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ORTHODONTICS

Robert L. Boyd, DDS, MEd

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Today Will Determine Tomorrow

Several years ago, at the request of the Strategic Planning Committee, and with the approval of the House of Delegates, the California Dental Association expanded its strategic plan to include the now "infamous" Goal 9. An overarching assessment of the structure of the organization with respect to governance and leadership as well as interrelationships between local components and the CDA in the provision of consistent, high-quality membership services to all was to be studied. The size of the state, number of components, varying membership of individual components, staffing patterns, geographical boundaries and budgets all needed to be evaluated to allow for consistent services throughout.

A large and diverse task force was developed and consultants were hired. Members, leaders, administrators, and other individuals were interviewed in an information-gathering mode to develop what could be construed to be a problem list for future action. This study, albeit a work in progress, was brought to the House of Delegates two years ago and a tremendous sense of unease was noted at many levels. Members and component staff expressed reservations about the intention of this study and had concern about the impact of any reorganization at the local level. The house put in place a second task force and additional information and analysis is underway. The work continues.

Goal 9 is not about eliminating components or staff positions. It is intended to provide a consistent level of quality services to each member regardless of the size, staffing pattern or location of the component, equality of benefits and a basic level of core services should be available to all members. This goal originated from the task force and was confirmed in the "Mind of the Dentist" survey.

Goal 9 is about change. Change frequently is an uncomfortable thing; but without change we would not have progress or growth. However, change just to do something differently does not make sense. But modification of structure or function to provide a better level of service to our members will benefit not only the organization as a whole, but also the membership as individuals.

Introspective analysis is always difficult and it is understandable that many of us do not want to alter our own our present situations. We do not want to leave our comfort zone, but we must strive continually to improve what we do and how we do it. That we "always do it that way" does not allow for creative thinking or advances.

In daily practice, we use technology and analytical skills to provide better, more efficient, and, hopefully, more cost-effective care to our patients. If change were reprehensible to all, our level of service to our patients would not be where it is today.

We need to be ever vigilant in developing means of improving the benefits to our members. Some services may best be delivered nationally by the American Dental Association, while others are bettered brokered by state associations in California and other states. All of us can agree there are significant functions that are delivered most efficaciously at the local level in the component.

Introspective analysis is always difficult and it is understandable that many of us do not want to alter our own our present situations.

The cost to, and ability of, a local component to deliver necessary services to its members must be weighted carefully. Partnering of small components or sharing of services might be a more effective and efficient means of doing what our organization needs to do for our dentist members and their staffs.

Being comfortable wearing an old pair of shoes may well be a place we would like to be but we risk being out of style in the contemporary environment. We could let personal prejudice and agendas stop us from being responsive to our members needs. Growth that necessitates change in the structure and organization of dental societies and associations is imperative to keep up with the needs of our members. After all, that is why organized dentistry exists.

If tomorrow we function as we do today, then tomorrow will be today over and over again with no room for growth. If today we look toward a better tomorrow, then our ability to grow is unlimited. The adage states "if it ain't broke don't fix it," but how do we know that it ain't broke? Self-assessment is a valuable part of organizational maturity. Things may change, or not. But until we study where we are and consider future needs, we will not know. ■■■■

Stepping up to Meet a Great Need

If you take the narrow view, it makes sense to advocate that it is better to do volunteer dental work at home within the U.S. borders because there is a great unmet need for dental care. However, in my opinion, the world view for volunteering outside the United States takes precedence for a variety of reasons.

There are many dentists, who, in their dental school youth, did mobile clinic adventures to the Central Valley of California. It was an experience like no other in terms of exposure to the dental needs of the migrant farm workers and their families. And, of course, not to be forgotten, wild nights of fun after a hard day's work. Ah, youth!

Many of those same dentists are now of a certain age and are decades-long veterans of dental practice and are in search of an adventure. The underlying altruistic concept has not been lost on them but the chance to use well-honed skills for good in Uganda or in the remote corners of Guatemala, for example, has a strong pull. It can be like turning the clock back 30 years mentally, though not physically, to say the least. I, for one, have never worked so hard as on these trips. For example, two dentists working without electricity or running water extracted 218 teeth in 3½ days. That is way more work than is done at home in the same time period. At the end of those days: Party, no! Bed, yes!

The downside, as I see it, is that there is a certain hit-and-run aspect to the volunteer trips. It is as though there are endless needs to be met and just a moment in which to address them. It is frustrating to go on a volunteer dental trip and only be able to relieve pain by extracting teeth, and know that nothing else will be done until another volunteer group shows up to do what it can. In a way, it is an unbroken cycle of need without much hope for improvement.

Beyond the unmet dental needs there is a greater need, as I see it, the lack of potable water and the impact of that on overall health. There are groups who focus on the water problem and how to obtain and deliver potable water to the population. The success of such projects can be far reaching both from a medical and dental standpoint.

So, after some repeat experience on foreign dental trips you ask yourself, "Why do it?" But then, because you are a dentist of a certain age and experience, and you welcome the adventure and the small bit of help you can give, you sign up again for another trip. Maybe Tanzania next time.

For those itching for an adventure, the American Dental Association will hold a volunteer symposium just prior to the annual meeting Oct. 14-15 in Las Vegas. Attending this symposium just might be the first step to a new professional adventure.

Kit Neacy, DDS
Covina, CA

Many of those same dentists are now of a certain age and are decades-long veterans of dental practice and are in search of an adventure.

Lee Ann Engle

Designing a User-friendly Web Site

By Dell Richards

Today, most dentists have Web sites or are planning on one. An educational tool, Web sites also can begin the relationship building with a potential patient even before that person has made an appointment.

But, having a Web site and having an effective, user-friendly Web site are two very different matters. Like most businesses, dentists create Web sites they like. They come up with a site plan they think works, use words that show their expertise, and choose colors that speak to them.

Rarely, do they step aside and ask what the patient wants. If they kept three

"The most important question to ask is 'Why are people coming to me and my site?'"

ERIC LAY

basic areas in mind, they could create a more user-friendly Web site. Those three areas are:

- Site plan,
- Design and copy, and
- Color.

When it comes to site plan, the first question to ask is: "What is the largest revenue-generating service?" "What is the reason someone is visiting the site and turning the dollars for them," said Eric Lay, president of Rocklin Systems, a Web site design and hosting firm. "The most important question to ask is 'Why are people coming to me and my site?'"

Lay suggested looking at business model, referral base, and revenue generated from each service. Then rank them.

"Those are the ones you want to emphasize the most," Lay said. "You want them to have a primary spot on your navigation."

This is especially true of the services page, where the most lucrative services should go on top. Presumably this would be the area of specialization and expertise, but not always. It depends on the practice.

While the bottom line is generating new patients, a Web site's secondary function is to educate the public on the services that separate one practice from another. In these cases, it should be something truly unique, at least in the local area. It might be something like a diagnostic laser. Or a Waterlase. Not an intraoral camera.

While the tag line and initial copy appeal to people who make decisions based on emotions, the educational aspect will satisfy people who are more analytical in their decision-making.

One huge mistake professionals often make is creating Web sites that speak to other professionals rather than the patient. This is where simple copy becomes paramount. (If the Web site needs to appeal to other dentists, have a separate, password-protected portal that also can be used for patient referrals and records.)

"You have to make sure the content is directed to the audience," said Lay. "You have to use words the patient uses. Do not use terms a patient wouldn't understand."

Because Web sites are a visual, scannable medium like television, language actually should be targeted to a third-grade level, an even lower level than articles or columns dentists might write for newsletters or publication in the popular press.

One prime example is the word "caries." Only dentists use that word. The public uses "cavities."

The reason for simplicity is simple: Every time a person hits a word they don't understand, they are likely to leave the site without acting, the last thing the dentist wants.

When it comes to language, dentists also need to make their Web site search engine friendly. Like everyone else, dentists want their name to come up first when a potential patient uses Google or another search engine to look for a dentist. "The idea is for a dentist to be on the first page as close to the top as possible," said Ed Williams, chief technology officer of American Web Services.

When looking up a dentist for the first time, potential patients generally use the name of their city (or neighborhood), then add the type of dentist they want. This is why many dental Web site design firms insist that patients register their practice with domain names such as "Sacramento family dental" or a variation thereof. If the dentist already has the practice registered in his or her name, a roll-over to that site can take them instantly to the dentist's original site.

Using specific key words in the text also will help raise the dentist on the search engine listing. As such, sprinkling the phrase "Sacramento family dental" through the copy is a good idea (if that is the domain name registration).

To find key words, however, dentists and Web site designers have to think like patients first, dentists and designers second. Not always an easy task.

Another way to raise visibility is simply to pay for sponsorships on Google, Yahoo and other major search engines. (Those are the list of links on the right-hand column of the screen.) While these can be very expensive, especially for a phrase like "cosmetic dentist" that are used in millions of pages across the Internet, other words can be less costly. Figuring out which ones are reasonable, while still being used often enough can be tricky.

Also, remember that flash animation does not help search engines. Pretty and exciting as it is, search engines cannot read copy in flash format.

When it comes to Web site design, an even more subtle aspect is color. Color creates emotional states in people that can be useful to the site or not.

One reason why blue is so popular not only on Web sites but logos, is that blue is universally favored by people. The color of sky and crystal clear water, blue is the most trustworthy and credible color not only on the planet, but on the color palette.

"Blue makes us feel comfortable," said Andy Markley, owner of Art 101, a Sacramento graphic design firm. "It's soothing and contemplative — and makes people want to stay on your site."

Its opposite — orange — makes people feel lively. "Red and orange are used for fast-foods and gas stations because they want you to get it and get out," Markley said. It pumps up the energy to make people want to hurry up, eat a Big Mac and sell a Happy Meal to someone else."

An exception is Starbucks. With its rich, dark green, it sells the idea of relaxation and the enjoyment of the Starbucks experience. And makes a pretty penny off a cup of coffee in the process.

Although often ignored but still a key component of design, class makes a difference in color choices. "It's tied to income," said Markley. "The higher the income, the richer the color people like."

That's why dark versions of colors such as blue and grey as well as black symbolize authority. Deep, rich wines and greens also are associated with wealth and higher status.

As men and women not only tend to see color differently and prefer different shades of the same color, another factor is gender. While fire-engine red is great for a sports car targeted to a male, auto manufacturers know that women tend to go for wine-colored cars more.

No matter what the final Web site choices are, taking these points into consideration will help the site be more effective.

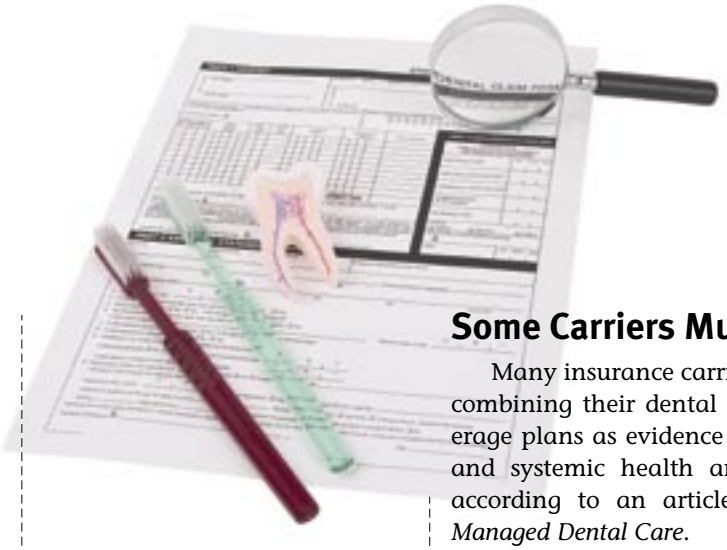
A practicing journalist, Dell Richards runs Dell Richards Publicity, a public relations firm specializing in dentistry and health care.

Every time a person hits a word they don't understand, they are likely to leave the site without acting, the last thing the dentist wants.

Fast Facts on Floss

A few things to ruminate, according to a recent issue of *The Dental Assistant*, the next time when reaching for the floss:

- Women are almost twice as likely to floss their teeth daily as men (40.2 percent versus 23.1 percent).
- The average American will spend $7 on dental floss this year. Americans bought 1.9 million miles of floss in 2001.
- Wax floss was introduced in the 1940s, and tape floss followed in the 1950s. On their heels were cinnamon- and mint-flavored floss.
- Charles Bass, a medical physician, is credited with making flossing an integral part of dental hygiene. After World War II, he also developed nylon floss as a replacement for the silk variety.
- The first commercially available dental floss, released in 1882, was an unwaxed silk floss by Codman and Shurtleft Co., a firm in Randolph, Mass.
- Levi Parmly, a New Orleans dentist, invented dental floss, a silken thread, around 1815.
- Marks from "flossing" have been found on the teeth of early humans.



Some Carriers Mulling New Insurance Options

Many insurance carriers are looking at combining their dental and medical coverage plans as evidence mounts that oral and systemic health are closely linked, according to an article in an issue of *Managed Dental Care*.

While it's too early to tell what the final shape of dental benefits will be, whether grouped together dental-medical plans or as stand-alone plans, industry leaders, the article stated, are looking at ways to offer packages that combine both types of insurance.

Indiana and Ohio, according to an ongoing study funded by Delta Dental of Michigan, has shown early evidence that diabetics who have periodontal disease are healthier if they obtain more frequent professional teeth cleanings.

"If the early findings prove correct, we plan to incorporate coverage of additional cleanings into benefit plan designs for our members with diabetes and periodontal disease, possibly as early as 2007," said Jed Jacobson, Delta Dental senior vice president of professional services and chief science officer.

Blue Shield of California, has introduced an enhanced small-group dental benefit for pregnant women on the basis of growing evidence that pregnant women with gum disease are more likely to deliver preterm babies.

But despite these developments nationwide, most insurance carriers are not quite ready to commit to hybrid dental-medical packages.

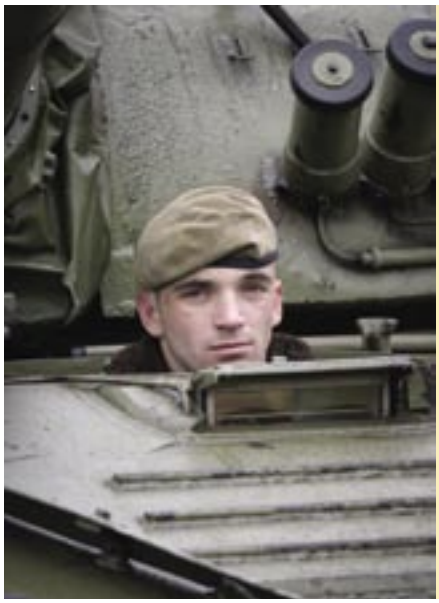
"Evidence does suggest that there may be a cost savings relationship between dental care and medical costs, but the data are not definitive at this time for a major change that would give an advantage to either carrier type," said Bob Clifton, vice president of Blue Shield of California's ancillary services. "It's a natural fit and it's possible that companies that offer both kinds of benefits could have a competitive advantage in the marketplace as market pressures change, but evidence of marketplace advantage remains to be fully demonstrated."

New Strength Antibiotic Approved by FDA

The U.S. Food and Drug Administration has issued a letter of approval for new strength antibiotic Keflex prescribed by dentists and physicians, Advancis Pharmaceutical Corp. recently announced.

In July, Advancis began marketing new strength Keflex products nationally. The newly approved 750 milligram strength offers health professionals an easier way to deliver a total dose of 1500 mg a day in two daily doses. Keflex has been available in 500 mg doses taken three times a day. Advancis received approval to market 333 mg and 750 mg capsules.

Keflex is a brand name for a cephalosporin antibiotic, which is used to treat infections. And according to Advancis, it is the most prescribed oral cephalosporin antibiotic in the United States. Generically known as cephalexin, dentists prescribe cephalosporins for oral infections, said Ronald Zentz, RPh, DDS, senior director, ADA Council on Scientific Affairs.



Combating Caries

Although service personnel receive care at makeshift dental offices the U.S. armed forces has scattered throughout the region, senior military dentists have said it is nearly impossible for them to fight caries in all active duty soldiers serving in Afghanistan and Iraq. What's more, because of the potential workload, one dental office, located on Tallil Air Base in Iraq, performs all treatment except for routine cleanings, according to Drs. Sean Boynes, DMD, MS, and Anne Lemak, in an issue of *The Bulletin*, the official publication of the Dental Society of Western Pennsylvania.

To help alleviate caries among the women and men on active military duty, the Pentagon has ordered xylitol gum in MREs or "meals ready to eat." Since these MREs have an elevated carbohydrate content, the risk for tooth decay among carb-consuming soldiers tends to be high.

Defense health officials are hopeful that including xylitol gum in the meals will help neutralize the effects of the meals and the poor dental hygiene habits that are common to military personnel living in war zones.

ADA to Honor Humanitarians

The American Dental Association has established a new award to annually honor a member whose work sets a shining example of humanitarianism for others in the profession.

The new ADA Humanitarian Award, which will be conferred by the ADA Board of Trustees, is set to debut in 2007. The ADA Center for International Development and Affairs will administer the new award, which was developed by the association's Committee on International Programs and Development. A member of the Council on Access, Prevention and Interprofessional Relations will assist CIDA with nomination review.

"So many dentists just give so much of their time and resources to help others," said Greg Chadwick, DDS, MS, and CIPD chair. "They don't do it looking for thanks, but we think it's important that the ADA recognizes them and their extraordinary efforts."

The award recognizes "individuals who have distinguished themselves by outstanding, unselfish leadership and contributions to their fellow human beings in the field of dentistry through the dedication of extraordinary time and professional skills to improve the oral health of underserved populations within the United States and/or abroad."

Potential recipients are those whose volunteer work and leadership:

- Contribute significantly to alleviate human suffering and improve the quality of life and oral health of those served,
- Demonstrate significant leadership and outstanding humanitarian volunteer accomplishments that bring honor to the profession,
- Serve as an inspiration to the dental profession,
- Show a commitment to humanity and selflessness in regard to direct personal or organizational gain or profit, and
- Establish a legacy of ongoing value and benefit to others.

More information will be available in upcoming issues of the *ADA News* or by contacting CIDA, (800) 621-8099, ext. 2727, or contacting John Hern at hernj@ada.org.

Honors

Jon Draper

Marc Geissberger, DDS, associate professor and chair, Department of Restorative Dentistry, University of the Pacific Arthur A. Dugoni School of Dentistry, was named president of the Omicron Kappa Upsilon National Dental Honor Society's Supreme Chapter for the 2006-2007 term.

Potential Shortage of Anesthetic

Because of a recent change in suppliers for Cooke/Waite Marcaine, the American Dental Association is trying to alert dentists to a possible shortage of the product. Whenever there is a supply change for a product, the new supplier is required to file an application with the U.S. Food and Drug Administration.

Marcaine is distributed by Kodak, which learned last year that the previous supplier had decided to stop production. The new supplier, whose name has not been made public, currently is waiting for FDA approval to supply Marcaine. Kodak will announce the new availability date once approval is received.

"There is no direct replacement for single cartridge dental local anesthetic Marcaine," according to Kodak's new fact sheet.

Dentists looking for an alternative to the dental cartridges should note that 0.5 percent bupivacaine with epinephrine, the same strengths as Marcaine, is available in a multidose vial.

Kodak's fact sheet is available online in a PDF format at www.kodak.com or by calling (800) 933-8031.

Upcoming Meetings

2006

Oct. 7-11	Pacific Coast Society of Orthodontists 70th Annual Session, Honolulu; Oct. 11-13 post-meeting program, Poipu Beach, Kauai; www.pcsortho.org, (415) 674-4500.
Oct. 16-19	ADA Annual Session, Las Vegas, (312) 440-2500.
Nov. 2-4	Hispanic Dental Association 14th Annual Meeting, Universal City, www.hdassoc.org or (217) 793-0035.
Nov. 5-11	United States Dental Tennis Association, Palm Desert, www.dentaltennis.org.
Nov. 12-18	57th American Academy of Oral and Maxillofacial Radiology 57th Annual Session, Kansas City, MO., www.aaomr.org.
Dec. 3-6	International Workshop of the International Cleft Lip and Palate Foundation, Chennai, India, (91) 44-24331696.

2007

April 15-21	United States Dental Tennis Association, Sarasota, FL, www.dentaltennis.org.
May 3-6	CDA Spring Session, Anaheim, (866) CDA-MEMBER (232-6362).
June 27-July 1	Academy of General Dentistry Annual Session, San Diego Convention Center, (888) 243-3368.
Nov. 27-Dec. 1	American Academy of Oral and Maxillofacial Radiology 58th Annual Session, Chicago, www.aaomr.org.

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

INTRODUCTION

Orthodontic Treatment

Robert L. Boyd, DDS, MEd

This issue of the *Journal of the California Dental Association* is dedicated to current issues, controversies, new treatment approaches and the future of orthodontic diagnosis and treatment. We are fortunate at the University of the Pacific Arthur A. Dugoni School of Dentistry to have several ongoing clinical and research efforts among our faculty in these various areas, which are covered from our perspective in this special issue.

The first article is about one of the most exciting new appliances to appear in the past 30 years, the Invisalign appliance. At Pacific, we were fortunate to be asked to do the first study of this new appliance in 1997, which was made available for clinical trials in 1998. Based on the positive results of this early study, Invisalign was introduced to all dentists in 2000. Since that time, almost half a million patients have been treated with the Invisalign appliance, and other companies are now making competing products. In this article authored by myself, Drs. HeeSoo Oh, Mohamed Fallah, and Victoria Vlaskalic, we discuss some of the advantages and limitations of this new approach. The most obvious advantages are improved esthetics, comfort, and hygiene as compared with

Guest editor / Robert L. Boyd, DDS, MEd, is a professor and the Frederick T. West Endowment Chair in Orthodontics, Department of Orthodontics, University of the Pacific Arthur A. Dugoni School of Dentistry.

The most obvious advantages are improved esthetics, comfort, and hygiene as compared with fixed appliances.

fixed appliances. Another advantage is the increased number of patients who had previously not sought treatment with conventional appliances, are now accepting treatment with Invisalign. However, since it is still early in the evolution of this appliance, it is important that dentists who wish to use it in their practice learn many new concepts before using this innovative approach.

In the article by Drs. Steven Dugoni and Maryse Aubert, the age at which children should start orthodontic treatment is discussed. This subject has been debated amongst orthodontists for many decades. Orthodontists can agree on what is a quality orthodontic result, but they disagree as to how and when to best obtain this result. Some orthodontists would prefer to begin in the early or late mixed dentition. Still others would rather postpone treatment until the permanent dentition at approximately 12 years old. This article evaluates the pros and cons of initiating treatment at different ages.

At the University of the Pacific our primary approach to early treatment of moderate to severe malocclusions is a two-phase approach. The first phase begins in the early mixed dentition at approximately age 8, and the second phase starts in the permanent dentition at approximately age 12. Results from studies of the two-phase method at Pacific show that early mixed dentition treatment with phase I orthodontic care can reduce or eliminate the need for full-banded phase II orthodontic treatment at a later age. These findings are in contrast to other studies that do not show any advantages of the two-phase approach and advocate that treatment should begin in the permanent dentition, which could shorten the treatment time and lessen the costs to the patient.

In addition to the disputes regarding when the appropriate time is to start treatment, this article discusses the disagreement within the profession on what types of problems should be treated at what age. Some orthodontists would like to treat crowding problems in the mixed dentition, believing that in doing so they will have a better opportunity to develop the arches and avoid extract of premolars. The investigators summarize their recommendations for successful early treatment by emphasizing thorough and accurate diagnosis, comprehensive treatment planning, and continued care during supervision until the eruption of the permanent dentition.

The article on craniofacial anomalies authored by Dr. Marie Tolarová and her team is focused on finding causes and prevention of cleft lip and palate. The authors present some of the new and promising developments now being tested on various dietary recommendations and genetic counseling techniques of these serious congenital malformations affecting so many children in the world today. This article also describes how the Pacific Orthodontic Department collaborates with Rotaplast International, Inc. participating on cleft lip and palate medical missions around the world. Our orthodontic faculty and residents travel to many different countries to help these unfortunate children with existing deformities through treatment, and perhaps just as important, to counsel families about genetic and dietary influences that could greatly increase the mother's chances of having a child with one or more of these severe birth defects.

With all of the attention being focused on restorative implants in dentistry today, Dr. Heon Jae Cho, one of the world's leading experts in the area of microimplants, has written a very interesting article on this technique. These devices are smaller versions of restorative implants that are used as temporary orthodontic anchorage devices to solve many of the problems that have plagued orthodontists, namely, unwanted, reciprocal movements of other teeth being used as anchorage.

The final article is by one of the foremost clinical orthodontic researchers in the world today, Dr. Sheldon Baumrind. In this article, Dr. Baumrind focuses on the concept of evidence-based treatment. He points out that thus far our profession has accumulated very little evidence with which to test currently available treatments. He further states that because the primary purpose of all clinical research in orthodontics is to improve the delivery of orthodontic treatment, the main tasks of clinical orthodontic research in the next two decades should include the study of: 1) how expert orthodontists make clinical judgments; 2) how good those judgments are; and 3) how we can develop strategies and tools such as 3-D technologies for making better clinical judgments.

All of the authors certainly hope you will enjoy reading this special issue about orthodontic treatment from our perspective at the Arthur A. Dugoni School of Dentistry. ■■■■

An Update on Present and Future Considerations of Aligners

Robert L. Boyd, DDS, MEd; HeeSoo Oh, DDS, MS, PhD; Mohamed Fallah, BDS, MDS; and Vicki Vlaskalic, DBSc, MDSc

ABSTRACT

This report reviews the orthodontic treatment of six different patients who received removable aligners. These cases include correction of deep overbite, open bite, mild-to-moderate crowding, large overjet, cases requiring premolar extractions, the presence of multiple restorations, and cases requiring periodontal-restorative treatments, the improved periodontal status with aligners compared to fixed appliances and the use in teenagers. This report demonstrates that a wide range of cases can be effectively treated, provided the cases are thoroughly reviewed at an early stage process using Invisalgn's ClinCheck software, which will show the specific details of all consecutive appliances prior to any treatment being started so as to determine the biologic and biochemical feasibility of treatment.

The Invisalign appliance was introduced in literature in 2000 by authors Boyd, Vlaskalic and Miller.[1] Since then, more than 400,000 patients around the world have had this treatment.[2] Although another clear, removable appliance has recently been introduced by OrthoClear, there is no literature demonstrating efficacy of this appliance. Since its introduction, there have been numerous reports of the effectiveness of Invisalign and two clinical trials that have studied this appliance.[3-23] This literature has demonstrated that the use of this appliance is successful for many different types of tooth movement.



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Authors / HeeSoo Oh, DDS, MS, PhD, (not pictured) assistant professor, member of Craniofacial Research Instrumentation Laboratory; and Mohamed Fallah, BDS, MDS, associate professor, director Predoctoral Program, are with the Department of Orthodontics, UOP Arthur A. Dugoni School of Dentistry. Vicki Vlaskalic, DBSc, MDSc, formerly a clinical assistant professor at the UOP Dugoni School of Dentistry, now lives in Melbourne, Australia.

Disclosures / Robert L. Boyd, DDS, MEd, owns a small amount of stock in Align Technology, which makes Invisalign. Mohamed Fallah, BDS, MDS, has part-time employment with, and also owns stock in, Align Technology.

The first clinical trial found tipping movements, rotations of incisors, and space closure as the most predictable movements.[20-21] However, this trial was limited to studying different appliance materials that are no longer used. New and better-performing materials have been upgraded for use in these appliances since then. This preliminary study also focused on the efficacy of a one-week versus a two-week change of appliance. The current protocol is two weeks of wear for each appliance. A more recent longitudinal clinical study reported that, in addition to tipping, space closure and anterior tooth rotations, intrusion was also successful.[23] Most notably, both of these clinical studies showed a statistically significant reduction of plaque and gingivitis during treatment. However, numerous other studies have shown increased plaque and gingivitis associated with the use of fixed appliances and the need for a highly structured preventive program to minimize these effects on periodontal tissues and enamel.[24-29]

Feasibility of Treatment

After the initial examination of a patient, the primary decision to be made is whether they can be effectively treated with a removable aligner. It is most important that this decision takes into account the level of expertise and experience of the dentist in using the aligner. For example, as a service for the dentist, digital photographs can be e-mailed to Align Technology for an evaluation regarding the feasibility of the treatment. A response will be provided to the dentist via e-mail within 48 hours.[2]

A 2004 article by Spears in the *Journal of the California Dental Association* showed that patients who require minor restorative dentistry and/or bleaching, can be good candidates for orthodontic treatment.[30] The author further concluded that these patients will be more likely to accept less invasive restorative dentistry and orthodontic treatment than extensive full coronal restorations (**Case 1**).

Another group of patients are teenagers who wish to improve their esthetics but are not interested in having fixed appliances (**Case 2**).

Many patients will only have complaints about the appearance of their anterior teeth. These patients can be good candidates for aligner treatment, even by a less-experienced dentist in conventional orthodontic treatment with fixed appliances, if there is an acceptable posterior occlusion (**Case 3**). In **Case 3**, there was also a pronounced decrease in the redness and swelling of the gingiva between pretreatment and post-treatment intraoral photos.

One of the most commonly encountered types of patients who wish to have aligner treatment are individuals who have previously received orthodontic treatment using fixed appliances (**Case 4**) or who do not want fixed appliances for their present orthodontic treatment. This is usually because esthetic concerns may be a significant factor, as many patients may not want to show metal or even clear fixed appliances in their smile.

Another type of patient who is a good candidate may be an individual with a history of successful periodontal treatment. This is primarily because of the previously discussed decrease in plaque and gingivitis associated with aligners versus the increased plaque and gingivitis associated with fixed appliances[3,5,22-23] (**Case 1**).

Patients with short roots may also be better candidates for aligners as a recent University of Florida study has shown no measurable root resorption in their longitudinal study of 100 consecutive aligner-treated patients (Wheeler T. in preparation). This is in contrast to fixed appliances, which generally show an average of 10 percent of patients having clinically significant root resorption of 3 millimeters or more.[31-32]

An interesting finding with the use of the aligners is that patients who have a shallow overbite, an edge-to-edge bite, or a slight open bite, can experience improvement in the overbite by approximately 1-2 mm during treatment[3] (**Cases 2 and 4**). This is most likely due to the intrusive effect on the posterior teeth because of the increased interocclusal distance established when the patient wears the appliance and the resultant biting force. This is in contrast to fixed appliances, which may often cause a decrease in overbite in these types of open bite patients due to their generally extrusive nature (**Cases 2 and 4**).

Patients who have excessive wear on their teeth from grinding or bruxing may also be good candidates for aligners because the appliance acts in a similar fashion to a nightguard during treatment (**Cases 1 and 4**). After treatment, aligner retainers are worn indefinitely at night, which can potentially lessen the effects of nocturnal clenching, grinding, or bruxing. A recent study by Nedwed and Meithke et al. showed that even among patients who had a history of parafunctional habits, i.e., clenching, grinding and bruxing, that aligner treatment had no increases in myofacial discomfort, but rather decreases as compared to those with fixed orthodontic appliances.[33] The authors attributed this to the double splint effect of the appliances.

Another advantage of aligners is found in patients with extensive porcelain, gold, or highly restored mouths. Bonded, fixed appliances are more difficult to retain in place during treatment on such surfaces as porcelain, gold and metal, and potential damage can occur on these surfaces at the time of debonding (**Case 5**).

Improvement of deep overbites is generally successful with aligners because of its predictable nature with intrusive orthodontic mechanics[3] (**Case 5**). Another advantage of aligners for patients with deep overbites is the disclusion of the teeth achieved, which eliminates problems encountered with

CASE 1

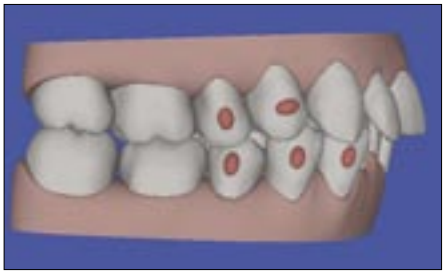
1a.

1b.

1c.

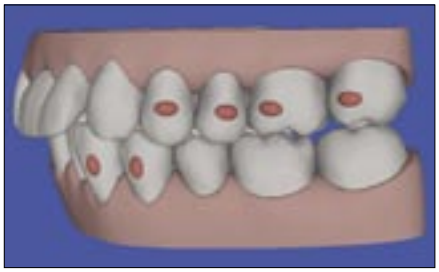
1d.

1e.



1f.

1g.



1h.

1i.

1j.

Figures 1a-e show the pretreatment views of a 52-year-old woman who had been successfully treated for generalized moderate periodontitis and whose chief complaint was "crooked front teeth and space between my front teeth." This patient agreed to aligner treatment followed by the placement of a crown on tooth No. 9. She was able to whiten her teeth during treatment as the aligners can effectively be used for this purpose.

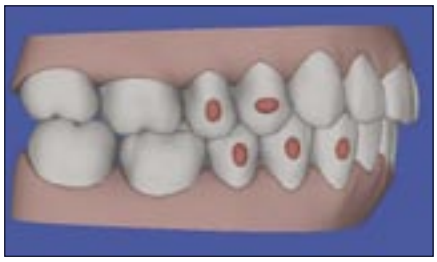
Figures 1f-j show still photos of the pretreatment computer models used with ClinCheck software.

CASE 1

1k.

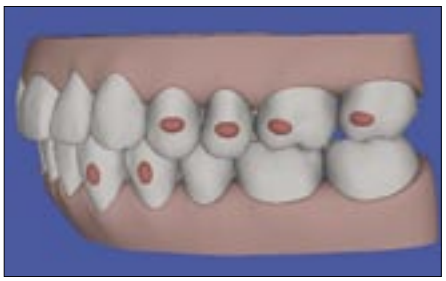
1l.

1m.



1n.

1o.



1p.

1q.

1r.

Figures 1k-m show the post-treatment results. A new crown was placed on tooth No. 9 and tooth whitening was completed. Note the remarkable similarity of the initial treatment projection in the ClinCheck software and the final clinical results.

Figures 1n-r show the post-treatment still photos of ClinCheck.

CASE 2

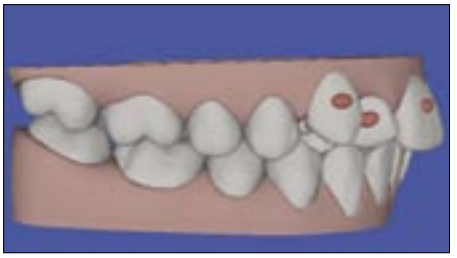
2a.

2b.

2c.

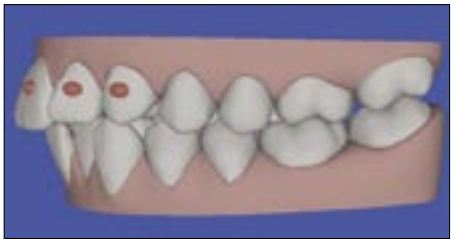
2d.

2e.



2f.

2g.



2h.

2i.

Figures 2a-e show a 14-year-old female who presented with a chief complaint of "my front teeth are crooked and do not touch in the front." She refused to have fixed appliances.

Figures 2f-j show still photos of the pretreatment computer models used with ClinCheck software.

2j.

CASE 2

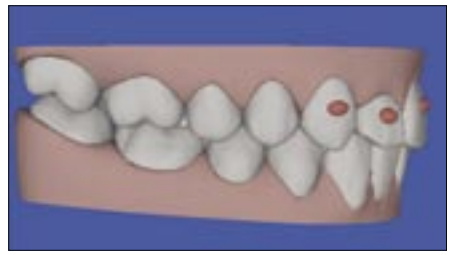
2k.

2l.

2m.

2n.

2o.



2p.

2q.

2r.

2s.

Figures 2f-j show still photos of the pretreatment computer models used with ClinCheck software.

Figures 2k-o show post-treatment results with closure of the open bite and excellent alignment of the teeth. Only one sequence of 20 upper and lower aligners and 13 months of treatment time were needed as this patient was very compliant with wearing her appliances.

Figures 2p-t show still photos of the final positions of the ClinCheck computer-generated models.

2t.

CASE 2

2u.

2v.

2w.

2x.

2y.

Figures 2u-y show the almost three-year post-treatment results, which show good stability of the correction of the open bite with only night-time wear of the final aligners as retainers.

CASE 3

3a.

3b.

3c.

3d.

3e.

3f.

3g.

3h.

3i.

Figures 3a-e show a 17-year-old female who had generalized gingivitis and a chief complaint of "crooked front teeth."

Figures 3f-j illustrate the final results showing a dramatic reduction of gingivitis just from the wearing of the aligner appliance and good alignment of the teeth.

3j.

CASE 4

4a.

4b.

4c.

4d.

4e.

4f.

4g.

4h.

4i.

Figures 4a-e show the pretreatment intraoral views of a periodontally healthy 29-year-old woman who presented with a chief complaint of "crowded teeth." Moderate upper and lower crowding and anterior and posterior cross-bites were present with a very shallow (less than 1 mm) overbite.

Figures 4f-j show the post-treatment results from 15 months of nonextraction treatment. Note the deepening of the overbite and the correction of crowding, as well as the anterior and posterior cross-bites. The slight posterior open bite seen here is a normal occurrence with aligners, which will close in approximately six to eight weeks after the patient changes to night-time only use of their retainers.

4j.

CASE 5

5a.

5b.

5c.

5d.

5e.

5f.

5g.

5h.

5i.

5j.

Figures 5a-e show pretreatment intraoral views of a 54-year-old patient whose general dentist had asked the patient to have improved alignment of her anterior teeth and correction of her deep overbite prior to receiving new crowns for teeth Nos. 7 to 10. Note the extensively restored dentition with a total of nine crowned teeth with either gold surfaces or porcelain.

Figures 5f-j show post-treatment results with correction of the deep overbite and crowding, and improved positions of the new crowns present from teeth Nos. 7 to 10. *(Restorative dentistry by Dr. Brian Kenyon, University of the Pacific.)*

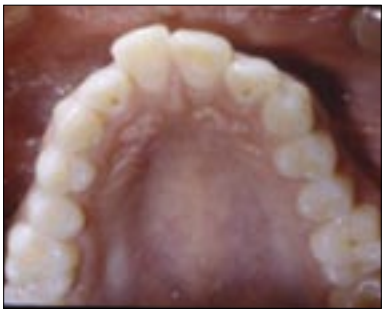
CASE 6

6a.

6b.

6c.

6d.



6e.

6f.

6g.

6h.

6i.

Figures 6a-f show intraoral views of a 31-year-old woman who presented with a chief complaint of a "large overbite." Note the very large overjet (13 mm) in Figure 6d, which was caused by significant dentoalveolar protrusion of the maxillary arch. The treatment plan was to extract both upper first premolars and to retract the upper anterior teeth to the positions of the lower anterior teeth.

Figures 6g-i show use of a three-tooth segment of fixed appliances on the canines, second premolars and first molars on both right and left sides facing the upper first premolar extraction sites. This was done because the clinician noted about 10 degrees of tipping had occurred about eight aligners from the end of treatment. Fixed appliances were used for only five months in conjunction with the final eight upper aligners, which were relieved at the gingival one-third for placement of the fixed appliances and archwires.

CASE 6

6j.

6k.

6l.

6m.

6n.

6o.

Figures 6j-o show the post-treatment intraoral views with acceptable root parallelism and complete correction of the excessive overbite and overjet.

fixed appliances and clearance between incisors when teeth are brought together. Dental anterior and posterior cross-bites can also be effectively treated by aligners (**Case 4**) because of this disclusion effect, as long as the cross-bites are dental and not skeletal in origin.

Case 6 shows the treatment of a severe class II division one patient with 13 mm of overjet and a deep overbite. Both upper first premolars were removed to facilitate the retraction of the upper anterior teeth due to the maxillary dentoalveolar protrusion present. Segmental fixed appliances were used during aligner treatment for the last eight stages to upright the roots, which had started to tip (total time in fixed segmental appliances was five months). The aligners were still worn during these eight stages to continue to move the other teeth, to provide a type of base arch for control of arch form during the root uprighting (thus preventing the need for upper anterior fixed appliances), and for guidance of the crowns of the tipped teeth into their correct position reflected in the final ideal positions of the crowns with the aligner. Tipping of teeth had been a problem during the initial years of aligner treatment for premolar extraction cases, but new protocols using thicker buccolingual diameter (1 mm) types of rectangular attachments have more recently allowed a higher percentage of patients to have premolar extraction treatment completed with aligners only.[3,5,21,22,34]

The main issue is to not let the teeth tip severely, i.e. more than 10 degrees, during space closure as that can lead to an extended treatment time to upright the severely tipped teeth.

Discussion

Recently, Nelson, described several advantages of the aligner software that were summarized from a meeting.[34,36] He stated that "This topic grows dramatically each year as practitioners figure out how to use it (aligners) to an advantage. This year the big topic was to do the first ClinCheck with no interproximal reduction (IPR) planned, to provide a virtual diagnostic set up. Then decide on the appropriate strategy to treat the case: distalization, elastics, extraction, IPR, expansion, or some combination. This gives you a therapeutic diagnostic setup — very valuable." Other advantages cited by Nelson included "Evaluating anchorage with the superimposition or surgical simulation tools" and that "The ClinCheck set-up can be used for diagnosis and treatment planning -- evaluate the need for IPR, expansion, extraction,

distalization, or proclination" as well as:

- Verifying that the technician has performed modifications,
- A consultation device to show treatment limits to patient,
- A communications tool to e-mail the abbreviated ClinCheck to patients and to referring doctors,
- Verifying that the aligner is tracking,
- Evaluating anchorage with the superimposition or surgical simulation tools and staging, and
- Addressing the patient's chief concern (of anterior tooth alignment) at the beginning of the series, and applying simultaneous movements to reduce the overall number of aligners."

Boyd further defined these unique benefits of ClinCheck by noting that the initial display of all of the stages throughout treatment allows the doctor to determine the biomechanical and biological feasibility of treatment by analyzing the pathways that the teeth are moved along during treatment.[35,37] The ability of ClinCheck to perform these functions is a unique advantage of aligners that has been secured by a number of patents. Specifically, Invisalign can make and number more than two stages of appliances before starting treatment, while still allowing the doctor to make changes at any time by doing a mid-course correction or case refinement with or without a new impression. Other companies like OrthoClear can only display two stages at a time. This prevents an overall look at the staging initially and requires the doctor to re-examine the staging at intervals of only two stages at a time. This would be very difficult to do on a case like those shown in this article as there were between 20 to 45 stages of treatment in these cases.

Summary

This article presented six patients' orthodontic treatments using the recently developed aligner appliance system. These treated cases show that a wide range of cases can be effectively corrected. The key to success is for the doctor to thoroughly review the entire staging process using ClinCheck software, which show the details and pathways of all of the individual tooth movements of all consecutive appliances in entirety before any treatment is started to determine the biologic and biomechanical feasibility of treatment. ■■■■

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Orthodontic Treatment in the Early Mixed Dentition: Is This the Optimum Time to Start Care?

Steven A. Dugoni, DMD, MSD, and Maryse M. Aubert, DDS, MA

ABSTRACT

The age at which children should start orthodontic treatment has been debated amongst orthodontists for many decades. Orthodontists can agree on what is a quality orthodontic result, but disagree as to how and when to best obtain this result. Some orthodontists contend that starting treatment in the primary dentition is the most effective means of orthodontic care. Other orthodontists would prefer to begin in the early or late mixed dentition. Still others would rather postpone treatment until the permanent dentition at approximately age 12. This article will evaluate the pros and cons of initiating treatment at different ages.

Treatment in the primary dentition may be indicated for correction of a posterior and/or anterior cross-bite, class II or III malocclusions, premature loss of primary tooth, a cleft palate or crowding.[1] Primary dentition treatment could begin at age 4 to 5. This may be followed up with additional care in the early mixed dentition and more orthodontic treatment in the permanent dentition. The patient could potentially require three phases of orthodontic care from the ages of 4 to 15.

Another approach to early treatment is a two-phase approach. The first phase begins in the early mixed dentition at approximately age 8, and the second phase starts in the permanent dentition at approximately age 12. Some orthodontists maintain that early mixed dentition treatment with phase I orthodontic care can reduce or eliminate the need for full-banded phase II orthodontic treatment at a later age.[2] Others contend that phase I treatment cannot produce

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lasting treatment results and that the patient will require a second phase of comprehensive care, which increases the number of office visits.[3]

Orthodontic researchers have analyzed patients' compliance with early treatment and have shown different results. Some authors state that cooperation is better in the mixed dentition with younger patients than the older adolescent patients.[2] Others will argue that early orthodontic treatment prolongs orthodontic care and the patient will tend to "burn out" by the second phase of treatment.[4]

Orthodontic treatment could begin in the late mixed dentition, at approximately age 11, and treatment would then be limited to one phase of orthodontic care.[5] This approach can be effective in correcting many malocclusions; however, occasionally initiating orthodontic treatment in the late mixed dentition phase can extend treatment time as much as four years while waiting for eruption of all permanent teeth. Patients can experience "burn out" with this potential prolonged treatment time.

Lastly, treatment could begin in the permanent dentition, which could shorten the treatment time and lessen the costs to the patient. The permanent dentition treatment would start upon eruption of the second molars, which may occur from the ages of 10 to 14. Initiating treatment at this stage could present a problem with the physically mature female patient who might complete her growth before eruption of the second molars. If full-banded orthodontic care is initiated with little or no growth remaining, correcting the class II malocclusion could become very difficult. There may be more need for extractions, surgical orthodontics, or compromised orthodontic treatment when the patient has finished his or her facial growth. The mandibular leeway space will also be lost if treatment were to be postponed to the permanent dentition. Loss of the leeway space results in a loss of arch length of 2 to 6 millimeters. The patient may be more prone to need extractions of permanent teeth in a crowded case if the arch length decreases by loss of the leeway space.

In addition to the disputes regarding when the appropriate time is to start treatment, there is also disagreement within the profession on what types of problems should be treated at what age. Some orthodontists would like to treat crowding problems in the mixed dentition, believing that in doing so results in a better opportunity to develop the arches and avoid extraction of premolars.[6] Other orthodontists contend that development of the arches will lead to relapse at a later age and that expansion treatment will not be stable.[7] Some orthodontists prefer to wait until the late mixed dentition to treat crowding problems before exfoliation of the second primary molars, in order that the leeway space can be used to resolve crowding.[5] Others would prefer to treat

CASE 1

Figure 1a. Phase I initial facial photo (age 7). Patient presents with complaint of an open bite due to thumb sucking habit.

Figure 1b. Phase I initial intraoral photo. Patient has a severe class II division 1 malocclusion with 8 mm overjet, -5 mm overbite, a narrow maxilla, and a severe class II skeletal pattern. She was treated with early (phase I) orthodontic treatment.

Figure 2a. Phase II (13 years old) initial facial photo. Start of the second phase of orthodontic care. Patient underwent phase I orthodontics for 18 months with fixed edgewise braces, a habit appliance and headgear. She wore a retainer after phase I orthodontics.

Figure 2b. Phase II initial intraoral photo shows closure of the open bite, expansion of the maxilla and reduction of the overjet.

CASE 1

Figure 3a. Phase II final facial photo. Completion of the second phase of orthodontics with full-banded orthodontics for 14 months.

Figure 3b. Phase II final intraoral photo. Note full correction of the malocclusion with the second phase.

Figure 4a. Facial photo, six years retention. Photo shows normal facial growth and a nice profile.

Figure 4b. Intraoral photo, six years retention, shows the stability of the orthodontic result six years after the completion of orthodontic care.

a crowding problem in the permanent dentition with extraction of premolars rather than expand dental arches due to potential relapse of the expansion at a later age.

Orthodontic research has shown that simply holding leeway space in the mandibular arch during the mixed dentition can resolve crowding in about 75 percent of cases without extraction or expansion treatment. It has also been demonstrated that treatment with a lingual arch can resolve crowding in the mixed dentition and demonstrated good long-term stability.[8]

Recent research on correction of a class II in the early mixed dentition has found that perhaps class II treatment should be postponed until the permanent dentition rather than started in the mixed dentition.[3] Researchers discovered that treatment changes that occurred in the first phase of orthodontic care relapsed by the start of second phase of orthodontic care. It was observed that patients who had two phases of orthodontic treatment did not have a significantly better outcome than patients who had one phase of orthodontic treatment in the permanent dentition.

Many orthodontists would prefer to correct a severe anterior open bite (**Case 1**), an anterior and posterior cross-bite (**Case 2**), class III maxillary deficiencies, and elimination of detrimental habits in the early mixed dentition rather than postpone treatment to the permanent dentition. Patients with severe flaring of the upper incisors should consider early treatment to help reduce the risk of trauma and fracture to the upper incisors. It is important that dentists identify at a patient's young age whether there are congenitally missing teeth, supernumerary teeth, or a dental midline shift. If the dentist does not recognize these problems until a later age, treatment will be more complicated and costly.

Early diagnosis of ectopic maxillary cuspids can often times prevent the impaction of a canine. The diagnosis can usually be made with radiographs; however, palpation of the buccal vestibule can also be effective in determining the position of the cuspid. Undiagnosed impacted canines can cause severe root resorption to the maxilla lateral incisors. More complicated orthodontic treatment may be avoided with early detection of ectopic cuspids.

At the Department of Orthodontics, University of Pacific Arthur A. Dugoni School of Dentistry, a comprehensive mixed dentition treatment approach is taught to the orthodontic graduate students. This approach teaches the students to closely evaluate the entire malocclusion of patients who are approximately 7 to 8 years old. After thorough review of diagnostic records, a treatment plan is established to address most or all of the problems present in the early mixed dentition. Treatment with the first phase is designed to correct all the

CASE 2

Figure 5a. Phase I initial facial photo (age 7). Patient presents with complaint of a cross-bite.

Figure 5b. Phase I initial intraoral frontal photo. She has a severe class II division 1 malocclusion with a bilateral cross-bite.

Figure 5c. Phase I initial intraoral side view photo. The patient presents a narrow maxilla and a severe class II skeletal pattern with 8 mm overjet. She was treated with early (phase I) orthodontic treatment.

Figure 6a. Phase II initial facial photo (age 11). Start of the second phase of orthodontic care. Patient underwent phase I orthodontics for 16 months with fixed edgewise braces, a maxillary expander, and headgear.

Figure 6b. Phase II initial intraoral frontal photo. Note the correction of the posterior cross-bite and reduction of the overjet and the good arch alignment.

Figure 6c. Phase II initial intraoral side view photo. The patient wore a retainer and a lower lingual arch after phase I orthodontic treatment, during the supervision phase. After review of these records, a second phase of treatment was not advised.

Figure 7a. Six years retention facial photo. Patient did not require a second phase of orthodontic care. Photos show the stability of the phase I orthodontic result six years after the completion of orthodontic care.

Figure 7b. Six years retention intraoral frontal photo. The patient had the bands removed after phase II evaluation and was given a set of removable retainers.

Figure 7c. Six years retention intraoral side view photo. Six years later she presented with the same nice arch alignment, a good class I, and ideal overjet and overbite.

problems. The goal is to eliminate or significantly reduce the need for phase II orthodontic care. This approach helps to produce a less complicated problem in the second phase, shortening the overall treatment time.

The objectives of early treatment could include establishing ideal overjet and overbite, aligning of the upper and lower incisors, establishing ideal torque, tip of the upper and lower incisors, adequate arch length, and obtaining a class I molar position. Treatment typically uses fixed orthodontic appliances, including bands on the maxillary first molars and brackets on the upper incisors. Headgear would be used for correction of most class II malocclusions. A facemask would be used to protract the maxilla forward in a class III skeletal pattern. The mandibular arch is usually treated with a lingual arch that is removable and adjustable. If crowding is present in the maxillary and/or mandibular arch, the first primary molars or primary cuspids are extracted to gain room for alignment of the incisors. The mandibular lingual arch is adjusted at each visit until alignment of the incisors is obtained. In order to determine the extent of mandibular crowding in the mixed dentition, the Hixon-Oldfather analysis is performed on the mandibular arch before placement of a lingual arch to obtain an accurate measurement of mandibular crowding.

At the conclusion of the first phase of orthodontic treatment, the patient will enter a supervision stage until the eruption of permanent teeth. During this supervision stage the patient wears a removable retainer and continues use of the lingual arch to maintain the alignment of the lower incisors. Occasionally, headgear is worn during the supervision stage to continue correction of class II molar position or to prevent rebound toward a class II problem.

For patients with a severe arch length deficiency, a serial extraction approach would be initiated in the early mixed dentition. Rather than attempt significant expansion of the dental arches, which would likely be unstable, the patient undergoes removal of primary cuspids and primary molars. This would be followed by extraction of premolars in late mixed dentition and then comprehensive full-banded orthodontic treatment in the permanent dentition.

The data indicated 42 percent of the patients who received early treatment did not require phase II full-banded orthodontic treatment as determined by the treating orthodontist.

The University of the Pacific's orthodontic department has conducted a research project with early orthodontic treatment.[9] The study involved patients who received an initial phase of treatment between the ages of 8 to 10. Patients were treated with a maxillary 2-by-4 appliance consisting of upper incisor brackets and upper first molar bands. Class II patients received headgear. Patients with lower incisor crowding had a lower lingual arch and, occasionally, extraction of the lower first primary molars when there was incisor crowding present. Treatment time for the first phase was approximately 12 to 18 months. The data indicated 42 percent of the patients who received early treatment did not require phase II full-banded orthodontic treatment as determined by the treating orthodontist. Patients who received only phase I early treatment had fewer visits, shorter treatment times, and significantly lower orthodontic fees than those who required full-banded orthodontic treatment. Patients requiring only phase I orthodontic treatment and no phase II treatment had less extensive treatment than patients in either the full-banded orthodontic treatment group or the two-phase orthodontic treatment group.

Further analysis of the data indicated that intermolar and intercanine arch width (maxillary and mandibular) increased during phase I and remained stable at the second-phase evaluation stage, at approximately age 12. There was significant improvement in the position of the maxilla and mandible, reduction of the overjet, and reduction of the molar position severity from class II to class I. There was a significant increase in width of the maxillary cuspids with an average of 4.2 millimeters. With early treatment subjects who required a second phase of treatment, all skeletal and dental changes observed at phase II evaluation were maintained and improved through the second phase of treatment. Eighty-two percent of early treatment cases did not require extractions of permanent teeth in the permanent dentition, substantially lower than compared to a rate of extrac-

tion of 25 percent in the low extraction rate practices and 85 percent in the high extraction rate practices.[10] According to the findings of the authors' study, early mixed dentition orthodontic treatment appears to be an acceptable treatment strategy for correcting problems and holding the result both skeletally and dentally. The changes remained stable at the phase II evaluation records and at the end of the second phase. The investigators believe that the key to successful early treatment includes thorough and accurate diagnosis, comprehensive treatment planning, and continued care during supervision until the eruption of the permanent dentition.

The best timing of orthodontic treatment is a decision made by the orthodontist, the parent, and the patient based on all the factors that impact success. All options should be reviewed with the parent in order that he or she may make an informed decision.

The American Association of Orthodontists, www.braces.org, recommends that all children get a check up with an orthodontist no later than age 7. An early exam allows the orthodontist to offer advice and guidance as to when the optimal time to start treatment would be for that specific patient. ■■■■

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Clinical Applications of Mini-implants as Orthodontic Anchorage and the Peri-implant Tissue Reaction Upon Loading

Heon Jae Cho, DDS, MS, PhD

ABSTRACT

Orthodontic tooth treatment depends on anchorage for improved results. There are many different sources of orthodontic anchorage. Segments of teeth or the entire arch have been the most common type of orthodontic anchorage. But in challenging situations, orthodontists frequently need extra-dental supplements of anchorage such as headgear, face mask, and intermaxillary elastics. Most of them require the patient's compliance. Recently, temporary mini-implants placed within the bone tissue have been used as orthodontic anchorage. It has been proven in many studies and case reports that the mini-implant is a very reliable anchorage source clinically and histologically.

The purpose of this article is to introduce the basic clinical application of mini-implants as orthodontic anchorage and to discuss basic concepts about the tissue reaction of peri-implant bone upon placement and loading either from orthodontic mechanics and/or function in the orthodontic treatment of the patients.

It is possible for mini-implants to supply absolute anchorage even though they may move slightly within the bone tissue without losing clinical stability. The primary application of mini-implants as orthodontic anchorage will be cases that need absolute anchorage for desired tooth movement.

Case 1

The first case is of a female patient, age 19 years, 11 months. The patient's chief complaint was lip protrusion. In the initial lateral cephalograph, her upper and lower incisors were severely proclined (**Figures 1a-i**).

Her problem list included having severe lip protrusion, severe upper and lower incisor protrusion, (**Figure 1j**). The patient wanted an invisible appliance.

Treatment objectives were to reduce upper and lower lip protrusion as much as 100 percent retraction of incisors into bicuspid extraction space possible, achieve class I molar and canine relationship, and normal OJ/OB.

The treatment plan included four first bicuspids extraction, retraction of upper and lower incisors with maximum anchorage, if possible, and using a custom-made lingual retractor for incisor retraction because the patient wanted to use an invisible appliance.

Specially designed, custom-made lingual retraction appliances were used. The primary mechanical property for the lingual retractor is rigidity because the goal was to retract six incisors as a segment without individual tooth movement (**Figures 1k-**

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CASE 1

1a.

1b.

1c.

1d.

1e.

1f.

1g.

1h.

1i.

Figures 1a-i. Initial facial and intraoral photos.

CASE 1

1j.

1k.

1l.

1m.

1n.

1o.

1p.

1q.

1r.

Figure 1j. Initial cephalometric radiograph.

Figures 1k-l. Lingual retractors.

Figure 1m. Lateral cephalometric radiograph with lingual retractors.

Figures 1n-r. Progress facial and intraoral photos.

CASE 1

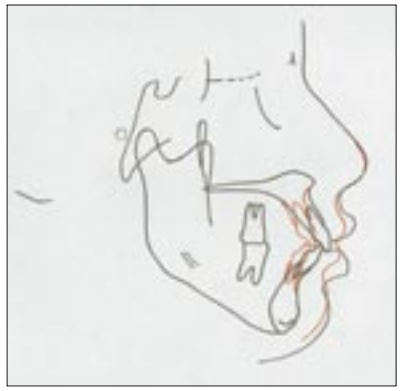
1s.

1t.

1u.

1v.

1w.



1x.

Figures 1s-v. Progress facial and intraoral photos.

Figure 1w. Progress cephalometric radiograph.

Figure 1x. Superimposition between initial and progress lateral cephalometric radiographs.

m). A 0.045 inch stainless-steel wire was used for fabrication of the lingual retractors. Two mini-implants were placed in the palatal area and another two mini-implants were placed in the lingual interradicular space between the lower first and second molars (**Figures 1k-m**). Nickel titanium coil springs were used to retract six incisors as one segment. Retraction forces were delivered to the hooks of the extended arms of lingual retractors from mini-implant anchorage. The resulting vectors were designed to pass through the centers of both incisor segments (**Figure 1m**). The result shows that her lip protrusion was reduced significantly (**Figures 1n-q**) and that the posterior occlusion was maintained (**Figures 1r-t**). There were no forces applied to the molars during treatment. The post-treatment lateral cephalometric radiograph showed that the upper and lower incisors had improved in their inclinations within basal bone (**Figure 1w**).

Superimposition of the lateral cephalometric X-ray showed that upper and lower incisors were retracted very efficiently without any forward movement of posterior teeth (**Figure 1x**) and thus the mini-implants served as absolute anchorage for this patient to retract incisors. The movement of incisor retraction is similar to that of surgical retraction of the anterior segment with subapical osteotomy (**Figure 1x**). At this point, the lingual retractors were removed for the finishing lingual appliance, however, the patient refused to have any further treatment because she felt that the esthetic results were exactly what she wanted and she did not have any functional problems. Despite a request for less than six months finishing treatment with lingual appliance, she did not want any further treatment.

Case 2

This case is a female patient, age 20 years, 3 months old. Her chief complaints and major problem list were anterior open bite and spacing (**Figures 2a-i**).

The primary treatment objective was the correction of an anterior open bite by intruding the posterior maxillary teeth either by surgery or orthodontic intrusion. The patient had a good vertical position of upper incisor relative to upper lip (3 mm incisor stomion). She also had a long lower facial height, which would indicate that incisor extrusion for open bite correction would not result in good post-treatment esthetics and stability. Other objectives were to close all the anterior spaces, achieve class I molar and canine relationship, and achieve a normal overjet and overbite.

The treatment plan was to intrude posterior teeth orthodontically in order to correct the anterior open bite since the patient refused a surgical option.

Two midpalatal mini-implants with a rigid transpalatal arch (.036") were used to intrude the maxillary posterior teeth (**Figures 2k-m**). The anterior open bite was corrected by a maxillary molar intrusion (**Figures 2n-r**).

The comparison between initial and progress cephalograms clearly showed the maxillary posterior teeth and TPA were intruded (**Figures 2m-s**). The treatment effect from the intrusion of posterior teeth was very similar to that from surgical maxillary posterior impaction since both induce the mandibular closing rotation.

Discussion

Two typical applications of mini-implants as orthodontic anchorage were shown. However, there are many other indications for mini-implants as orthodontic anchorage, such as molar protraction, molar distalization, presurgical orthodontic preparation, prerestorative tooth movements (uprighting, intrusion of severely extruded unopposed tooth/teeth, space redistribution, and reduction of size of the edentulous span, etc.). There are numerous case reports using mini-implants as orthodontic anchorage.[1-7]

Traditionally, the orthodontic molar intrusion was very difficult tooth movement because it was not easy to get adequate anchorage for molar intrusion. Mini-implants served very nicely as an adequate anchorage source for molar intrusion and anterior retraction for these patients.

Peri-implant Tissue Reaction Upon Loading

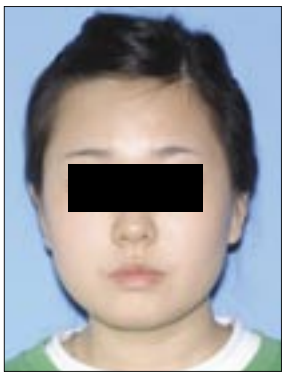
Premature loosening of mini-implants is one of most common problems in the usage of mini-implants as orthodontic anchorage. In order to have good stability, it is very important to understand the peri-implant tissue reaction upon implantation and loading whether it is therapeutic (orthodontic), functional, or combined. Initial stability of mini-implants depends on solid mechanical locking of thread of mini-implants into cortical bone.[8] After successful healing, the entire osseous tissue connecting the implant to host bone was entirely lamellar bone.[9] Trisi reported that, after two-month healing and four-month loading, an almost continuous trabeculum layer of bone, 100 to 200 m thick, surrounded the implant surface.[8] Bone, like other relatively rigid materials, is subject to fatigue.

There are numerous studies about bone responses around mini-implants.[8-20] Upon loading, whether it is from therapeutic (orthodontic) or function, there will be microstrain in the peri-implant tissue because there is a large mismatch between the modulus of elasticity of bone and that of a titanium mini-implant. The peak strain history (bone deformation over time) of dynamic (normal cyclic) loading is related to the magnitude and frequency of functional loads. Bone cells are sensitive to strain (deformation) along functionally loaded bone surfaces. Frost proposed a biomechanical relationship for skeletal adaptation, referred to as the "mechanostat."[21-24]

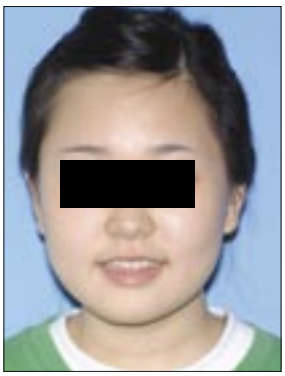
Biomechanical control of osseous adaptation (bone modeling and remodeling) is related to the magnitude and frequency of dynamic (intermittent) loads. Bone is a composite biomaterial that structurally adapts to its mechanical environment. Suboptimal loading results in atrophy of both bone mass and structural orientation. The peak strain history (bone deformation over time) dictates the osseous response. Bone deformation (strain) is expressed as microstrain (μE), which is strain x 10^{-6}. The upper limit of the physiological loading range for steady-state maintenance of bone is only about 10 percent of its ultimate strength (2500/25000μE). Repetitive loading at more than 4000μE results is pathological overload and will induce eventual fatigue failure of bone.[21-24] The formation of microdamage or microscopic cracks in the bone matrix has been associated with elevated or altered strain environments and with fatigue loading.[25-29] Bone microdamage is manifested by the presence of well-defined microcracks in lamellar bone tissue.[10] Microcracks refer to discrete and microscopically visible flaws that may progress and eventually lead to a complete failure of the trabeculum. Trisi reported microcracks either around implants placed in cortical bone or in peri-implant cancellous bone.[10]

Previous studies reported that the remodeling of the peri-implant bone remains elevated throughout the implant's life when implants are under load.[30,31] This increased turnover (remodeling) rate is a natural repair process of microdamage in bone and fibrous tissue.[32] Thus, late (secondary) stability of mini-implants within the bone tissue depends upon the balance between accumulated microstrain of peri-implant bone tissue and density of peri-implant bone and its healing capacity (rate of remodeling).

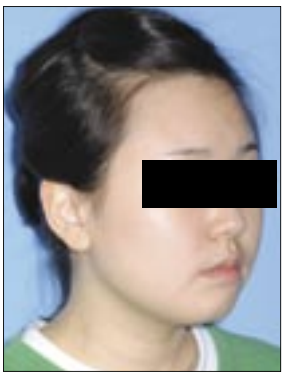
CASE 2



2a.



2b.



2c.

2d.

2e.

2f.

2g.

2h.

2i.

Figures 2a-i. Initial facial and intraoral photos.

Figure 2j. Initial cephalometric radiograph.

2j.

CASE 2

2k.

2l.

2m.

2n.

2o.

2p.

2q.

2r.

2s.

Figures 2k-l. Appliance for maxillary molar intrusion.

Figure 2m. Lateral cephalometric radiograph with maxillary molar intrusion appliance.

Figures 2n-r. Progress intraoral photos.

Figure 2s. Progress cephalometric radiograph.

Besides premature loosening, there are some other possible complications from usage of mini-implants as orthodontic anchorage. These include possibility of root damage, risk of infection, and soft tissue irritation at/near the site of mini-implant placement. Sometimes, subjective discomfort from soft tissue irritation makes it impossible to use the mini-implants as sources of orthodontic anchorage.

Conclusion

The cases shown in this article demonstrate the effective use of a mini-implant as an orthodontic anchorage to solve difficult problems during orthodontic treatment that have very limited solutions available.

There are some potential complications from these new devices, but well-placed and well-maintained mini-implants can be great anchorage solutions for various challenging orthodontic cases.

In order to use this new tool more properly, it may be necessary to understand the reaction of tissues surrounding the mini-implants upon placement and loading. ■■■■

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Pacific Craniofacial Team and Cleft Prevention Program

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ABSTRACT

There is no doubt modern genetics have greatly influenced our professional and personal lives during the last decade. Uncovering genetic causes of many medical and dental pathologies is helping to narrow the diagnosis and select a treatment plan that would provide the best outcome. Importantly, having an understanding of multifactorial etiology helps direct our attention toward prevention.

We now understand much better our own health problems. In some cases, we can modify our lifestyle and diet in order to prevent "environmental factors" from triggering the mutated genes inherited from our parents. Good examples are diabetes and cardiovascular diseases. If we realize we might have inherited genes for cardiovascular problems from several ancestors who had heart attacks, we already know that these genes will make us only "susceptible" for disease. Those who exercise, watch one's weight, diet, and carefully monitor one's lifestyle will very likely — though possessing "susceptibility genes" — stay healthier and, maybe, will never experience any cardiovascular problems.

In principle, the same applies for craniofacial anomalies, especially for nonsyndromic cleft lip and palate. One needs to understand genetic and environmental causes of nonsyndromic orofacial clefts in order to prevent them.

With all this in mind, the Pacific Craniofacial Team and Cleft Prevention Program have been established at the Department of Orthodontics, University of the Pacific Arthur A. Dugoni School of Dentistry in San Francisco. A partnership with Rotaplast International, Inc., has

Continued on Page 824



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made it possible for the faculty, orthodontic residents, and students to participate in 27 multidisciplinary cleft medical missions in underdeveloped and developing countries by donating professional and educational services, and, last but not least, by collecting valuable data and specimens to further research.

A significant number of research studies, including 15 master of science theses, have been accomplished in UOP's Craniofacial Genetics Laboratory, with contributions by faculty, undergraduate and graduate students. It has been leading to a better understanding of etiology of nonsyndromic orofacial clefts. It has been learned that genetic factors and environmental factors are ethnicity-specific and, in many places throughout the world, location-specific. Thus, a specific protocol for cleft prevention has to be worked out based on genetic and nutritional studies of each specific population group in order to be effective. This is our ultimate goal.

While the 19th century has been called the "century of biochemistry" and the 20th century referred to as the "century of physics," the 21st century may be nicknamed the "century of molecular biology." The influence of molecular biology has been strongly felt in all fields of medicine and dentistry. More and more details are being uncovered about the functioning of the human body, and about the roles of a genetic background and its interactions with the environment.

There is no doubt that human genetics and medical genetics are important parts of today's modern health care in its all three main branches: diagnostics, treatment, and prevention. Among present health problems worldwide, the treatment and prevention of congenital anomalies is an area of very serious concern. The combined efforts of scientists and health care providers sharing information and skills, and collaborating on research projects at domestic and international levels are absolutely crucial for the improvement of care of the patients affected with congenital anomalies.

The Division of Craniofacial Genetics at the Department of Orthodontics at Pacific Arthur A. Dugoni School of Dentistry is a leader in primary prevention of one of the most common and most serious congenital anomalies: cleft lip and palate.

During the last six years since the craniofacial genetic research (including a busy molecular genetic laboratory) was established at the University of the Pacific Arthur A. Dugoni School of

Figure 1a. A Filipino boy affected with unilateral cleft lip and palate on the left side, before surgery.

Figure 1b. Same child two days after surgery.

Figure 2. Drs. Donald Poulton and William Olin examining cleft patients in Caracas, Venezuela. Dr. Olin is a professor at the University of Iowa in Iowa City, Iowa.

Figure 3. Dental/genetic team in Venezuela (Drs. Cooper Owens, Poulton, Marie Tolarová, Charles Brodsky, and Javier Mir).

Dentistry, efforts have been strongly focused on finding causes of orofacial clefts and on development of the best clinical protocol for their prevention.

A partnership with the Rotaplast International, Inc., the nongovernmental organization that provides free reconstructive surgeries to underprivileged children affected with cleft lip and palate worldwide (**Figures 1a and b**), allowed UOP's faculty, residents, and students not only to deliver professional services and acquire new experience, but also to bring back valuable data and specimens for genetic research (**Figures 2-4**). A participation of dental professionals (dentists and orthodontists) in the Rotaplast cleft medical missions is now a firm part of the graduate program. It has brought another dimension to education and training of the school's graduates. With no exception, the work of residents and their contributions to the success of each mission is highly prized. They are bringing back from those two weeks — working many times more than 12 hours a day — not only what they learned professionally, but also warm feelings in their hearts remembering their patients whom they helped to start a better future. During the last five years, the department professionally participated (in dental and genetic fields) in 40 Rotaplast cleft medical missions (**Figures 5-8**).

Since 2000, 15 residents of the school's graduate program in orthodontics either have accomplished or have been working toward their master of science in dentistry theses in the craniofacial genetics field. Many more students got their first research experience and excitement in the craniofacial genetics group. At present, the school has 23 DDS or IDS students. Residents and students presented their research results not only on Pacific Research Days, but also at California Dental Association, American Association for Dental Research, International Association for Dental Research, and American Association of Orthodontics meetings. In addition, there have been 12 visiting scholars who not only learned a great deal of population genetic and molecular genetic techniques, but also significantly supported research of residents and students, and thus contributed to many research projects (**Figure 9**).

What We Know About Orofacial Clefts

Orofacial clefts include a cleft lip, either unilateral or bilateral, that can occur either alone, or together with a cleft palate, and a cleft palate alone. Orofacial clefts develop during the embryonic period due to a failure of embryonic facial processes to fuse in a specific timeframe, specifically, cleft lip between six and nine weeks of pregnancy, and cleft palate between nine and 12 weeks of pregnancy.

Cleft lip and palate anomalies are the most common and most serious congenital anomalies of the orofacial region and the second most common congenital anomalies in general. Their birth prevalence in California is 1.77 per 1,000 births, one in every 566 newborns.[1,2] A baby with a cleft is born every two min-

utes somewhere in the world, accounting for 660 babies born with a cleft every day. This adds up to 230,000 children born with clefts every year worldwide. With a projected population growth that is estimated at 1.8 million per year, the number of new cases will be increased by 3,200 babies with cleft every year. More details are given Section 1.

Clefts have a significant genetic component[2,3] (Section 2). Therefore, individuals affected with cleft and also their nonaffected relatives are at a statistically significant higher risk to have a child with a cleft compared to the general population. Each individual affected with a nonsyndromic cleft lip and palate has during his/her lifetime from eight to 12 relatives whose risk for having a child affected with orofacial cleft is from 10 to 40 times higher than a risk in the general population. The highest risk of recurrence, on average 4 percent (40 times higher than in the general population), is for the first-degree relatives, i.e., for siblings of an individual with a cleft and for their children. In other words, at least four out of 100 parents who have had one child affected with a cleft, or who themselves were born with a cleft, will have a baby with a cleft.

Environmental factors also play a significant role in etiology of orofacial clefts. Important toxic factors and nutritional deficiencies interacting with the genetic background for clefts are dealt with in Section 3.

A treatment of children affected with orofacial clefts is challenging, lengthy, and requires a multidisciplinary team approach. An estimated average lifetime medical cost for a treatment of one individual affected with cleft lip with or without cleft palate, CL±P, in the United States is about $101,000.[4] This includes an immediate cost of $30,000/case in the first year of life. Based on an estimate of 7,500 newborns with orofacial clefts/year in the United States, in this year alone, the lifetime medical cost for babies born with orofacial cleft in the United States will total $750 million or more. A prevention of this anomaly can save not only suffering, but also millions of dollars.

Figure 4. Drs. Cory Costanzo and Thomas Ellerhorst preparing specimens for DNA analysis in Guatemala.

The authors were among the first to explore an inverse relation between folic acid intake and the risk of recurrence for CL±P.[5,6] Families with a high risk of recurrence are not only the first on the list of those who need prevention, but they are also the best target population for a prevention effort. They represent a preselected population with respect to phenotype homogeneity and, therefore, they have the highest probability of a positive preventive effect, as well as of the highest return of monetary investment. More about prevention will be covered in Section 4.

Section 1. Epidemiology

The authors conducted extensive genetic and epidemiological studies of orofacial clefts in two large population samples: the Czech population and the California population.[1,3,7] The authors were also specifically interested in the prevalence of clefts in Hispanic populations and evaluated population-based samples of Hispanics from California.[8]

To determine the proportion and birth prevalence of "typical" orofacial clefts (cleft lip, cleft palate and cleft lip and palate) and "atypical" clefts (median, transversal, or oblique facial clefts) and conditions for their occurrence, the authors analyzed a population-based sample of 4,433 cases ascertained from 2,509,881 California births.[1] The birth prevalence of isolated CL±P was 0.77 per 1,000 births and of isolated cleft palates, 0.31 per 1,000 births. Non-Hispanic whites had the greatest prevalence of isolated clefts; Asians a slightly lower prevalence; and blacks the lowest. Asians had the lowest prevalence of cleft palates; in whites and Hispanics, it was almost twice as high.

Section 2. Molecular Genetics

Over the past decade, there has been

Figure 5. Drs. Jamson Wu and Christopher Anderson with their patient (wearing premaxilla cup) and her mother in Guatemala City.

Figure 6. Drs. HeeSoo Oh and Costanzo in operating room in Guatemala.

a considerable interest in identifying genes that contribute to the etiology of orofacial clefting. Recent advances in modern molecular biology, new methods of gene therapy, and the availability of complete genome sequences led to understanding of the roles of particular genes associated with embryonic development of the orofacial complex.

The first candidate gene that showed an association with nonsyndromic cleft lip and palate was transforming growth factor alpha, TGFA in a Caucasian population.[9] Transforming growth factor beta 3 gene TGFB3 and MSX1 were found to be a strong candidate genes involved in orofacial clefts and dental anomalies.[10,11] Oh and Porter suggested that allele 4 (9 CA-repeats) occurs significantly more often in cleft population compared to controls.

In 1994, the methylenetetrahydrofolate reductase MTHFR gene was cloned and since then, 17 mutations have been described, including clinically most significant C->T substitution at nucleotide 677.[12,13] This common mutation has been identified as the first molecular risk factor for neural tube defects and for cleft lip and palate.[14,15] In the authors' Mendoza study, a significant association was found with mutated allele and CL±P, strongest in cases of bilateral clefts.[16] At present, MTHFR deficiency is considered to be the most frequent hereditary defect of folate metabolism.[17]

Studies from the authors' Craniofacial Genetics Laboratory have been focused on mutations of various candidate genes and their roles in etiology of nonsyndromic cleft lip and palate in different populations.[18] Costanzo suggested a strong association of reduced folate carrier gene (RFC1) with nonsyndromic cleft lip and palate in Guatemala.[18] In collaboration with the University of Colorado, the authors demonstrated a highly significant association between poliovirus receptor-like gene (PVRL1) and NCLP in northern Venezuela.[19]

Based on the authors' results, it seems very likely that a different spectrum of genetic factors constituting a genetic susceptibility to nonsyndromic cleft lip and palate exists in different populations. The authors' studies strongly suggest that a spectrum of genes participating in the etiology of orofacial clefts, as well as spectrum of environmental factors triggering a genetic susceptibility created by a combination of these genes, is "location specific," i.e., varies in different countries and different locations.[20]

Recently, Zucchero reported that variants of interferon regulatory factor 6, IRF6, gene might be responsible for 12 percent of nonsyndromic cleft lip and palate.[21]

In summary, based on recent studies, approximately 15 percent to 20 percent of nonsyndromic cleft lip and palate are determined by combinations of MSX1, RFC1, IRF6 and TGFB3 gene polymorphisms.

Section 3. Gene-environment Interactions in Etiology of Orofacial Clefts

The factors contributing to etiology of orofacial clefts include folic acid intake and mutations related to folate metabolism, poor maternal nutrition,

smoking, alcohol and drug consumption, and a presence of other altered genes (so-called candidate genes) known to be associated with orofacial clefts. Studies looking at the role of smoking with TGFA and MSX1 suggested that mutations in these genes might be susceptible to detrimental effects of maternal smoking.[22]

The authors' pilot study of gene-environment interactions in the etiology of cleft lip and palate anomalies was conducted in Mendoza, Argentina, in collaboration with University of Nijmegen, the Netherlands.[15,16]

Altogether, 140 families of individuals affected with orofacial cleft and 110 control families were analyzed. Both cases and controls came from a middle or low social class. Data on socioeconomic status, diet composition, other lifestyle information, blood levels of folic acid and vitamins were compared between cases and controls and their mothers. In general, the diet of families of cleft patients was poorer than that of the controls. The results of the red blood cell and plasma analysis showed significantly lower levels of folate in Argentineans compared to a Dutch control sample. Evaluation of MTHFR 677CT polymorphism in case and control groups revealed a significantly higher frequency of mutations in cleft populations, indicating that problems behind compromised folate metabolism can occur on a genetic level. It was concluded that exogenous factors, including lifestyle characteristics, together with nutrition, may play an important role in the etiology of the orofacial clefts in Argentina, however, even in the presence of normal amounts of dietary folate, the fetus of a mother carrying this mutation, or fetuses that are carrying it themselves would be at much greater risk of developing a cleft.[16] Later, a detailed nutritional study of the Mendoza cleft population revealed a low daily intake of folate and high intake of Vitamin A in the diets of mothers of cleft children.[23]

The authors' studies on periconceptional supplementation of the mothers' diet with folic acid showed a 65 percent to 82 percent decrease in recurrences and a 27 percent to 50 percent decrease in occurrences.[5,6,24] These results strongly suggest the major role that vitamins and folic acid play in the etiology of orofacial clefts.

Even when the 677 CT mutations in MTHFR seem to increase the susceptibility for clefting, the authors hypothesize, that this circumstance may be overcome by supplementation with folic acid. Thus, the nutrition seems to play an important role in triggering the genetic susceptibility for orofacial clefts and probably for other dysraphic congenital anomalies as well.

Section 4. Prevention of Orofacial Clefts

There is no doubt orofacial clefts are going to be the next congenital anomaly (following neural tube defects), for which a primary prevention — most likely involving folic acid supplementation — will become a part of health recommendations and policies. There is clear evidence for a role of folic acid in the prevention of neural tube defects.[25-27]

The size of the preventive effect was found to be directly proportional to a given dose of folic acid.[28] Moreover, there are numerous articles pointing to a preventive effect of folic acid in other dysraphic congenital birth defects.[29] A high number of scientific communications have presented suggestions or evidence for a preventive effect of folic acid on orofacial cleft anomalies.[5,6,24,28,30]

Figure 7. Dr. Ellerhorst with his patient in Guatemala.

In a nonrandomized interventional study, the authors found a dramatic reduction of cleft recurrences after periconceptional supplementation by multivitamins and high dose of folic acid. The first results were published in *Lancet* in 1982, and the complete final evaluation followed later.[5,6] The authors prospectively evaluated 221 pregnancies in women at risk for a child with CL±P. The 10-step protocol included multivitamin supplementation and folic acid (10 mg/day), beginning at least two months before a planned conception and continuing for at least three months thereafter. A comparison group was comprised of 1,901 women at risk for a child with CL±P who received no supplementation, and gave birth within the same period as the study group. In the supplemented group a 65.4 percent decrease of recur-

Figure 8. Drs. Ellerhorst, Costanzo and Oh with their cleft patients.

Figure 9. Craniofacial Genetics Laboratory at Pacific Arthur A. Dugoni School of Dentistry. The team is working on DNA isolation and analysis from different saliva specimens. (From left to right: Drs. Aurora Patino; Laura Reid and Gabriela Pitigoi-Aron, Department of Restorative Dentistry; Drs. Midori Obara (orthodontics 2007), and Alia Al-Jabeiti, (orthodontics 2008).

Table 1

Prevention of CL±P by Periconceptional Vitamin Supplementation (Particularly With a High Folic Acid)

Proband	Nonsupplemented (without/with cleft)	Supplemented (without/with cleft)	Efficacy expected occurrence	Decreased by (%)
CL±P (1)	1,824/77	211/3	8.67	65.4
Male with CL±P (2)	1,149/42	129/1	4.58	78.2
Female with CL±P (3)	675/35	82/2	4.14	51.7
Unilateral CL±P (4)	1,511/55	163/1	5.76	82.6
Bilateral CL±P (5)	313/22	48/2	3.29	39.2

[1]Fisher's exact test was used for all results. (1) P=0.030579; (2) P=0.063169; (3) P=0.227924; (4) P=0.02433612; (5) P=0.3734264.

rence of a cleft was observed (**Table 1**). Subset analysis by a patient's sex and severity of cleft showed the highest supplementation efficacy in individuals with unilateral clefts (82.6 percent decrease). No efficacy was observed for female individuals with bilateral CL±P. Generally, the efficacy was greater for subgroups with unilateral than with bilateral clefts and for male individuals.

Similarly, a large population-based case control study in California demonstrated that periconceptional use of multivitamins, which usually contain 0.4 mg or more of folic acid, reduced the risk for CL±P by approximately 27 percent to 50 percent. This was based on data derived from a population-based case-control study of fetuses and live-born infants with orofacial anomalies (731 mothers with an infant with a cleft and 734 mothers with unaffected baby).[24]

However, the most interesting results that actually strongly support the authors' justification for using a high dose of folic acid in the prevention of nonsyndromic cleft lip and palate are those of Czeizel and his colleagues. The first of his study of periconceptional supplementation with a multivitamin

containing a low "physiologic" dose of folic acid (0.8 mg) did not show any preventive effect.[28] However, a following study indicated a reduction of nonsyndromic cleft lip and palate after the use of high doses of folic acid (3-9 mg) in the early postconceptional period, pointing out "a dose-dependent effect" of folic acid in the prevention of orofacial clefts.[28]

During the last several years, an optimal design for an orofacial cleft prevention trial has been extensively discussed.[31-34] The authors are aware there are several key questions that need to be addressed in future scientific studies in order to clarify the highly probable association between cleft lip and palate anomalies and a lack of vitamin intake.[31] A proposal for a multicenter randomized double-blind trial of primary prevention of clefts has been developed by the authors' group and only a lack of funding is holding them back from carrying out the study that would lead to an efficient cleft prevention protocol.

Conclusion

Regardless of excellent surgical results and an advanced multidisciplinary treatment approach, the birth of a child with cleft lip and palate is a serious event, which should not happen without strong effort to prevent it, especially if we have tools in our hands that can lead to a birth of a healthy child. ■■■■

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Current Clinical Research in Orthodontics: A Perspective

Sheldon Baumrind, DDS

ABSTRACT

This essay explores briefly the approach of the Craniofacial Research Instrumentation Laboratory to the systematic and rigorous investigation of the usual outcome of orthodontic treatment in the practices of experienced clinicians. CRIL's goal is to produce a shareable electronic database of reliable, valid, and representative data on clinical practice as an aid in the production of an improved environment for truly evidence-based orthodontic treatment.

The past 15 years have seen greatly increased interest in the concept of "evidence-based treatment" in medicine, in dentistry, and more recently, in orthodontics. The implicit assumptions underlying the advocacy of evidence-based treatment are that the better the available evidence, the better the clinical judgments will be, and that the better the clinical judgments, the better the outcomes the treatments will be. To be sure, these assumptions seem intuitively reasonable, but we have thus far accumulated very little evidence with which to test them. The primary purpose of all clinical research in orthodontics is to improve the delivery of orthodontic treatment.[1-4]

For that reason, it seems reasonable that the main tasks of clinical orthodontic research in the next two decades should include the study of 1) how expert orthodontists make clinical judgments; 2) how good those judgments are; and 3) how strategies and tools can be developed for making better clinical judgments.[5-8]

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Remarkable recent advances in information processing technology make it possible to investigate these areas using exciting methods and techniques not previously available. At the Craniofacial Research Instrumentation Laboratory, CRIL, we seek to utilize these methods and techniques to improve the quality of service that orthodontists of the future will be able to provide to their patients.[9]

With regard to the study of how expert orthodontists make clinical judgments, CRIL engages in the systematic examination of the actual operations of the treatment process. That process can be thought of as having two components: treatment planning and the visit-by-visit conduct of treatment. The target of each component is the complex, multidimensional, and highly integrated patient seated in the chair.

For purposes of treatment planning, the density of information in the intact patient is so great and so heavily layered as to be too complex for direct analysis. Instead, it is customary to generate a series of transforms called "physical records." The minimum set of physical records that experienced orthodontists consider necessary for the development of a comprehensive orthodontic treatment plan includes study casts, lateral cephalograms, panoramic or intraoral dental X-rays, and facial photographs (**Figure 1**).

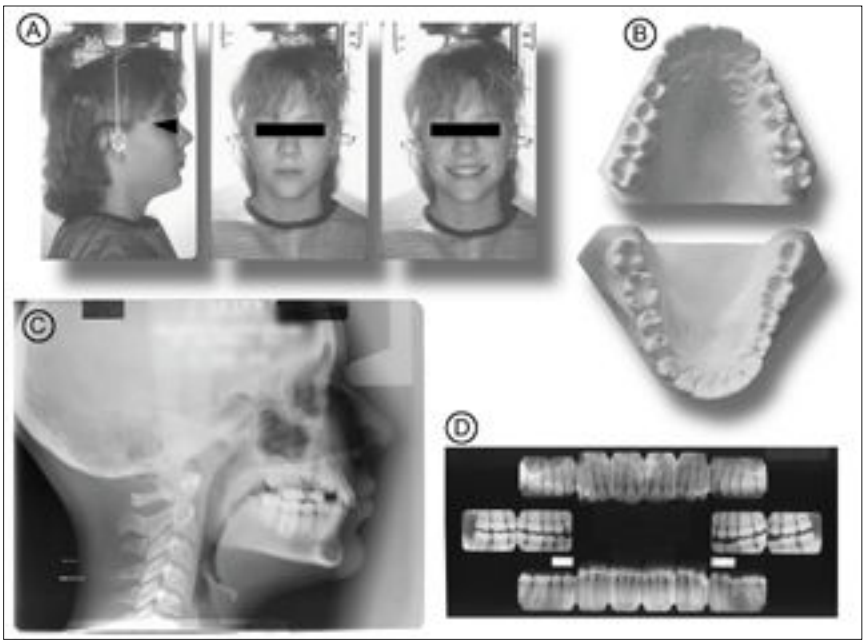


Figure 1. The basic physical records used in classical orthodontic diagnosis and treatment planning. A) Semistandardized facial photographs; b) study casts; c) standardized lateral cephalograms; and d) panoramic and/or intraoral X-ray images.

Each such transform makes some aspects of the patient's morphology more readily apparent by discarding information about other aspects. For example, the study casts allow us to view the teeth and arch form most clearly (even from the lingual aspect, which is impossible in the living subject). But study casts discard all information about how the jaws and teeth are attached to the rest of the head (i.e., about their relationship to the surface of the face and to the bony armature of the skull).

Similarly, facial photographs give us the best currently available information about the outside surface of the face, but they lose all information about the skull and teeth. Likewise, lateral cephalograms give us relatively good information about the spatial relationships between the jaws and the skull, but only at the cost of throwing away almost all information about the surface of the face and the details of dental arch form. In the past, the orthodontic clinician has examined each kind of physical record separately and then reintegrated the data extracted from all of them as a conceptual operation. How this task of reintegration is performed, by mentally filtering out inconsistencies, discounting redundancies, and identifying underlying patterns of interaction among data from the different kinds of record is a key mystery in need of comprehensive study, because it is a key element of clinical judgment in orthodontics.

The recent introduction of 3-D volumetric X-ray scanners (such as i-CAT, MercuRay and NewTom) may simplify the clinicians' task of interpretation because these instruments allow us to see the hard and soft tissues of the teeth, jaws, and skull in a single common registration. These new images are fully digital and can be viewed and manipulated by the clinician on a conventional computer monitor[10,11] (**Figures 2 and 3**).

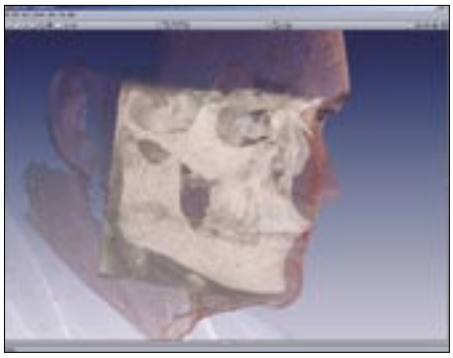
Work at the University of the Pacific and earlier work at the University of California, San Francisco, contributed consequentially to the development of these new techniques.[12-17] Yet the imag-

2a.

2b.

Figure 2. Milestones in the current migration toward integrated 3-D craniofacial mapping in orthodontic diagnosis and treatment planning. A) Generating a volumetric cone beam CT X-ray image with the i-CAT X-ray scanner at the Department of Radiology, Arthur A Dugoni School of Dentistry; and b) capturing a 3-D surface map of a patient's face using the school's 3dMD stereo-camera system.

3a.



3b.

Figure 3. The digital information from the i-CAT X-ray scanner and the 3dMD stereo-camera system can be integrated into a unified craniofacial map. A) Surface view of the combined 3-D digital data set; and b) a cutaway representation of the volumetric i-CAT dataset viewed through a mesh rendering of the patient's facial surface.

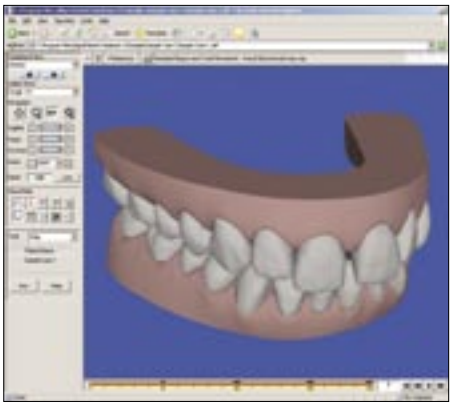


Figure 4. Computer monitor display of a patient's dentition in ClinCheck, a software program developed by Invisalign for planning orthodontic treatment in three dimensions.

es produced by radiographic systems of any sort tend to be ambiguous.[18,19] Hence, we and other orthodontic research groups are currently engaged in studying the new devices carefully in order to gain a relatively complete understanding of their attributes and limitations.[20]

How skilled clinicians exercise clinical judgment during the visit-by-visit conduct of orthodontic treatment is even less well understood than is the process of treatment planning. Though this question has thus far been completely unaddressed in any systematic way, clinicians know from experience that the actual conduct of treatment is crucially different from treatment planning. Indeed, many observers believe the generally high success rate of contemporary orthodontic treatment is based less on the goodness of our treatment plans than on the high level of clinical judgment and technical skill of experienced orthodontists — more specifically on their experience-driven ability to make "in-course adjustments" when the limitations in our biological understanding lead to unexpected aberrations during treatment.

Almost all the available information on in-course corrections during orthodontic treatment is contained in our written visit-by-visit treatment records, even though in many cases those notes leave much to be desired. The belief at CRIL is that in order to be able to analyze the way of in-course corrections are made during treatment, it will be

necessary during the next few years for orthodontists to develop rigorous quantitative methods for improved encoding and subsequent analysis of the visit-by-visit written records of orthodontic treatment progress. Preliminary studies in this area are currently in progress at CRIL.

How good our clinical judgments really are have also been underinvestigated in the past. We need to learn how well expert orthodontists' treatment preferences, taken as predictions, actually correlate with subjective and objective measures of treatment outcome. Studies in this area necessarily need to be blinded and performed with replication in such a manner that inter-rater and intra-rater statistics on reliability and validity can be gathered. One early study in this difficult and important area is currently in progress at CRIL. In this study, we are assessing the reliability with which experienced clinicians have used a 3-D virtual treatment planning method called ClinCheck in the planning of orthodontic treatment with the Invisalign appliance (**Figure 4**).

The main point of this paper has been to propose that future clinical studies in orthodontics seek to capture and retain much more information about each patient sampled than has been possible during earlier clinical investigations in the field. This strategy is considered to be desirable because it is consistent with the manner in which decision-making works in clinical orthodontics. Such a strategy has now been made much more practical by the emergence of many new electronic tools, particularly the digital scanner, the 3-D cone beam digital X-ray image, the relational database, and the Internet.

Our aim is to promote conditions in which data obtained from representative and random samples in a blinded and unbiased manner can be shared by serious clinicians and craniofacial investigators of different persuasions. It is hoped that in this way we can contribute to the consistency with which our specialty of dentistry continues to provide the public with treatment of the highest quality. ■■■■

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Unearthing Dentistry's Origins

A painless laser that will render a dental visit a total delight on a par with Disneyworld, only cheaper, rates a semiannual rediscovery.

Dentistry's roots probed – Practice found to be at least 4,000 years older than first thought

The Associated Press occasionally has a slow news day. This was one of them.

Inevitably the riveting revelations of celebrity affairs, pregnancies, marriages, infidelities, and divorces — in that order — are all duly recorded. Long-lost pets that find their way home eight months later after traveling 3,500 miles by foot or paw has proven popular, but none has topped the annual research that proves chocolate is good for you.

About twice a year, in an effort to keep its satiated readership from reverting to reading books, the Fourth Estate feels an obligation to print a dentally oriented piece.

Thus, it is that we learn of the periodic discovery of a vaccine for caries. A painless laser that will render a dental visit a total delight on a par with Disneyworld, only cheaper, rates a semiannual rediscovery.

The burden of the reporting falls on the staffer who has to come up with the headline journalistic tradition dictates must have one of the following terms in a 48-point font: painless, grindless, shotless, and, in the case of the above headline, roots.

The exact number of people outside the dental profession intrigued by ancient dental practices is unknown, but is estimated to be 11, give or take a couple. Until recently, the last recorded incident to capture the

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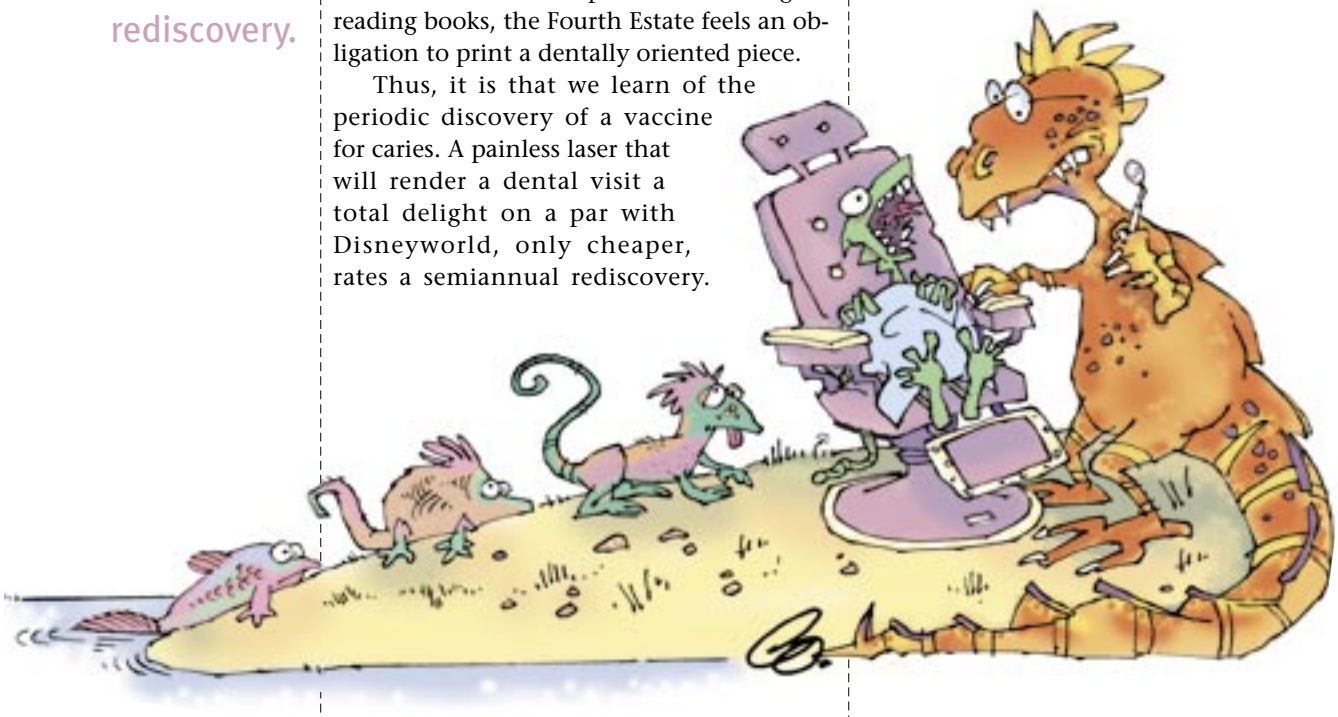

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attention of the *AP*, *Reuters*, and yours truly, occurred some eight years ago when researchers digging about in a Gallo-Roman cemetery just south of Paris unearthed the earliest known dental implant. This was a wrought-iron tooth imbedded in the maxilla of a man who lived about 1,900 years ago. The iron tooth, as seen in X-rays, was said to have been a "perfect fit," giving rise to speculation that a Gallic blacksmith must have been moonlighting as a dentist on the side.

The ancient Etruscans in northern Italy are reported to have made partial dentures, crowns, and simple bridges as early as 2,500 years ago. That these prostheses were so crude in their fabrication, a first-semester dental student of today responsible for a similar mishmash would be summarily stripped of his name tag and drummed out of the corps, is beside the point.

Currently, the *AP*, quoting the French journal *Nature*, has one-upped itself with the revelation that "primitive dentists drilled nearly perfect holes into live, but undoubtedly unhappy patients between 5500 B.C and 7000 B.C." The evidence was found in a Pakistan graveyard where nine skulls with 11 holes were unearthed. According to Roberto Macchiarelli, an anthropology professor at the University of Poitiers, France, the drilling was done on "ordinary men and women." Ordinary in terms of them screaming like banshees during the procedure, probably. The fact that thousands of Pakistanis later migrated to the United Kingdom, is coincidental.

Close examination of the prepared teeth indicates that no attempt was made to fill the holes with anything. Without a doubt, this was the work of a freshman Pakistani dental student who wouldn't get into Filling 101 until next semester. Richard Glenner, a Chicago dentist and author of dental history books, offered that the drilling could have been decorative or to release evil spirits. Evil spirits were right up there with tooth worms when it came to causing dental mischief years ago. "Why did they do it?" Glenner asked. "No one will ever know."

Evil spirits were right up there with tooth worms when it came to causing dental mischief years ago.

Well, fine! If my analysis of media attention is correct, we can expect to read a dateline of Garden of Eden in about five years revealing how Adam's remains had been found and that dentistry done to close a diastema, probably at Eve's behest, was even older than we thought. He was also wearing a Mesopotamia Bridge, the precursor to the Maryland Bridge. Top that, Fox News! ■■■■