodyne was, but the prefix by itself soared into universal usage and has since been appended to every known human condition and most commodities in existence. That's how über cerebral Norman Hicks was. Finally, in 1964, superstars Dick Van Dyke and Julie Andrews in a freshet of superfluity, delivered the ultimate use of *super* in the song *SUPERCALIFRAGILISTICEXPIALIDOCIOUS*. Walt Disney's superego prevented the studio from curbing the superciliousness of this superdooper production, which is the reason it didn't superannuate on the spot.

Fortunately, Norman didn't live to witness the amazing adaptability of the English language when *super* was

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