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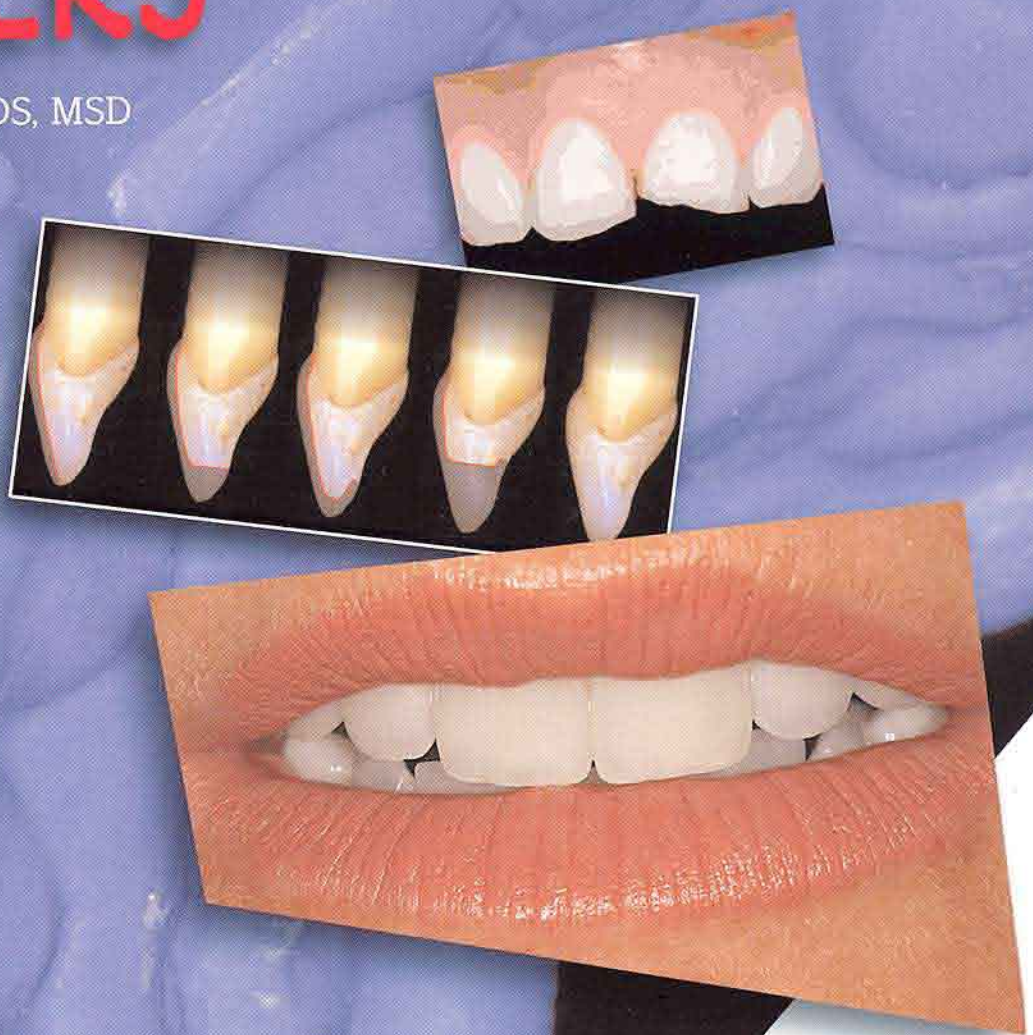
February 2004

Esthetic Correction
Fracture Loads
Short Teeth

PORCELAIN VENEERS

Careen W. Young, DDS, MSD



OF THE CALIFORNIA DENTAL ASSOCIATION
Journal
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DEPARTMENTS

FEATURES

Jack F. Conley, DDS

It's All About Smiles

It is February and it is fitting we comment on the charitable contributions of California dentists and their association this month. Feb. 7 marks the second annual "Give Kids A Smile" day conceived by the American Dental Association in 2002 for its inaugural installment in February 2003.

California Dental Association members, their staff members, and dental students from throughout the state helped to make the initial outing of this outstanding program a tremendous success. Members of the dental industry also strongly supported the effort with contributions of materials and supplies. As this column was being drafted, many colleagues had already indicated their intent to participate in the 2004 program. We anticipate the turnout will again demonstrate the profession's long history of commitment to the prevention of oral disease.

As 2003 entered its last few months, there were additional reasons for there to be "smiles" for organized dentistry in California. On Nov. 12, the California Dental Association Foundation was notified that its joint venture with the Dental Health Foundation to develop and administer oral health education and training targeting dental decay in underserved children aged 5 years and younger, had been awarded a $7 million contract from the California Children and Families Commission. This contract is believed to be the single largest oral health education grant ever awarded in California. The project will provide education and training for dentists and other primary care professionals as well as increasing consumer awareness of the importance of early oral health care for young children.

This is an accomplishment that should bring pride to all members of CDA and especially to the board and staff of the Foundation. The Foundation, while still in a stage of relative infancy, has demonstrated by this initiative a strong commitment to contribute to improved oral health education, and ultimately to the oral health of the California populace.

Dental leadership in community oral health matters did not stop here. CDA, the CDA Foundation, the Mid-Peninsula Dental Society, and the California Fluoridation Task Force worked tirelessly and helped provide the resources to help Palo Alto voters reject a measure that would have overturned a 49-year history of water fluoridation in that city by banning its future use.

Another instance in which CDA and the Foundation have been battling anti-fluoridation efforts is the defense of the benefits of fluoridation in litigation involving the City of Watsonville vs. the California Department of Health Services.

Finally, in mid-December, "smiles" were again in strong evidence when it was announced that the Metropolitan Water District of Southern California had signed a CDA Foundation fluoridation funding contract in which the foundation will fund $5.5 million to enable the MWD to build water fluoridation facilities at each of the

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five water district treatment plants. These facilities will enable the MWD to provide fluoridation to approximately 17 million customers in the greater Los Angeles basin.

These accomplishments should bring great satisfaction, particularly to those in the profession who have worked relentlessly for years to advance the benefits of community water fluoridation to the oral health of the public. But more importantly, we feel it really does illustrate the important impact that the foundation has had in advancing the profession's leadership in public oral health issues in a relatively short time.

For many years, February has traditionally featured a focus on dental health, particularly for children. That makes this month a particularly good time to celebrate some rather significant progress in the public health efforts of the dental profession in California. We doubt that the progress described would have been possible without the emergence of the CDA Foundation. The funding, made possible by the foundation, and the linkage between the foundation and the community have clearly been beneficial to the achievement of these recent public oral health initiatives. Without the foundation, dentistry would not have the opportunities it now has to influence these initiatives.

We anticipate the foundation will continue to build the image of the profession as the leader in advancing the oral health of the public through contributions of resources and support for preventive initiatives. The end result will be improved smiles for the public and smiles of pride for the profession. CDA

Illustration: Lee Ann Engle

Progress on Engineered Mandibular Condyle Holds Promise for Other Joints

By utilizing adult stem cells from rats, scientists have produced a mandibular condyle, an exact 3-D formation of the human joint.

Emphasizing their discovery is preliminary and that major scientific tests await, researchers, as reported in the December 2003 issue of the *Journal of Dental Research*, are encouraged because they created it from a single population of stem cells and then prompted them to form two distinguished levels of cartilage and bone — the first ever in the tissue engineering field.

University of Illinois at Chicago scientist and an author on the study Jeremy Mao, DDS, PhD, said the work is helpful for not only learning to engineer mandibular condyles but other body joints.

The mandibular condyle joins the lower jaw to the temporal bone of the skull on both sides of the head at the temporo-

"We began our research using mice that were no larger than a human hand, and, obviously, it wasn't possible to engineer a large human tibia or femur that way."

ADEL ALHADLAQ, DDS, MS

mandibular joint or TMJ.

"The TMJ is a synovial, or free-moving, joint," Mao said. "So are the knee, hip, and shoulder joints, all of which include rounded, moveable condyles. We certainly hope our results will be applicable to other synovial joints."

The most significant result of the study was that within the tier of the implants inserted with osteoblasts, mineral deposits in island structures were found, an indication that osteoblasts adhered to their biological program and produced bone. With the other layer, scientists identified "sparse chondrocyte-like cells within abundant extracelluar matrix," that produced proteins characteristic of cartilage.

Scientists have long wanted to engineer body joints including hips and knees using a person's own cartilage and bone generating adult stem cells. The question has been how to best manage the cells and encourage them to form tissues exactly matching the 3-D structure and mechanical strength of healthy and normal joints.

Tissue engineering blends the principles of life sciences and engineering to manipulate the body's biological materials to mend, rebuild and eventually replace tissues and organs, bone and cartilage that are damaged.

Success in the area of tissue engineering would cut out the need for bone grafts and prevent complications related to artificial replacement joints including immunorejection, transmission of pathogens, atypical wear and tear, and donor site defects.

Advancements in the area of tissue engineering are expected to have remarkable healing possibilities; however, those with acute arthritis face some limitations. "People with very severe osteoarthritis or rheumatoid arthritis often have large condyle defects, so the entire condyle needs to be replaced," said Mao.

In 2001, Mao, his team of dentists, cell biologists, surgeons, materials scientists and clinicians embarked on an effort to create a mandibular condyle.

"Why the mandibular condyle?" posed Adel Alhadlaq, DDS, MS, a coauthor on the paper and a University of Illinois at Chicago scientist. "We began our research using mice that were no larger than a human hand, and, obviously, it wasn't possible to engineer a large human tibia or femur that way. Because the mandibular condyle is smaller and could be transplanted into a mouse, it was just a practical structure to try and engineer."

Mao noted that his research team had long been interested in temporomandibular joint disorders, an often excruciating condition that approximately 90 million Americans suffer from.

The December 2003 issue of *The Journal of Dental Research* chronicled the success of Mao's team who isolated adult mesenchymal stem cells taken from rat bone marrow and treated them to separate into cartilage- or bone-producing cells, osteoblasts and chondrocytes. Individual adult mesenchymal stem cells can generate thousands of osteoblasts or chondrocytes.

The team then seeded the differentiated cells into a hydrogel polymer solution and placed them into a polyurethane form made from a human mandibular condyle.

Scientists subsequently inserted three small molded structures just under the skin of severe combined immunodeficient (SCID) mice. Each implant then was encapsulated in a hydrogel coat that subdivided into layers seeded either with osteoblasts or chondrocytes, in an effort to engineer distinct layers of cartilage and bone.

Approximately two months later, Mao and his team collected the three tissue-engineered condyles from the mice. The scientists discovered the implants formed their own into "firm" structures, retaining the exact contour and 3-D structure of the sculpted human mandibular condyle.

Mao said he and his team now would work to improve the mechanical and biological properties of the tissue-engineered condyle.

"It is no small task by any measure to recapitulate what nature does perfectly during development," said Mao. "Although we understand many of these cues during natural development, we need to learn how to utilize them to tissue engineer mandibular condyles."

Using Up-to-Date Codes Leads to Quicker Payment

Dentists who use the current version of the Code on Dental Procedures and Nomenclature will be paid more expediently than those utilizing the outdated codes.

"It doesn't matter to us if a claim is filed electronically or on paper," said Bill Blake, application manager for the life and dental subsidiaries of Blue Cross Blue Shield of Illinois, Texas and New Mexico. "Once claims are entered into our claims adjudication system, they're really all the same. And if current codes are used, the claims can be paid faster."

Only the current dental terminology, as published in the CDT-4 for electronic claims or paper, are the codes Blue Cross Blue Shield recognizes.

Philip Hardin, WebMD Dental president, the nation's largest claims clearinghouse, suggested dentists utilize the CDT-4 codes as soon as "is practical."

ADA always has recommended utilizing the current code version to make the coding and claim filing process easier as well as take into account advances in clinical practice when reporting. The Oct. 16, 2003, deadline for electronic transactions and code sets, under the Health Insurance Portability and Accountability Act of 1996 (HIPAA), provided more motivation for dentists to use the current version of the code as required under the electronic claims submission rules.

"Under HIPAA, we're not supposed to change any of the codes that come in," Blake said. "If dentists send in claims under obsolete codes, we've got to ask them if it's OK to change the code to update it, and then the claim just takes longer to process."

"Under HIPAA, we're not supposed to change any of the codes that come in."

BILL BLAKE

The Genetics of Cleft Palate and Cleft Lip

A recent review of the genetics of cleft palate (CP) and cleft lip (CL) was to educate dentists on the differences between non-syndromic and syndromic cleft as well as help dental professionals recognize and provide genetic counseling for patients and their families.

In The Journal of Clinical Pediatric Dentistry, published in Summer 2003, researchers said both CP and CL are the single most common defects affecting the oral facial structures. Additionally, it has been the topic of many studies, according to All India Institute of Medical Sciences, New Delhi, India, researchers.

Treating these cases not only requires speech therapy, multiple surgeries, but orthodontic and dental treatments by the patient's 18th birthday. Cleft palate and lip can be seriously disfiguring. In children, it also can affect function to a certain extent.

Researchers said care requires meeting the basic medical needs of the patient, but also educating patients and their parents about the genetics of CL and CP. Studies have shown that genetics is a significant factor in the etiology in the cleft conditions. Using a good family history, dentists can determine the possible extent to which the genetic factors are involved in the etiology of CP and CL and provide counseling on genetics.

However, the researchers cautioned that results were inconsistent when trying to identify susceptibility loca via family and case-control studies. They speculated it's possible that initial predictions of the complex interactions associated with facial development were underrated.

Another Brush with History

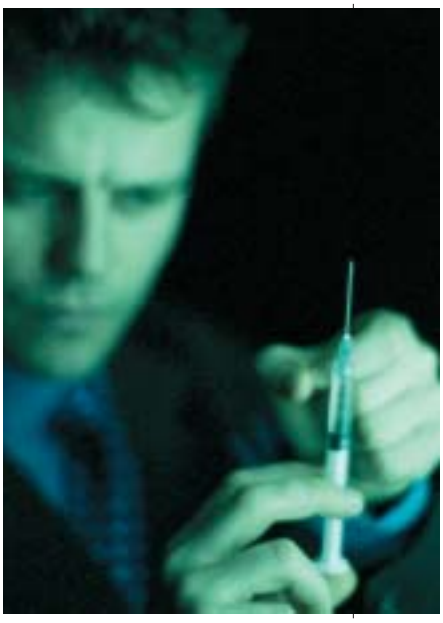
A toothbrush recently unearthed at the former site of a Minden, Germany, city hospital is speculated to be at least 250 years old.

According to the Landscape Association of Westfalen-Lippe, which is overseeing the excavation, the bristles have disintegrated. What remains is a four-inch handle made of animal bone. On the other side of the toothbrush is a small, sculpted spoon thought to be used for cleaning ears.

A similar toothbrush was found months before in early 2003 near the city of Quedlinbug in central Germany, approximately 100 farther east. Experts dated that personal hygiene tool at around 1750, the oldest discovered in Europe. The second toothbrush, experts said, may have been manufactured from the same workshop.

Use of toothbrushes in the 18th century became more common wealthier Europeans made caries-causing sugar a staple to their diet.

Identifying the Substance Abuser



With prescription medication the second-most abused substance after alcohol, and with approximately 22 million substance abusers in the U.S. alone, it is highly likely general dentists during their career will encounter such a patient.

Substance abuse and chemical dependency presents health care and societal problems. It's also a complication for dentists regardless if they're treating current abusers or those in recovery, according to an article in the Academy of General Dentistry's newsmagazine, *AGD Impact*.

The challenge for the dentist is to identify the common indicators of a drug-seeking patient, understand the contraindications between street drugs and medications used in dental treatment as well as the oral health implications of drug abuse. Dentists also must concisely and sympathetically talk to the patient about the risk factors of abuse and how to get help.

Successfully treating recovering addicts and alcoholics involves the dentists learning about the chemical dependency disease process, using added precautions when prescribing potentially addictive medications, as well as understanding the possible impacts of anesthesia and mouthwash on a patient's sobriety.

Michael Fishman, MD, an addiction specialist and program director of adult addiction medicine services at Atlanta's Ridgeview Institute, said like most people, dentists share a general ignorance of the disease process of chemical dependency.

"There is a bias about addiction, a belief that persists that chemical dependency is a moral issue and not a disease," Fishman said. "The problem is that this bias can be deadly when it is held by health care professionals."

Fishman warned a doctor's ignorance of addiction can endanger patients and leave general practitioners exposed on several fronts, from lawsuits for prescribing a drug that triggers a recovering addict's relapse to threats from a drug-seeking addict. Cases are rare, but they do occur.

According to Richard C. Engar, DDS, FAGD, attorney in fact/CEO for Professional Insurance Exchange in Salt Lake City, there have been patients who've accused dentists of creating an addiction, having them relapse or blaming them for health complications related to drug interactions.

Engar said that continuing education or reviewing practice management policies could help GPs protect themselves and provide care to patients with substance abuse problems extending beyond their oral health.

UCSF School of Dentistry to Research Tobacco-Cessation

Hoping to prevent 600,000 premature deaths annually from tobacco use, the UCSF School of Dentistry will utilize a grant to research tobacco-ending programs in dental offices.

The $2.4 million grant, from the National Institute of Dental and Craniofacial Research and the National Institute on Drug Abuse, allows researchers to look at different methods that dentists can assess and treat a patient's addiction to tobacco. The affiliated Delta Dental Plans in California and Pennsylvania will help researchers collect information and identify dental offices to be included in the study.

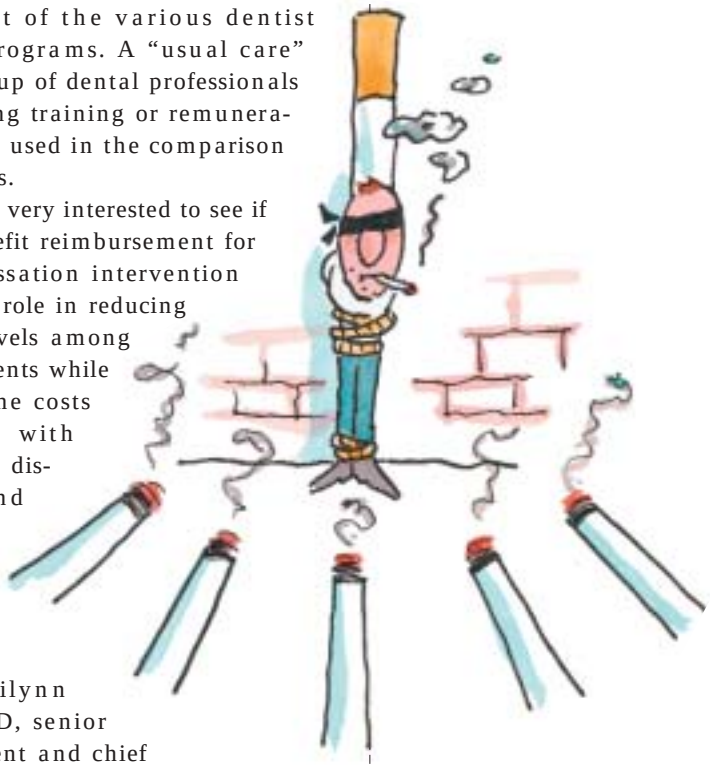
According to research, an estimated 10 percent of patients advised by healthcare workers to stop using tobacco products actually comply. And since nearly half of the 46 million American adult smokers visit a dentist annually, dental professionals have an opportunity to provide tobacco-cessation resources to the patients.

"Given that about one third of all smokers die prematurely, we think reaching that 10 percent in the dental office could translate into 600,000 premature deaths avoided," said Margaret M. Walsh, RDH, EdD, Professor in the department of Preventive and Restorative Dental Sciences at UCSF, and principal investigator of the five-year study.

"In addition to increasing risk of heart disease, lung disease, cancer, and other illnesses, tobacco use is associated with 75 percent of all squamous cell oral cancers and 50 percent of adult periodontitis cases in the nation," Walsh said. "Tobacco use also significantly predicts failure of periodontal therapy and dental implants, impairs oral wound healing, increases the risk of dental caries, and affects a wide range of oral soft tissue changes."

Selected dentists, who also are members of Delta Dental's network, will be trained by UCSF researchers to provide tobacco-ending counseling to patients in a dental setting. Some of the dentists will be monetarily compensated for the service.

The study will assess a number of factors. Among them, how insurance reimbursement may affect the quantity of patients counseled in the dental office and the impact of the various dentist training programs. A "usual care" control group of dental professionals not receiving training or remuneration will be used in the comparison of programs.

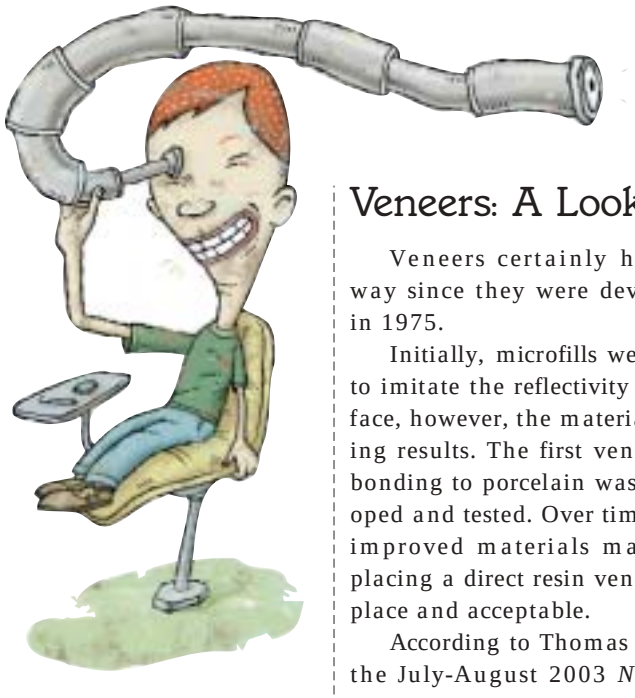


"We are very interested to see if dental benefit reimbursement for tobacco cessation intervention can play a role in reducing smoking levels among dental patients while lowering the costs associated with periodontal disease and other tobacco-related dental problems," said Marilynn Belek, DMD, senior vice president and chief dental officer for Delta Dental.

"If effective, it is conceivable that group benefit sponsors would be very interested in incorporating tobacco cessation benefits as part of a dental benefits program," said Belek, adding the company looks forward to collaborating on the project.

Walsh previously completed research on tobacco cessation, primarily on techniques to assist dentists and dental hygienists in the use of oral cancer screenings as a "teachable moment" to encourage smokers to quit.

Among the key collaborators on the grant include members of the Department of Preventative and Restorative Dental Sciences: Steven Silverstein, DMD, MPH, UCSF Professor; Jane Weintraub, DDS, MPH, UCSF Professor; James Ellison, DDS, MPH, UCSF Assistant Professor; Umo Isong, DDS, PhD, UCSF Assistant Professor; and Stuart Gansky, DrPH, UCSF Assistant Professor.



Matt Mullin

Veneers: A Look Back

Veneers certainly have come a long way since they were developed and tested in 1975.

Initially, microfills were commonly used to imitate the reflectivity of the enamel surface, however, the materials had disappointing results. The first veneers evolved when bonding to porcelain was successfully developed and tested. Over time, light curing and improved materials made the process of placing a direct resin veneer more commonplace and acceptable.

According to Thomas D. Larson, DDS, in the July-August 2003 *Northwest Dentistry*, using any veneer on a tooth in those early days was viewed as drastically different from what was considered accepted treatment.

There now are three types of tooth preparation. The method selected is based on the materials bonded to the tooth, what porcelains are utilized and type and shade of discoloration the operator is trying to conceal.

Other developments over the years include the practice of using layered composites with large particle or hybrid composites to replace missing tooth structure layered with a microfill. Although this method did not address the issue of composites that cracked, it did decrease it to a level more reasonable, said Larson, an associate professor in the restorative sciences department at the University of Minnesota School of Dentistry.

Upcoming Meetings

2004

Feb. 15-21	Barbados Dental Association 16th annual Midwinter Convention, Barbados, www.barbadosda.org
Feb. 19-22	Chicago Dental Society 2004 Midwinter meeting, Chicago, www.cds.org/mwm/
March 2-3	Academy of Laser Dentistry Certification Program, Standard Proficiency and Advanced Proficiency, Palm Springs, (954) 346-3776, www.laserdentistry.org.
March 3-6	Academy of Laser Dentistry 11th Annual Conference, Palm Springs, (954) 346-3776, www.laserdentistry.org.
March 5-8	Academy of Laser Dentistry 10th Anniversary Conference and Exhibition, Destin, Fla., (954) 346-3776, www.laserdentistry.org.
March 10-13	International Association for Dental Research's 83rd general session and exhibition (also 33rd annual meeting of the American Association for Dental Research and the 28th annual meeting of the Canadian Association for Dental Research), Honolulu, Hawaii, (703) 299-8094, www.dentalresearch.org.
April 15-18	CDA Spring Scientific Session, Anaheim, (866) CDA-MEMBER (232-6362).
April 27-May 2	American Academy of Cosmetic Dentistry's 20th annual Scientific Session, Vancouver, British Columbia, www.aacd.com.
Sept. 8-11	International Federation of Endodontic Association's sixth Endodontic World Congress, Brisbane, Queensland, Australia, www.ifea2004.im.com.au.
Sept. 10-12	CDA Fall Scientific Session, San Francisco, (866) CDA-MEMBER (232-6362).
Sept. 30-Oct. 3	ADA Annual Session, Orlando, Fla., (312) 440-2500.

To have an event included on this list of nonprofit association meetings, please send the information to Upcoming Meetings, *CDA Journal,* P.O. Box 13749, Sacramento, CA 95853 or fax the information to (916) 443-2943.

Correction

In the January 2004 issue of the *Journal*, a list of council members was inaccurate. The correct list for the Council on Membership is:

John P. Cunningham, DDS

Nita V. Dixit, DDS

Joseph M. Nunez, DDS

Parisa Zarbafian, DDS

Judee Tippett-Whyte, DDS

Porcelain Veneers — From Diagnosis to Execution

Careen W. Young, DDS, MSD

The technique of porcelain veneers was first introduced in the early 1980s. This procedure became very popular because it offered clinicians a superior treatment alternative to porcelain fused to metal crowns and direct resin bonding as a means to altering the shape and color of teeth for cosmetic reasons. The advantages of utilizing porcelain veneers are many. Significantly, less tooth reduction is involved, finish lines may be supragingival, teeth may be restored with a beautiful tooth-like surface and corrections to minor mal-alignments in tooth position are possible. But have porcelain veneers been overused? Have they been utilized where orthodontics, bleaching and minor tooth reshaping may have accomplished the desired esthetic objectives? Examples of "rotary orthodontics" are frequent among mailings received at the dental office. Just because we have a hammer does not mean we must use it. Bonding still has a place in conservative esthetic dentistry. I echo the philosophy expressed in the November 2002 issue on Oral Facial Esthetics: Use the most conservative treatment that will accomplish the patient's esthetic goals and leave the patient in a healthier state than when you began.

Previously, patients having cosmetic dental procedures had their teeth bonded or crowned and accepted or even sought out the "bonded look" or the white, "Chicklet" look of Frank Sinatra's smile. Today, esthetic dentistry has matured. It commonly begins with a dental facial evaluation and may involve a multidisciplinary treatment plan. Patients desire restorations that appear more natural and

which enhance the appearance of their smile. Aside from alterations to the shape and color of the teeth, the treatment plan may involve lengthening the teeth and altering the patient's occlusal plane, smile line, vertical dimension or gingival architecture. Consequently tooth preparation considerations must evaluate whether finish lines will be placed on enamel or what was previously root surface (dentin), the amount of facial reduction necessary, what is the desired finished length of the tooth, whether incisal reduction is necessary, and how much unsupported porcelain there may be.

The authors who have contributed to this issue are well-respected clinicians who focus on multidisciplinary esthetic dentistry. This issue of the *Journal* will address the treatment planning considerations for incorporating porcelain veneers into a treatment plan as an alternative or in addition to orthodontics or surgery. It will address the criteria for designing an esthetic smile, principles of preparation design and provide a technique for provisionalizing prepared teeth so that the esthetic design may be communicated to the patient and laboratory technician.

■ Frank M. Spear, DDS, MSD, provides a series of decision-making criteria for determining whether porcelain veneers, orthodontics or both, should be utilized in the esthetic treatment plan and discusses what the limitations of treatment will be if orthodontics is not performed.

■ Stephen J. Chu, DMD, MSD, Susan Karabin, DDS, and Saiesha Mistry, DDS, illustrate clinical conditions associated with short teeth. Their paper provides a flow chart to determine the appropriate multidisciplinary treatment plan which may involve porcelain veneers, orthodontics, periodontics or orthognathic surgery.

■ Tal Morr, DDS, MSD, outlines the criteria to evaluate when designing an esthetic smile.

■ John C. Kois, DMD, MSD, discusses the diagnostic criteria to consider when determining the preparation design for anterior teeth.

■ Jacopo Castelnuovo, DDS, MSD, compares the fracture resistance of four different incisal edge finish line designs and makes recommendations regarding the length of unsupported incisal edge porcelain.

■ Careen W. Young, DDS, MSD, describes a new quick and simple technique for fabricating provisional veneers which may be utilized to verify the esthetic possibilities with the patient. The provisional restorations may provide the technician with a blueprint for the definitive restorations.

I hope you will enjoy this issue of the *Journal* and find it a beneficial reference when your esthetic treatment plans involve porcelain veneers. CDA

Contributing Editor / Careen W. Young, DDS, MSD, is a clinical professor, primary oral health care, at the University of Southern California School of Dentistry, and has a private practice in Beverly Hills, Calif.

The Esthetic Correction of Anterior Dental Mal-alignment Conventional vs. Instant (Restorative) Orthodontics

Frank M. Spear, DDS, MSD

ABSTRACT

Creating a flow sheet may assist in the decision whether to use conventional orthodontics and what the limitations of treating the patient will be if treatment is performed without any orthodontics. The decision process can be viewed as a series of questions, and depending upon the answer to the questions, the practitioner and patient can decide on whether to involve orthodontics or not. Questions can create a framework to help separate the patients who would benefit from orthodontic intervention from those we all enjoy treating who can be managed with purely restorative care.

Over the last two decades, nothing has changed the way dentistry is practiced as much as endosseus root form implants and adhesive dentistry.[1-6] When introduced to the profession, both technologies provided the ability to restore patients in more conservative ways, leaving more natural teeth minimally altered. Over the 20 years that have followed their introduction, both technologies have suffered from, at times, overuse. With therapists deciding that implants were so successful, why not remove more teeth and use more implants. To the extent that on occasion patients who would routinely have been treated with periodontics and restorative dentistry in the past now are being treated with full mouth extractions and implant reconstructions.

This same phenomenon has also been applied to adhesive dentistry, particularly bonded porcelain, and especially in patients with problems of malalignment where conventional orthodontics would have been used in the past. Now "instant orthodontics" is being performed routinely with bonded porcelain. In fact, in every major city in the country, one can look in the Yellow Pages and find a dentist offering "Two appointment orthodontics."

It is now commonplace to have at least one publication a month arrive at the office showing a patient with unrestored teeth receiving 10 or 20 bonded porcelain restorations correcting a problem of alignment.

The purpose of this paper is not to judge whether all of these treatment plans are right or wrong, as I spend the majority of my practice time performing bonded porcelain restorations to alter patients appearance, but to create a flow sheet to aid in making the decision on whether conventional orthodontics should be used, and what the limitations of treating the patient will be if treatment is performed without any orthodontics.

The decision process can be viewed as a series of questions, and depending upon the answer to the questions, the practitioner and patient can decide on whether to involve orthodontics or not.

■ ***Question 1. Will the teeth need to be restored to satisfy the patient's esthetic desires whether orthodontics is performed or not?***

Author / Frank M. Spear, DDS, MSD, is founder and director of the Seattle Institute for Advanced Dental Education, and maintains a private practice limited to esthetics and fixed prosthodontics in Seattle, Wash.

Figures 1 and 2. A patient who desired an esthetic correction of her smile. Even if orthodontics had been performed to correct alignment, the teeth would still have needed restorations to improve their appearance and condition.

Figure 3. The completed restorations on the patient in Figures 1 and 2. Because all the other considerations were acceptable, the alignment correction was managed with the restorations.

Figure 4. An adult who required restorations on her peg-shaped lateral incisors and had impacted permanent canines. The maxillary esthetics and canine replacement could be managed restoratively, but the occlusal relationship, particularly the anterior crossbite and natural canine guidance, could only be corrected with orthodontics.

Figure 5. The patient from Figure 4 following exposure of the impacted canines and orthodontics to bring them into correct alignment and correct occlusion. (Orthodontics courtesy of Dr. Vince Kokich.)

This is a critical question to answer. If the teeth will need to be restored because of existing restorations, poor tooth size or shape, or color problems uncorrectable with bleaching, then orthodontics will have to provide some other significant benefits in order to be chosen to correct mal-alignment. If, on the other hand, the teeth would not require restorative treatment other than perhaps bleaching and re-contouring following orthodontic treatment, there are compelling reasons to do conventional orthodontics and leave the teeth unrestored.

As good as our current techniques and materials are, there is certainly no evidence that restorations will survive a lifetime when placed in young individuals.[7-9] Because of this, the expediency of the quick fix must be weighed against the long-term consequences of preparing teeth in patients who would not require restorations if conventional orthodontics was performed.

On the other hand, if the teeth need restorations even after orthodontics, the treatment planning process becomes an issue of whether an acceptable result can be achieved by the restoration alone, or if it will be necessary to utilize both orthodontics and restorative dentistry to create the desired esthetic outcome.

Will the teeth need to be restored whether orthodontics is performed or not?

Yes? Go to Question 2 (**Figures 1 through 3**).

No? Orthodontics is the preferred treatment plan.

■ ***Question 2. Can the occlusion be managed without orthodontics but with restorative dentistry?***

Often times restorative dentistry can solve the esthetic problems of maxillary and mandibular anterior teeth but cannot correct the occlusal relationship of the anterior teeth (**Figures 4 and 5**). This is especially true of patients with inadequate or excessive overbite or overjet or single tooth anterior crossbites.

For the restorative dentist, the most common occlusal problems encountered when desiring to restore the maxillary anterior teeth to a new length are a lack of room due to inadequate overjet, particularly in cases of excessive wear or a concern that the new longer restorations will create an excessively deep overbite that may result in fracture of the porcelain.

Equally common is the restorative dentist's thought process in solving these problems of space, which typically involves a desire to increase the vertical dimension of the occlusion. Often a measurement is made from the CEJ's or gingival margins of the maxillary central incisors to the mandibular central incisors, to determine if this distance is decreased below the average of 18 to 20 mm to decide if a vertical opening is required to regain lost vertical dimension.[10,11] Unfortunately, all that this measurement evaluates is the state of eruption of the maxillary and mandibular anterior teeth, not the vertical dimension of occlusion. Unless the posterior teeth, particularly the molars, show significant wear or are lost, it is highly unlikely that the patient has lost vertical dimension.

So why not increase the vertical restoratively? Primarily because of the cost to the patient and the need to re-

Figures 6 and 7. A patient with severe attrition of his mandibular anterior teeth and what appeared to be a loss of vertical dimension of occlusion.

Figure 8. A measurement made from the CEJ's or gingival margins of the maxillary to mandibular centrals, showed a distance of only 10 mm, appearing as a significant loss of vertical dimension. Examination of the posterior teeth showed no wear and an acceptable occlusion. Measuring from the gingival margins of maxillary to mandibular first molars revealed a normal vertical dimension of occlusion, the anterior measurement simply reflected secondary eruption of the anterior teeth due to severe wear.

Figure 9. Orthodontics was performed to intrude the lower incisors and level the lower arch after they were first built up. The upper arch was also leveled.

Figure 10. Final restorations consisted of four maxillary anterior restorations and four mandibular anterior restorations. The posterior teeth and vertical dimension remained unchanged. (Restorations courtesy of Dr. Gregg Kinzer.)

store posterior teeth which otherwise would require no treatment. How can orthodontics overcome the problem? If the problem is one of excessive overbite due to wear and anterior eruption, orthodontics can level the arches intruding the anterior teeth allowing the restoring dentist the ability to restore the anterior teeth and leaving the patients posterior teeth unrestored (**Figures 6 through10**). If the problem is one of inadequate overjet, as in an end to end occlusion, the orthodontist can strip or extract mandibular teeth creating room for the mandibular anteriors to be retracted, creating a normal overjet to properly position or restore the anterior teeth, leaving vertical dimension unchanged. Another occlusal issue found commonly in cases of severe crowding is the inability to create any type of normal canine relationship in the occlusion even with full coverage restorations. Again, orthodontics cannot only resolve the canine relationship, but allow the restorative dentist to change from a very aggressive restoration to a conservative veneer, or no restoration at all.

Can an acceptable occlusal relationship be created with restorative dentistry alone?

Yes? Go to Question 3.

No? Orthodontics is preferred.

■ ***Question 3. Is the most apical free gingival margin level esthetically acceptable?***

With the emphasis on esthetics that has occurred over the last 25 years, the relationship of gingival levels to appearance is now well accepted.[12] What does not seem to be as well understood, however, is why aberrations in gingival margin levels occur. That is, why are the free gingival margins at different levels on two central incisors in the same patient? What we know biologically is that in most patients the biologic width is constant for that patient around all teeth.[13,14] Therefore, variations in gingival margin height must be due to differences in bone level or sulcus depth between teeth in the same patient. If recession of facial bone on one central has occurred so that its bone level is 3 mm apical to the adjacent centrals, it would not be surprising to see the gingival margin on the central with the bony recession also recede. What also can happen however, is to have the bone levels vary not because of bony recession, but because of differences in tooth eruption.

An example would be two overlapped central incisors, one to the lingual and one to the facial. The tooth to the lingual will always wear more than the one to the facial. And as it does, it will erupt bringing the bone coronally with it and resulting in a coronally placed gingival margin. Another possibility which can lead to aberrations in gingival margin heights, is to have the bone levels correct, but variations in sulcus depth between the centrals. The tooth with the shallower sulcus will have a more apically positioned gingival margin than the one with a deeper sulcus. This variation in sulcus depth is very common in cases of anterior tooth malposition. The more labially inclined teeth having thinner gingiva and a shallow sulcus, and the more lingually placed teeth

Figure 11. A patient sought esthetic correction of her anterior teeth. The central incisors and left lateral would require some restorative treatment whether orthodontics is performed or not. The occlusion is acceptable and the most apical free gingival margin, which is on the left central, is acceptable. The tissue on the right central and left lateral is coronally positioned relative to ideal.

Figure 12. Note, in the incisal view, how the free gingival margin levels correspond to the labial lingual position of the teeth in the alveolus. The right central having tissue more coronal due to its lingual position and the left lateral having more coronal tissue than the right lateral, even though it has had a crown placed which attempted to correct the lingually positioned root.

Figure 13. A gingivectomy was performed on the right central and left lateral to correct their tissue levels esthetically. Whether or not bone removal will also be necessary will depend upon whether the tissue levels were incorrect, due to variations in the vertical eruption of the teeth which created discrepancies in the bone, or if the bone levels are correct and the variations in tissue existed due to differences in the sulcus depth due to labiolingual differences.

Figure 14. To determine whether variations in the bone or sulcus depth created the original discrepancies in tissue level, sounding with a probe to bone can be performed. Note on the left central incisor, which had the more labial position and did not have a gingivectomy, that the tissue is 3 mm coronal to bone which would be normal for most patients.

Figure 15. On the right central, 1 mm of tissue was excised to correct tissue level, yet sounding reveals a 3 mm depth. This means that prior to the gingivectomy, the tissue was 4 mm coronal to the bone and had a 2 mm sulcus as opposed to the 1 mm sulcus of the left central. This variation in tissue height above bone can be explained by the differences in labiolingual position.

Figure 16. On the left lateral, 3 mm of tissue was removed to correct the gingival level. Sounding depth still reveals 3 mm of tissue coronal to bone. This means that prior to the gingivectomy there was 6 mm of tissue coronal to the bone and 4 mm sulcus due to the lingual root position.

Figure 17. This photo is of a patient following gingivectomy, tooth preparation and provisionalization. The challenge, however, remains root position. The restorations have corrected the coronal alignment, but the roots of the right central and left lateral are still lingually positioned. This has a high potential for the gingiva to rebound coronally negating the esthetic benefits the gingivectomy has provided, and may require that periodically the tissue on the right central and left lateral will need to be excised to maintain pleasing esthetics for the patient. While this is not a biologic problem, it is certainly an annoyance for the patient. Orthodontically aligning the teeth prior to the restorations would have eliminated this problem.

having thicker gingiva and a deeper sulcus (**Figures 11 through 17**).

So what does all of this have to do with whether I use orthodontics or not? We all know periodontal surgery can alter gingival margins, and we also know it is much easier to remove tissue or bone than create it.[15-17] So the critical question is, is the most apical free gingival margin level an acceptable one? Because if it is, then it will be possible to use either gingivectomies or osseous surgery to apically position the gingival margin heights on all the other teeth relative to the most apical tissue. If however doing that creates excessively long and thin looking teeth, then a new problem exists. While connective tissue grafting is very predictable and effective at covering exposed root surfaces, it is far less predictable at moving tissue coronally to cover enamel or ceramic on labially positioned teeth. So if the patient has a high smile line and the most apically positioned free gingival margin is unacceptable due to a labially positioned tooth, orthodontics to reposition the teeth and tissue is the most predictable solution.

Orthodontics can also be used to correct the other situations described. A coronally positioned gingival margin due to a lingually positioned tooth and deep sulcus can have the tooth correctly positioned and the gingiva will thin to a normal thickness sulcus depth and

Figure 18. This patient presented after reading about cosmetic dentistry and desired the restoration of all her maxillary teeth to change their appearance. She also made it clear she desired a near-perfect final result. Her left central was the only anterior tooth that would require restoration, other than some incisal bonding on the right lateral and central, if she did orthodontics. A review of her papilla levels however quickly changed her mind. Due to the rotated left lateral, the papilla between the lateral and central is apically positioned due to the small gingival embrasure. Restoring the teeth cannot move the papilla coronally and will result in a very long contact.

Figure 19. From the incisal, the rotation of the lateral and the narrowing of the embrasure is obvious.

Figure 20. Because the bone level was correct, when orthodontics corrected the rotation following placement of a correctly shaped temporary on the left central, the papilla returned to its normal level. Following orthodontics the only restoration placed was the replacement crown on the left central and direct bonding the incisal edges of the right lateral and central.

level. Finally, a tooth in labial version with slightly apical thin tissue and a shallow sulcus can be correctly positioned with the gingiva thickening, getting a normal sulcus depth and level.

As an aside, it currently is very popular to sculpt the free gingival margins using a laser or electrosurge to ideal levels during cosmetic restorative procedures.[18] This results in a far more pleasing final result esthetically. However, the practitioner must identify the cause of the gingival aberration prior to selecting the mode of treatment for the gingival levels. If the problem is one of bony levels, then flap surgery and osseous re-contouring will be necessary to provide biologic health and tissue stability. If the problem is excessive sulcus depth due to a lingually positioned tooth, then sculpting the tissue will be biologically acceptable. But since the tooth is in lingual version a significant amount of tissue re-growth may occur, and it may be necessary to periodically re-trim the tissue to maintain the ideal appearance. Orthodontically repositioning the same tooth can alleviate the problem (**Figures 11 through 17**).

Is the most apical free gingival margin level acceptable?

Yes? Perform surgery to correct tissue and go to Question 4.

No? Can it be covered with grafting? No? Orthodontics is preferred.

■ ***Question 4. Are the papilla levels harmonious?***

Similar to free gingival margin levels, the papilla levels are critical to the overall esthetics of anterior teeth.[12] Papilla that are too far apically positioned either result in an open gingival embrasure (black space) or the development of an excessively long contact and subsequent rectangular looking teeth. Three factors come into play in establishing papilla levels. Underlying bone level, the patient's biologic width, and the gingival embrasure form and size. Of these, the patient's biologic width will be relatively constant for them, but bone level and embrasure form can vary dramatically with tooth eruption. This can create a significant esthetic challenge for the restorative dentist. In general, unless the patient has had wear or excessive overjet and secondary eruption, the bone interproximally is rarely positioned too far coronally. And, unless the patient has had periodontal disease, the interproximal bone is rarely too far apical. This means that in most cases which present for cosmetic procedures, variations in papilla level will be related to embrasure form. The interesting thing to note, is excessively large embrasures, as in the presence of diastemas, can result in papillae that are apically positioned.

Excessively small embrasures, as can happen in overlapped or rotated teeth, can also result in papillae that are apically positioned. The key question then becomes, is the most apically positioned papillae acceptable? That is, will its position result in an excessively long contact and disharmony of coronal form which is esthetically displeasing? If the answer is yes, then orthodontics is the only option to correct it.

Currently there are no periodontal surgery procedures which can increase the height of interproximal bone, or grow predictable interproximal soft tissue. But, orthodontics can erupt teeth to move interproximal bone coronally, close diastemas to move soft tissue papillae height coronally, or align overlapped teeth allowing the papillae to move to the normal coronal position above the bone. Of these examples, the case of significantly mal-aligned overlapped teeth is the one most often benefiting from orthodontics to correct papillae levels. Typically, cases of multiple diastema may not have normal papilla heights, but heights of all the papillaes are even. Therefore, the final result is harmonious, just with slightly larger contacts than if the diastema were closed.

Mal-aligned teeth however, are a significantly different problem. Some embrasures are normal with normal papillae height, others are very small

Figure 21. This patient, a dentist, desired the restorative correction of his teeth mal-alignment rather than orthodontics. The teeth would need restoration to achieve his esthetic goals whether orthodontics was completed or not. The occlusion could be managed without orthodontics. His high lip line didn't show the discrepancies in free gingival margin levels, and the papilla levels, which did show, were acceptable. However, to bring the left lateral into alignment would virtually guarantee pulpal involvement during tooth preparation, and subsequent endodontics.

Figure 22. This occlusal view shows the labial positioning of the left lateral. When presented with the option of endodontics versus short-term orthodontics, the patient chose orthodontics.

Figure 23. Following stripping of the teeth, five months of orthodontics achieved the alignment shown.

Figure 24. The final result now consisted of conservative porcelain veneers from first premolar to first premolar except for the right lateral incisor, which had the pre-existing crown.

due to overlap and with significantly apically positioned papillae. In these patients, if orthodontics is not performed, there is often significant disharmony of contact length and final coronal form (**Figures 18 through 20**).

Are the papilla levels harmonious?

Yes? Go to Question 5.

No? Orthodontics is preferred.

■ ***Question 5. Can an acceptable contour and arrangement be created?***

This is really a question of coronal width and length. In my role as an educator, this is the question I get most often concerning instant orthodontics. A student will approach me carrying a photograph or model with either large diastemas or severe crowding, and say, "Do you think I need to send the patient to an orthodontist?" What they are really asking is, can I make these teeth look good given their existing position and alignment? My response to the question is always the same. That is, without drawing my desired tooth form on a photograph, or doing a diagnostic wax-up on the model, I don't know. Having said that, I believe a few comments are appropriate concerning contour and arrangement.

First, let's start with patients with multiple diastemas. This occurs for two reasons. Inappropriately small natural anterior teeth or normal teeth with an excessively large arch form. The two may be very different to treat. The patient with diastemas due to small teeth, is almost always best treated with restorative dentistry whether any orthodontics is done or not. The patient with normal size teeth but a long arch form, can often be treated either way, with restorative alone or with orthodontics alone. The key to answering either question is to perform a diagnostic wax up or set up on mounted models. The other extreme is the patient with severely overlapped and crowded teeth. This patient commonly presents biologic and structural problems as well which we will address in the next question. The esthetic question that must be answered for both the patient with diastemas or crowding is, how will the teeth look if they are restored in their current position? It is common to read articles discussing the use of the "golden proportion" in planning treatment for patients with mal-alignment.[19,20] And while this may be a useful tool for doing a wax up or set up, it can fall short of creating ideal esthetics in patients with diastemas or crowding. The reason for this is quite simple. The golden proportion creates a proportionate relationship of the teeth relative to their widths.

This seems logical, but the evidence is clear that different anterior teeth carry more weight in the patient's assessment of esthetics, particularly the maxillary central incisors. While conversely, the maxillary lateral incisors can have large variations in their width and still be judged esthetic as long as they are symmetrical. This concept is especially true in developing the plan for patients with an extreme amount of excessive space or crowding. In either case, the golden proportion will apportion the space to a percentage, which on one extreme may create very large centrals and on the other, very small centrals. It is esthetically more pleasing to create ideal proportion to the centrals for either case and allow the laterals to be wider or narrower than ideal. The proportionate centrals will create the illusion of a pleasing smile, while the misproportioned laterals will rarely be noticed if they are symmetrical to each other.[12]

Can an acceptable contour and arrangement be created?

Yes? Go to Question 6.

No? Orthodontics is preferred.

■ ***Question 6. Are the structural compromises necessary to correct the alignment acceptable?***

One of the great strengths of bonded porcelain is its conservative nature compared to conventional full coverage restorations.[4] When mal-alignment is being corrected, the tooth preparation must get significantly more aggressive and the labially positioned tooth having significant amounts of labial reduction done to bring it into line, sometimes requires a near amputation of the existing coronal form. The more lingually positioned teeth need significant lingual tooth preparation to avoid an excessively thick incisal edge and rotated teeth may need a combination of significant labial and lingual reduction on mesial and distal to accomplish the desired alignment. This issue of varying amounts of tooth preparation brings up an interesting challenge in determining what is or is not an acceptable treatment plan. Classically, dentistry has always espoused the most conservative treatment possible for any tooth, yet there are not clear cut guidelines to suggest a particular preparations reduction will create "X" percentage change in success.

It does seem prudent however to add the patient's age and current dental condition into the equation when answering this question. The younger the patient and the fewer restorations currently, the more the desire to stay conservative with our tooth preparations.

Can an acceptable contour and arrangement be created?

Yes? Go to Question 7.

No? Orthodontics is preferred.

■ ***Question 7. Are the biologic consequences of correcting the alignment restoratively acceptable?***

This question really has two components. The pulpal and the periodontal. If the desired contour will require a tooth preparation which exposes the pulp, or amputates the pulp and coronal tooth structure, strong consideration must be given to treating the situation with orthodontics. As good as we believe our pulp caps or endodontics procedures are, they definitely are not 100 percent.[21-23] And, in a young individual, elective endodontic therapy and a foundation restoration may impact whether or not the tooth lasts for the patient's lifetime (**Figures 21 through 24**).

The periodontium is a different issue. It has two distinct components to how it may be adversely affected with a restorative correction. First is the issue of gingival health and contour. Anytime a rotated or lingually positioned tooth is being corrected restoratively, there is the potential for significant alterations in emergence profile.[24] This may or may not have an impact on gingival health. What certainly has

the potential for negatively impacting the periodontium is the restorative alignment of severely overlapped teeth. As the teeth overlap, the contact moves apically. As the contact moves apically, the risk of violating the biologic width when preparing the teeth and getting subsequent inflammation increases. This occurs when we attempt to separate the contact cervically with our tooth preparation because the contact has moved apically due to the overlap. Simply separating it with a bur has a high likelihood of placing the margin in the attachment. Note the apical position of the contact between the left central and lateral in **Figures 18 and 19**, as an example.

Are the biologic consequences correcting the teeth restoratively acceptable?

Yes? Perform instant orthodontics using restorative dentistry.

No? Orthodontics is preferred.

So the ideal "Instant Ortho" patient would: Need the teeth restored whether ortho was done or not, will have an ideal occlusion without any orthodontics, has free gingival margin and papilla levels that are manageable non-orthodontically, can have a pleasing and esthetically acceptable contour and arrangement without orthodontics, and finally, the tooth preparations required wouldn't mutilate the teeth structurally or biologically. What is amazing is how many patients meet these requirements and truly are good candidates for a non-orthodontic esthetic correction. What is equally amazing is how often I see patient treatment where these parameters were violated and the patient or dentist are trying to figure out why the ceramic fractured, prep broke off, tissue got red, or overall esthetic result is mediocre and asymmetric following a restorative only correction.

The purpose of this paper has not been to condemn or promote the orthodontic or non-orthodontic approach, but rather to highlight the criteria by which we decide how to evaluate and proceed with the multiple treatment options available. With the clinical parameters described above, I'd like to discuss the other non-clinical reason that dentists use for not performing orthodontics. "The patient didn't want orthodontics." As my orthodontic colleague Vince Kokich says, "Nobody wants orthodontics." And, I believe that this is absolutely true until the patient gets presented the legitimate benefits and consequences of each approach. I refer to this as the Pro vs. Con list for each method of treatment. And I would encourage you to create a written list and present it to the patient detailing the risks and benefits of each method of treatment, orthodontic and non-orthodontic. Essentially, this list is an informed consent sheet for the purpose of treatment. An example may look like this:

What is amazing is how many patients meet these requirements and truly are good candidates for a non-orthodontic esthetic correction.

Orthodontics

Pro
- Less money
- Fewer restorations
- No root canals
- No perio surgery
- Non-orthodontic

Con
- Time
- Retainer after treatment

Pro
- Less time

Con
- More money
- More restorations
- Aggressive tooth preparations
- Perio surgery

I grant you the above example looks very biased toward orthodontics, and yet it is a very real example of what I commonly see in practice. I can tell you that after having the pros and cons outlined for them, patients who didn't want orthodontics suddenly decide it might not be so bad. And, after this presentation, an interesting secondary benefit occurs. The patient recognizes that you just presented to them a very honest assessment of what's possible and in some instances sold them on not having you do the treatment. That level of commitment to their well being creates a high level of respect toward you and the referral of everyone else they know who may be considering esthetic care. Among those people will be plenty who do need esthetic care without orthodontics and will trust what you tell them because of the reputation and integrity that you have developed within your community for putting their health above monetary gain. The great paradox is that as you seemingly send some treatment away, the ultimate gain is you get more treatment to do than you ever would have had by performing excessive or inappropriate treatment on one patient and having it fail. I'm not saying this occurs overnight, but practices are built over years by a clear sense of core values that are adhered to even when there is an initial desire to bring in more money.

In conclusion, this paper, as I stated in the beginning, was not written to condemn "Instant Orthodontics" as I enjoy performing it as much as anybody. But, in this author's opinion, it is being performed excessively in many patients' mouths who would need little or no restorative care with orthodontic intervention. Even worse, it is being performed unsuccessfully relative to the longevity or health of the result. It is my hope that the ques-

tions above can create a framework to help separate the patients who would benefit from orthodontic intervention from those we all enjoy treating who can be managed with purely restorative care. CDA

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Short Tooth Syndrome: Diagnosis, Etiology, and Treatment Management

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ABSTRACT

The periodontal-restorative team is uniquely positioned to provide the esthetic procedures that today's sophisticated patient population has come to expect. Not only is health and function of great desire but also esthetics is in demand. Armed with periodontal-plastic procedures and technically advanced restorative materials, the periodontal-restorative team can provide these patient needs. The challenge becomes making the correct diagnosis and selecting the appropriate treatment regimen.

Aesthetic dentistry with the associated contemporary paradigms has become endemic in modern day clinical dentistry. Today's esthetic-minded periodontal surgeon is called upon to not only recognize and diagnose esthetic deformities due to a variety of periodontal etiologies, but also employ creative surgical techniques to address these issues. Subtleties in papilla position and gingival architecture in a 3-D spatial relationship, i.e. height, fullness, and shape, become critical parameters for predictability and success especially to the restorative dentist and patient.

Frequently, short teeth are a common "chief complaint" expressed by patients dissatisfied with the appearance of their smile since the teeth are visually disproportionate in size. The diagnostic assessment of the smile is reflective of the amount of gingiva and tooth exposed during smiling.[1] The appearance of short teeth can be due to excessive gingival display (**Figure 1**) and/or a lack of incisal tooth display (**Figure 2**).

This clinical condition can be termed "Short Tooth Syndrome." The etiology associated with each specific condition must be identified separately and elucidated by the clinician since the treatment planning and management is different for each condition.

An excessive amount and display of gingiva can result in a "gummy" smile appearance with teeth having a proportion close to unity (length to width ratio equal to 100 percent) or a perfect square. Surgical periodontal treatment, specifically esthetic crown lengthening, becomes imperative in these situations in order to restore the esthetic "frame-



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Figure 1. A "gummy" smile due to excessive gingival display lending to the visual perception of short teeth (STS). The smile is unesthetic since the teeth appear to be disproportionate relative to the surrounding gingival tissues as well as excessively square in reference to tooth shape and dimension.

Figure 2. An unesthetic smile due to a lack of incisal edge tooth display lending to the visual perception of short teeth (STS).

Figure 3. Classic chronic inflammatory response of the gingival tissues that is non-plaque related due to violation of the "biologic width." In an effort to gain retention on short clinical crowns, the preparations of the teeth and the margins of the restorations were extended too far apically and interproximally into the supracrestal connective tissue fibers.

work"; i.e. tooth proportion and "the golden proportion."[2] Injudicious tissue removal without consideration of biologic parameters can have tremendous negative consequences (**Figure 3**). Frequently, periodontal surgery is indicated in these case types in order to avoid invasion of the biologic width by restorative procedures.

As previously mentioned, a lack of tooth display or incisal exposure can also give the appearance of short teeth. In this situation, forced or active orthodontic extrusion or restorative treatment can be rendered. As one can see, the diagnoses for each clinical situation can be difficult, varied, and complex.

Tooth eruption involves a complex series of events and has not yet been fully elucidated. However recent investigations have added to our knowledge base on this subject. Active eruption occurs as the tooth elongates through amelogenesis, dentinogenesis and cementogenesis. Osteoclastic activity removes bone in a genetically predetermined path allowing the tooth to enter the oral cavity. A series of elegant investigations have identified the dental follicle as the tissue responsible for active eruption *and not* the formation of the root.[3] The dental follicle eventually becomes the periodontal ligament.[4] Active eruption is complete when the tooth reaches its functional occlusion. Passive eruption is a process by which the epithelial attachment of the gingival tissue retracts from the enamel portion of the crown onto the root into adult position just apical to the CEJ allowing for a fibrous connective tissue attachment at the base of the sulcus (the biological width)[5] (**Figure 4**). These two processes appear to be controlled by different groups of regulatory genes. Alterations in either of these processes can result in "Short Tooth Syndrome."

This article will identify common periodontal and restorative esthetic deformities responsible for "Short Tooth Syndrome" (STS), their diagnosis and etiologies commensurate with the esthetic and biologic basis of treatment, as well as treatment management.

Short Tooth Syndrome

The following list of clinical scenarios comprises the clinical conditions associated with STS:

- Altered Eruption
  - a – Active
  - b – Passive
- Excessive Incisal Attrition
  - a – Compensatory Eruption
- Delayed Eruption Maxillary Incisors
  - a – Excessive Eruption of Mandibular Incisors
- Vertical Maxillary Excess

Figure 4. Diagrammatic representation of the normal physiologic position of the osseous crest, free gingival margin, and clinical crown exposure relative to the CEJ.

Altered Eruption (Active and Passive)

Aberrations of physiologic tooth eruption have periodontal and esthetic implications. **Figure 4** exemplifies the normal physiologic relationship between the osseous crest, gingival tissues, and the CEJ.

In altered eruption, one finds the gingival margin located excessively incisal to the CEJ, covering a portion of the anatomic crown with soft tissue.[6,7] Various expressions of altered eruption (active and passive) have been described and classified in **Table 1**. The diagnostic process includes identifying the classification of the situation to be treated. This enables the clinician to select and execute the appropriate surgical procedure to reveal the anatomic

Figure 5. Diagrammatic representation of altered *active* eruption (Type IB). Note the relationship of the CEJ relative to the osseous crest which in this situation is more incisal than the physiologic norm (at the CEJ). The free gingival margin (FGM) is higher on the anatomic crown than normal.

Figure 6. Clinical example of Type IB; altered active eruption case type. Teeth appear short in dimension and there is an adequate zone of attached keratinized gingiva.

Figure 7. Sounding revealed 4.0 mm from the free gingival margin to the osseous crest. However, sounding was done incorrectly because the probing depth was only 1.0 mm which would mean that the biologic width was 3.0 mm which is 1.0 mm greater than the norm. In thin periodontal biotypes or where there is a thin osseous crest, it is commonly misidentified since the tip of the probe can easily slip off the crest of bone.

crown. This condition has been categorized into type and subcategory. Type denoted the amount of attached gingival and subcategory, the relationship of the osseous crest to the CEJ. Four case types have evolved from this classification system.[8,9] It is important to delineate that altered '*active*' eruption is reflective of subcategory B, where the osseous crest is at the CEJ (**Figures 5 through 9**). Altered '*passive*' eruption is indicative of subcategory A, where the osseous crest is *apical* to the CEJ (physiologic norm) **Figures 10 through 15**. The gingival margin is incisal to the CEJ in all case types and the zone of keratinized attached gingiva is variable.

The esthetic periodontal diagnostic assessment of the smile must establish one of two scenarios:

- Too much gingiva is revealed
- Too little tooth is revealed

Once it is determined that the gingival margin to tooth relationship needs to be modified, evaluation of the periodontium is necessary.

What is commonly referred to as the "gummy smile" is actually excessive gingival display, a condition that can be caused by a variety of factors. Excessive gingival display may be the result of a skeletal deformity, which is due to an overgrowth of the maxilla in the vertical dimension (vertical maxillary excess). This excessive display may also be due to a "short" upper lip or hyperactiv-

Figure 8. Flap surgery revealed the true position of the osseous crest relative to the CEJ which in this case is at the CEJ. Note that the osseous crest ledge is thin as well as the CEJ quite bulbous lending to an incorrect sounding number of 4.0 mm where a reading of 2.0 should have been registered.

Figure 9. Six months post-healing showing healthy gingival tissues, restoration of proper biologic width, and re-establishment of proper tooth dimensions. Patient is now ready to receive esthetic restorative dentistry. (Surgery courtesy of NYUCD Aesthetic Dentistry Program and Dr. Brian Chadroff.)

Table 1

Classification of Altered Eruption (active and passive)[9]

Type IA

- Osseous crest *apical* to the CEJ (passive)
- *Adequate* amount of attached gingiva
- Gingival margin incisal to the CEJ

Type IB

Osseous crest *at* the CEJ (active)
Adequate amount of attached gingival
Gingival margin incisal to the CEJ

Type IIA

Osseous crest *apical* to the CEJ (passive)
Inadequate amount of keratinized tissue
Gingival margin incisal to the CEJ

Type IIB

Osseous crest *at* the CEJ (active)
Inadequate amount of keratinized tissue
Gingival margin incisal to the CEJ

Figure 10. Diagrammatic representation of altered *passive* eruption (Type IA). Note the normal physiologic position of the CEJ relative to the osseous crest. The FGM is higher on the anatomic crown than normal.

Figure 11. Clinical example altered passive eruption with the associated "gummy" smile.

Figure 12. The mucogingival junction (the junction between attached keratinized gingival and mucosal tissue) is identified with a periodontal probe.

Figure 13. Zone of keratinzed tissue is identified and measured with a periodontal probe (7.0 mm in this case).

Figure 14. The FGM is more incisal than normal leading to the appearance of a short clinical crown. Pocket depth is measured to be 3.0 mm. The amount of attached keratinized gingival is deduced by subtracting the pocket depth from the zone of keratinized tissue. In this case 7.0 mm – 3.0 mm = 4.0 mm attached keratinized gingival. The average histologic pocket depth is 1.0 mm, which leaves 2.0 mm of free gingival tissue which can be excised without violating the biologic width.

Figure 15. Left lateral smile of patient post-esthetic restorative treatment with ceramic laminate veneers. Proper length of tooth dimension and proportion is restored through gingivectomy and restorative diastema closure. (Surgery courtesy of Dr. Ken Magid and esthetic restorative dentistry by Dr. Saiesha Mistry.)

ity of the obicularis oris muscle.[6] In addition, the appearance of "too much gum" may be due to physiologically short clinical or anatomic crowns.[7]

The importance of determining the cause of excessive gingival display cannot be overemphasized. If the origin of the excessive gingival display is a skeletal abnormality, then orthognathic surgery and orthodontic procedures should be considered. If the excessive gingival display is a dental deformity then correction of the gingival and osseous architecture is indicated (altered eruption).

The relationship between perioral and intraoral structures is fundamental to dental esthetics. The three structures that compose the smile — the lips, the gingiva, and teeth — must have a harmonious relationship for an acceptable esthetic appearance. During a full smile, the lips determine the amount of both the gingiva and clinical crown that is revealed, and it is the gingiva along with the incisal edge position, that influences the amount of clinical crown that is visible.[10]

Figure 16. Diagrammatic representation of isolated (central incisors) incisal attrition with compensatory dentoalveolar eruption. Note the normal ossous crest to CEJ relationship yet the more incisal position of the osseous crest of the central incisors relative to the adjacent teeth.

Figure 17. Clinical example during smiling of incisal attrition of the maxillary central incisors with compensatory eruption. Note that the centrals appear too short relative to the adjacent teeth.

All of the tissues, soft and hard, follow the contour of the CEJ of the tooth resulting in a normal **parabolic form**. This undulating form is apparent in the gingival margin, the base of the crevice, the junctional epithelium, the connective tissue attachment and the osseous crest. Appreciation of this relationship is important during tooth preparation procedures. The **finish**

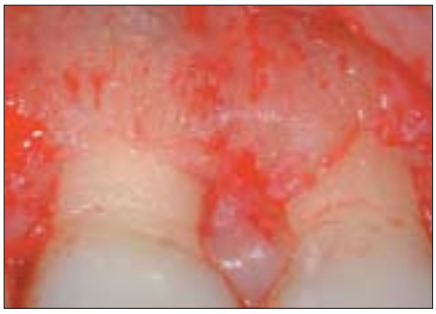

Figure 18. Periodontal flap surgery reveals pattern of bone deposition indicative of tooth eruption. Note the longitudinal or vertical pattern of bone that has been deposited as the tooth erupted after incisal wear.

Figure 19. Post-osseous recontouring to re-establish the biologic width and proper tooth dimensions as well as expose adequate tooth structure for esthetic restorative dentistry to be performed.

Figure 20. Ceramic laminate veneers are fabricated and contours evaluated with gold powder. (Courtesy of Adam Mieleszko, CDT; MAC Dental Arts, Inc., New York.)

line within the crevice should follow this anatomy otherwise inadvertent invasion of the biologic width can occur.[11] (**Figure 3**.)

Periodontal surgery plays an important role in achieving esthetic outcomes by developing the proper tooth proportion and by placing the gingival margin in a suitable position relative to the lip. Two categories of surgical procedures are utilized, **resection and augmentation.**

In situations where smiling reveals too much tissue or too little tooth, **resective** periodontal procedures are utilized to move the radicular gingival margin apically and at times, the interdental papillae. A variety of procedures are available for this purpose (**Table 4**). Election of a specific technique is influenced by the relationship of the gingival margin to the underlying osseous crest, the osseous crest relative to the CEJ and the quantity of *attached* keratinized gingiva.

Certain variables must be considered in performing osseous resective surgery when the osseous crest is located at the CEJ (subcategory B). Firstly, the osseous crest is to be established sufficiently apical to the CEJ (2.0 mm minimum) to allow for the formation of the biologic width onto the cementum. The parabolic form of the osseous crest over the radicular surface must mimic the original architecture, that is, thick-flat or thin-scalloped depending upon the periodontal "biotype" present.

Augmentation procedures are employed when the clinical or anatomical crown is too long due to mid-facial gingival recession or the zone of attached gingival tissue is insufficient. Bone and tissue grafting and regenerative procedures are used to restore a more physiologic relationship between tooth, bone level, and tissue height.

Figure 21. Intraoral view of eramic veneers three days post-cementation. Note restoration of proper tooth size (length/width dimensions) and proportion (75 percent).

Figure 22. Dentogingival smile analysis showing restoration of proper esthetic parameters tantamount for a successful esthetic outcome. (Surgery courtesy of Dr. Susan Karabin and esthetic restorative dentistry by Dr. Stephen Chu.)

Incisal Attrition with Compensatory Eruption

Tooth structure loss is physiologic and occurs as a natural consequence of aging and wear (**Figures 16, 17**). However, several factors including erosion, abrasion and attrition may render tooth structure loss pathologic. In physiological tooth structure loss, vertical dimension is maintained by alveolar bone remodeling; i.e., compensatory tooth eruption resulting in an elongation of the dento-alveolar process (**Figures 18 through 22**). Despite generalized tooth surface loss, the freeway space and the resting facial height appear to remain constant due to dentoalveolar compensation[13] in physiologic attrition due to aging. Similarly, proximal tooth wear is compensated for by compensatory orthodontic tooth movement thereby maintaining tooth to tooth contacts. If isolated pathologic vertical tooth loss has occurred which involves selective teeth, then it is highly likely that compensatory growth has occurred to some degree.[12] In addition, freeway space and vertical dimension of occlusion or VDO, is unaltered in these case types.

If excessive generalized tooth loss affecting occlusal surfaces of the teeth has occurred, then it is highly likely that a reduction in occlusal face height VDO or an increase in freeway space (FWS) has occurred. This diagnosis may be convoluted by forward posturing of the mandible.

Table 2

Normal physiologic eruption sequence of the permanent dentition[14]

Maxilla	Mandible
1st molar	1st molar
Central incisor	central incisor
Lateral incisor	lateral incisor
1st premolar	canine
2nd premolar	1st premolar
Canine	2nd premolar
2nd molar	2nd molar[14]

Table 3

Vertical maxillary excess classification

Degree	Gingival display	Treatment
I	2-4 mm	Orthodontic intrusion only Orthodontics and periodontics Periodontics and restorative therapy
II	4-8 mm	Periodontics and Restorative Therapy Orthognathic Surgery
III	+ 8 mm	Orthognathic Surgery with or without adjunctive periodontal therapy and restorative therapy

Figure 23. Diagrammatic representation of delayed eruption of the maxillary incisors and excessive eruption of the mandibular incisors. Characteristic is the reverse smile alignment of the anterior teeth and the bi-level occlusal plane and short tooth appearance of the maxillary incisors. Note the normal osseous crest to CEJ relationship. **Figure 2** is the clinical smile of such a patient type with STS with lack of incisal tooth display due to delayed eruption of the maxillary incisors (DEMI).

Figure 24. Intraoral view of short maxillary anterior teeth due lack of interocclusal space during eruption. Note the Angle pseudo-Class III relationship.

It has been observed that the FWS remains constant (3.0 mm) in the normal dentition and even in those patients who exhibit significant tooth surface loss, the VDO is unaffected in 80 percent of the cases. This is important with respect to patient assessment. If restoration of worn teeth is being planned then the extent of dentoalveolar compensation would appear to determine the treatment strategy thereby defining the need to carry out measures such as crown lengthening to restore the esthetic clinical crown dimensions. Alternatively, restoration of a patient's dentition may be provided at an increased VDO[13] if excessive attrition with loss of VDO is identified by an increase in phonetic FWS.

Delayed Eruption of the Maxillary Incisors with Excessive Eruption of the Mandibular Incisors

It is not uncommon that the primary maxillary incisors (A's and B's) can be lost at any early age prior to the final development and eruption of the permanent teeth. Caries and trauma are the most common etiology to early primary tooth loss. **Table 2** outlines the normal physiologic eruption sequence for the maxillary and mandibular permanent dentition. Premature loss of the deciduous teeth, when the permanent tooth bud is still depth in the alveolar bone, allows the bone to heal the residual socket in a knife edge contour which further delays the eruption of the permanent tooth.

The delayed eruption of the maxillary anterior dentition frequently allows the mandibular incisors to overerupt thereby creating an unfavorable esthetic tooth proportion of the anterior teeth (**Figures 2, 23**). The resultant occlusion tends to be unfavorable as well since a Class III maxillomandibular relationship frequently results as the centric occlusion scheme as a consequence of inadequate inte-

Figure 25. Disarticulated view of the maxillary and mandibular teeth and plane of occlusion. Note the bi-level planes evident between the anterior and posterior teeth for both the maxilla and mandible. The reason why the canines are involved with the mandible anterior plane being more incisal is that the mandibular canines erupt before maxillary canines (Table 2).

Figure 26. Diagnostic wax up showing corrected occlusal plane through projected esthetic restorative treatment. Note bi-level plane of occlusion is corrected by shortening and retro-inclination of the lower incisors and lengthening of the maxillary incisors. (Courtesy of Jason Kim, CDT; Oral Design, New York.)

Figure 27. Maxillary anterior dentition is restored with ceramic veneers on Nos. 6,7,10 and 11 and all-ceramic crowns on Nos. 8 and 9. Incisal edges of lower incisors are considerably shortened through selected occlusal adjustment.

Figure 28. Soft tissue gingivectomy is performed to expose proper crown length. Sounding revealed ampule biologic dimension.

Figure 29. Ceramic laminate veneers are fabricated to restore the lower dentition. Note the internal effects (mammelons) constructed into the ceramic restorations. (Courtesy of Adam Mieleszko, CDT; MAC Dental Arts, Inc., New York.)

Figure 30. Intraoral view disarticulated showing corrected plane of occlusion with ceramic veneers cemented into place.

Figure 31. Centric occlusion view showing correction of pseudo-Class III occlusion to a Class I occlusion (Angle Classification).

Figure 32. Extraoral smile view showing correction of esthetic parameters through proper diagnosis, case planning, and esthetic restorative dentistry. (Surgery courtesy of Dr. Susan Karabin and esthetic restorative dentistry by Dr. Stephen Chu.)

rocclusal space (**Figure 24**). There is limited interocclusal space to restore the teeth to a more favorable length since the lower incisors are an obstacle due to excessive eruption. The lack of length of the maxillary incisors give the false pretense that there has been a loss or decrease of vertical dimension of occlusion. Increasing the VDO in therapeutic correction of the condition would be a mistake since loss of VDO is not the etiology of the delayed eruption case type. Treatment requires orthodontic extrusion of the maxillary sextant and intrusion of the mandibular sextant or in this case, restoring the maxillary anteriors to the proper length and at the existing VDO by selective incisal reduction of the over-erupted mandibular incisors (**Figures 25 through 32**). Aggressive correction of the mandibular incisor teeth frequently necessitates crown-lengthening of the dentition in conjunction with restoration with indirect bonded restorations. The crown-lengthening procedure may or may not involve osseous recontouring based upon the amount of over-eruption and incisal reduction required. In addition, elective endodontic therapy may be necessary in severe cases.

Vertical Maxillary Excess

This gummy smile frequently results from a skeletal dysplasia, specifically the hyperplastic growth of the maxillary skeletal base (**Figures 33**

Figure 33. Diagrammatic representation of vertical maxillary excess (VME). The excessive dimension of the maxilla gives the visual appearance that the teeth are too small and short even though they may not be.

Figure 34. Extraoral full front view of a patient with VME. Note the excessive gingival display at the expense of the hyperplastic development of the maxilla. Teeth appear to be relatively small and are visually overpowered by the gingival tissues.

Figure 35. Extraoral lateral view of the same patient. Excessive development of the maxilla is highly evident.

Table 4

Comprehensive summary table for each condition of STS identifying the different diagnoses, etiologies, and treatment regimens recommended

Condition	Etiology	Diagnostic Features	Treatment Regimens
Altered Passive Eruption	Gingival margin fails to recede to a level near the CEJ during tooth eruption	Gingival margin located incisal to the CEJ	Depends on the amount of the attached gingiva and the position of the alveolar crest relative to the CEJ – Gingivectomy – Flap surgery with or without ostectomy – Apical positioning of flap
Altered Active Eruption	Osseous crest fails to resorb to a level 2.0 mm apical to the CEJ	Gingival margin located incisal to the CEJ	Periodontal surgery with ostectomy
Compensatory Eruption	Tooth surface loss – Pathologic or excessive	1. Reduction in facial height Increased freeway space (Generalized) 2. VDO unaffected, freeway space constant (Localized)	1. Increase vertical dimension (generalized) 2. Crown lengthening (localized)
Delayed Eruption	Early loss of primary maxillary incisors Delayed eruption of maxillary permanent incisors Over-eruption of mandibular incisors	1. Class III maxillo-mandibular relationship 2. Over-erupted mandibular incisors 3. Short maxillary incisors	1. Selective incisal reduction followed by crown lengthening or orthodontic intrusion of mandibular incisors 2. Orthodontic extrusion of maxillary incisors or restoration
Vertical Maxillary Excess	Skeletal dysplasia such as hyperplastic growth of the maxillary skeletal base	1. Teeth positioned farther away from skeletal base 2. Excessive gingival display	Depends on severity of gingival display – Orthodontics – Periodontics – Elective Endodontic Therapy – Restorative Therapy – Orthognathic Surgery

and 34). This results in the teeth being positioned farther away from the basal skull with excessive display of the gingival dento-alveolar housing below the inferior border of the upper lip (**Figure 35**). The diagnosis is predicated upon the degree of severity and the classification consists of three degrees depending upon the amount of gingival display (**Table 3**). The treatment management is quite different for each degree category.

In vertical maxillary excess (the gummy smile) careful evaluation of tooth size is critical. If the clinical crown length is "short" compared to average tooth lengths then a crown-lengthening procedure with the removal of tissue and/or bone is appropriate. If the clinical crown is of normal length but appears short because of a high lip line and there is a large display of gingival tissues, lengthening these teeth may result in teeth that are too long and can be esthetically unacceptable (**Figure 36**). This problem can be resolved by shortening the incisal edges of the teeth. However, careful analysis of the periodontal root length, pulp chamber size, and incisal guidance/anterior occlusal scheme must be done prior to deciding on this course of action since there are associated negative consequences such as compromised periodontal support, endodontic involvement, and loss of incisal guidance, respectively.

Summary

The periodontal-restorative team is uniquely positioned to provide the esthetic procedures that today's sophis-

Figure 36. Intraoral view of patient in Figures 34 and 35. Intraoral view is deceptive since excessive growth of maxilla is not obvious in this view and teeth appear to be normal in dimension except for some evidence of generalized incisal attrition. The amount of tooth exposure is predicated upon the smile line to be created, the root length in bone, potential endodontic involvement, and incisal guidance required for anterior disclusion.

ticated patient population has come to expect. Enhancing one's appearance has become the mantra of the maturing "baby boomer" population. Not only is health and function of great desire but also esthetics is in demand. Armed with periodontal-plastic procedures and technically advanced restorative materials, the periodontal-restorative team can provide these patient needs. The challenge becomes making the correct diagnosis and selecting the appropriate treatment regimen. Each individual patient must be carefully analyzed as to whether their deficiency is anatomic, functional, or both and the consequences of treatment must be fully understood in order to provide the utmost in esthetic periodontal-restorative care (**Table 4**). CDA

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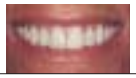

Understanding the Esthetic Evaluation for Success

Tal Morr, DMD, MSD

ABSTRACT

With any restorative procedure, a thorough evaluation, diagnosis, and treatment plan is essential for a positive outcome. When dealing with esthetic dilemmas, the same holds true. Without a sequential esthetic evaluation, diagnosis, treatment plan, and execution, an acceptable outcome is difficult to predict. The treating clinician should be able to visualize the esthetic problem, visualize the proposed changes, and devise a way to achieve the result while still maintaining mechanically, functionally, and biologically sound principles.

Esthetic Evaluation

The following method of evaluation for esthetics is the author's expressed opinion. Esthetics is subjective and hence there are many concepts that work well.

Incisal Edge Position of the Centrals

The first objective for evaluation is to envision the future positions of the final restorations. In order to facilitate this, the clinician should find a starting point in the evaluation process. A good starting point is the incisal edge position of the upper central incisors at rest. The patient is seated and asked to say the letter "m" followed by relaxation of the lips (**Figure 1**). The amount of central incisor showing is evaluated and measured. According to Vig et al,[1] the average amount of tooth exposure with the lips at rest in men was less than women. As the age of the patients increased, the amount of incisal edge display decreased, and short upper lips generally displayed more maxillary tooth structure than long lips. The future incisal edge position may be related to the sex, lip length and age although more importantly, how youthful the patient wants to appear, and the patients overall self image, and personality. The less tooth exposure, the older appearing is the smile. Generally, the author's objective is to make his patients look more youthful. If this is the case, there should be some tooth exposure evident at rest, the more, the more youthful appearing.

Occlusal Plane

The next step in this evaluation process is the occlusal plane. This is done by having the patient smile (**Figure 2**). The occlusal plane allows evaluation of the whole arch relative to the chosen incisal edge position. The occlusal plane is actually a flat plane derived from the incisal edges of the centrals, bisecting the cusp tips of the canines and continuing posteriorly (**Figure 4**). What gives the illusion that it is radial in relationship to the lower lip (follows the curvature of the lower lip) is the cant of the maxilla in a sagittal plane (anterior to posterior) (**Figure 2**).

Generally, the occlusal plane is obtained by paralleling (canine to canine) to the interpupillary line assuming no asymmetries in the eyes (**Figure 3**). This reference plane is used even if there are inherent irregularities of the lips. The only time the interpupillary plane is not used as a reference is if the eyes are not level. If this is the case, the occlusal plane should be paralleled to the floor by mounting the diagnostic models using an earbow leveled with the floor.

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Figure 1. The incisal edge position at rest is the first critical step in the esthetic evaluation.

Figure 2. Having the patient smile allows visualization of the occlusal plane relationship to the lower lip.

Figure 3. The occlusal plane is achieved by paralleling a line bisecting the cusp tips of the canines and a line bisecting the corners of the eyes.

Figure 4. A line drawn from the incisal edges of the centrals should bisect the cusp tips of the posteriors to create a harmonious occlusal plane. A line perpendicular to the occlusal plane will help establish the facial plane of the incisors.

Figure 5. The midline should be perpendicular to the occlusal plane.

Figure 6. The gingival zenith is the most apical point of the free gingival margin.

Another reference for the occlusal plane is the curvature of the lower lip. The incisal edge positions of the upper teeth should follow the curvature of the lower lip if the objective is to make the patient appear more youthful, assuming no irregularities in the smile. If the objective is to make the teeth appear more age appropriate, it is not uncommon due to wear of teeth for the occlusal plane to be flattened out relative to the lower lip. If this is the case, the plane should parallel the interpupillary line with the incisal edges and cusps equidistant from the lower lip (if the lip is symmetrical).

Facial Plane of the Incisors

A line drawn on the midfacial plane of the incisors should bisect a line drawn on the occlusal plane perpendicularly (**Figure 4**). Evaluating the facial plane gives an idea if the facial contours of the proposed restorations need to be modified to create the appearance of being perpendicular to the occlusal plane. This can be done by making the cervical contour slightly more pronounced or by tapering the incisal edges lingually (if the teeth are proclined) or by bringing the incisal edges outward (if the teeth are retroclined). Any modifications to the incisal edges of the centrals in a facial-palatal direction should be evaluated functionally and phonetically as well as esthetically (whether the lip support will be adversely affected).

Midline

In an ideal esthetic setting, the maxillary midline should coincide with the midline of the face. In reality, the verticality of the midline appears to be much more critical than the mediolateral position.[2] As long as the midline is perpendicular to the occlusal plane and hence the interpupillary plane, the smile can appear balanced (**Figure 5**). If the midline deviates in verticality from being perpendicular, this can create lack of flow and symmetry to the smile. Generally, the midline is made to line up with the middle of the face and the philtrum of the lip. If a severe mediolateral abnormality exists, orthodontic or orthognathic treatment may be necessary.

Gingival Health and Balance

Successful treatment of the anterior dentition requires both a harmonious integration of hard and soft tis-

Figure 7. The axial inclinations of the teeth should be toward the mesial from an apical-incisal direction. The posterior teeth should flow with the axial inclination of the cuspid to create a smooth transition from anterior to posterior.

sue.[3] When evaluating the soft tissue, health and harmonious gingival contours are essential for esthetics. In a healthy situation, the gingival tissue follows the cervical contours of the teeth with the apical extent of the free gingival margin (**gingival zenith**) lying distal to the center of the tooth (**Figure 6**). On the mesial and distal aspects of the teeth (interproximally) the cervical embrasures between the teeth are filled by the scalloping of the tissue forming the papillae. For the appearance of health and beauty, the papillae should fill the cervical embrasures. Balance is achieved with the tissue heights of the centrals and canines at the same level and the tissue heights of the lateral incisor slightly more coronal.

There are subtle variations of this pattern that are acceptable as long as the cervical margin of the contralateral centrals are at the same level, the contralateral canines on either side are close to being at the same level, and the lateral incisors are not cervical to the centrals and canines.

In the esthetic evaluation, final position of the soft tissue will be dictated by the incisal edge position chosen for the occlusal plane. By using the average measurements of 10.4-11.2 mm for the central incisors[4-6] and measuring cervically, the new soft tissue levels can be visualized. If they differ from the present soft tissue levels, the possibility of performing either orthodontics, soft tissue grafting, gingival reshaping, or esthetic crown lengthening for the purposes of leveling the tissues becomes evident. This decision process is based on whether there is a need for root coverage or tooth exposure.

If veneers are being considered, and the tissue needs to be raised cervically to create a harmonious gingival contour, exposure of dentin may indicate the need for a different type of restoration. Ideally for long-term predictability of ceramic veneers, the preparation should remain in enamel due to the documented strong bond to enamel vs. the variability of bonding to dentin.

Arrangement

From clinical experience, when patients present for esthetic changes, they are usually seeking correction of irregularities or mal-alignments. In nature, there is no such thing as perfect symmetry. Although more patients are seeking correction of mal-alignments of their teeth by doing orthodontics, there is still no such thing as perfectly aligned teeth. If our goal is to please our patients yet still make our restorations appear life-like, creating symmetry of the central incisors and making any slight rotations or irregularities in alignment on the laterals or canines can create a pleasing and natural esthetic appearance to our restorations.

Any obvious irregularities in alignment or rotation that create imbalance should be noted by the clinician in the evaluation. If there exists any crowding or mal-alignment that will create a lack of space after alignment of the teeth, the patient should be informed of the limitations of veneers or crowns to align the teeth or that overlapping may be necessary. If overlapping is not an option, orthodontics may be the best option. Again, only in the diagnostic wax-up phase can the overall arrangement to be assessed as to whether it will create the esthetic goal that the patient and the dentist are trying to achieve.

Another important criteria for esthetic success in arrangement are the position of canines. The canines are important in transitioning the anterior aspect of the arch to the posterior. The more visible the distal aspect of the canine, the wider the anterior segment of the arch will appear, creating a squarer shape to the arch with a loss of a smooth transition from anterior to posterior. Only the mesial half of the canine should be visualized from an anterior perspective (**Figure 6**). Although the golden proportion is a mathematical concept that does not take into consideration dominance, symmetry, and overall subjective creativity, it does emphasize the fact that the canine, viewed from a facial perspective can be seen only from the mesial aspect. The facial aspect of the canine ideally should be made to flow with the posterior facial aspects to create a smooth transition from anterior of the arch to the posterior (**Figure 7**).

Ideally, the heights of contour of all the upper anterior teeth should follow the gingival zenith (distal to the middle of the tooth) with the **axial inclination** (**Figure 7**) from a cervical-incisal direction toward the mesial.

Tooth Dimension and Proportion

Dominance and relative symmetry of the centrals are two of the fundamental parameters for esthetic success[7] (**Figure 8**). The centrals are the focal

Figure 8. The central incisors should be dominant relative to the other anterior teeth. The incisal embrasures help to define the tooth form and to create individuality to the teeth. The internal characterization and translucency is critical in mimicking nature.

point of the smile and should appear appropriate in size and relatively symmetric. In terms of the overall size and proportion of the teeth, there are studies of average measurements that tend to be useful as guidelines for the dimension of the future restorations.[8-10] Not only are there many studies that show the average length and width of teeth, but Sterret et al,[11] found that the width/length ratios of unworn incisors and canines both fall within 77-85 percent. Centrals and canines have similar crown length with an average of 1-1.5 mm longer than lateral incisors.

Evaluation should include a subjective evaluation of the existing dimension and proportion of the existing teeth and any planned changes. Any severe discrepancies should be noted in the clinical examination. Alteration of the length of the teeth via esthetic crown lengthening or soft tissue grafting will alter overall dimensions and proportions of the final tooth form. Future tooth proportion and dimension can only be determined during the diagnostic wax-up phase of treatment because in reality, the arch form and occlusal relationship will dictate the width of the teeth. Any changes in the length of the teeth as dictated by the evaluation should be incorporated into the diagnostic wax up. Waxing over the tissue on the diagnostic model to change the crowns length is necessary to visualized if the proposed changes in tooth dimension and contour will be acceptable with a change in the soft tissue contours.

Tooth Contour and Incisal Embrasures

There are three basic shapes of teeth: square, ovoid, and triangular. Although there are three natural tooth forms, all anterior teeth are formed by three facial lobes and one palatal lobe. The conjunction of the three facial lobes create the mamelons. As a result, all incisal edges are rounded in youth. As we age, the teeth wear at varying degrees. This in turn creates a squarer appearance to the incisal edges of the centrals, and flattening of the cusps on the canines. If the objective is to create a more youthful smile and delicate smile, rounder incisal edges and more pointed cusp tips on the canines are necessary and vice-versa.[12]

The **incisal embrasures** (**Figure 8**) are formed by the interrelationships of the incisal edges of the anterior teeth and the cusp tips of the canines and posteriors. They are important in creating a life-like appearance to any restoration. The interaction of the incisal embrasures with the space between the lower teeth or lower lip and the incisal edges of the upper teeth when laughing (**negative space**) helps to outline and give individuality to the teeth. In youth, with less wear, the incisal embrasures are quite large with the smallest between the central incisors and progressively getting larger as you move in the arch posteriorly (**Figure 8**). If there has been some wear due to function or parafunction, not only do the teeth wear but the incisal embrasures get smaller. If a youthful appearance is the objective, larger incisal embrasures are essential.

Color and Character

In the evaluation step, it is important to determine what types of color changes are necessary for the final restorations. If the color of the final restorations is not going to be changed relative to the existing color of the teeth or only slight modifications in color are required, veneers may be the ideal type of restoration due to their inherent translucency. If a moderate color change is required, it may still be possible with veneers although the technician should be given slides of the preparations and of shade tabs to be able to visualize the areas to be blocked out in the porcelain. If severe color changes are required, either bleaching prior to preparation or choosing a different type of final restoration may be indicated.

Characterization of the teeth such as translucencies, crack lines, etc. on remaining natural teeth should be noted if the veneers are to match them (**Figure 8**).

Diagnostic Wax up

The diagnostic wax-up phase of treatment is one of the most essential aspects in all of the treatment. It is only through the wax up that all of the alterations that were planned as a result of the esthetic evaluation can be tested. All of the criteria for esthetic success should be implemented in the wax up. If any of the changes are not possible, this is where it will be discovered, and not after preparing the teeth.

Tissue Recontouring

Once the wax up is complete, visualization of the proposed soft tissue alterations are possible. The soft tissue levels may be waxed up on the model so that

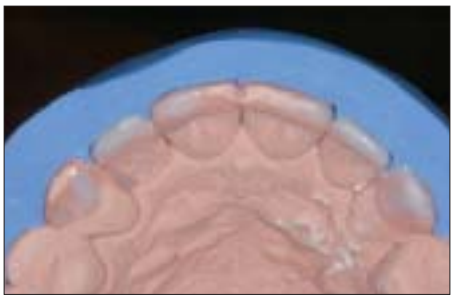

Figure 9. A facial matrix made off the wax up model helps to ensure proper reduction of the facial and interproximal aspect of the preparations.

Figure 10. A palatal matrix made off the wax up model helps to ensure proper incisal edge reduction.

Figure 11. A full matrix of the wax up allows fabrication of the provisional restorations.

the proportion and dimension of the teeth can be evaluated. If even more accuracy is required than just visualization, a surgical stent can be made from a model of the wax up by making a vaccuform cut to the desired soft tissue levels. By use of the wax up, the modifications can be made intraorally to idealize the soft tissue form whether through esthetic crown lengthening or connective tissue grafting.

Provisionalization and Final Impressions

Using a facial matrix made off of the diagnostic wax-up model to check preparation depth both facially and interproximally, proper reduction of the preparations can be ensured (**Figure 9**). A palatal matrix helps to achieve proper incisal edge preparation (**Figure 10**), and a full contour matrix of the diagnostic wax up helps to fabricate the provisionals. By loading the matrix with acrylic and seating the matrix on the preparations, the contours of the wax up will be formed in acrylic (**Figure 11**). Only by virtue of the provisionals can the esthetic alterations be visualized and checked. The wax up may look great on the model but only by visualizing the provisionals in the mouth can a true evaluation be made.

Any final contour changes should be made to the provisionals intraorally so that they are as close as possible to the desired width, length, contour, and arrangement of the final restorations. Once the contours are idealized, the provisionals should be measured to verify adequate preparation and only once ideal, the final impression is taken. Once the provisionals are cemented, alginate impressions are taken to produce stone casts of the provisionals in the mouth.

Laboratory Considerations

All of the models are cross mounted so that the provisional model is transferable with the preparation model. Indexes made off of the provisional model help transfer the information from the provisionals to the final restorations.

The final color, character, and texture are all defined in the final restorations. Photos are made of the preparations and shade tabs so the laboratory technician can determine if any block out any necessary areas to achieve the desired color. Internal characterization is paramount to success of any restoration. Teeth have varying amounts of translucency and internal characterization. In the older patient, crack lines are a very common occurrence. All of these minor characterizations help to lend a natural appearance to the final restorations. Surface texture is also important. Teeth erupt into the mouth with a very complex surface morphology of horizontal lines (lines of retzius) and vertical grooves (between the lobes). This surface texture reflects and deflects light and hence makes the teeth appear brighter. Due to erosion and abrasion over time, the surfaces of older teeth tend to display less surface texture. This allows more light to be absorbed and hence lower value to the teeth. Surface characterization is based on matching adjacent teeth or the by overall objective of youthfulness or aging.

Case Presentation

A 45-year-old patient presented to the office for a consult regarding her oral condition (**Figure 12**). She had a history of numerous restorative procedures (crowns and large composite fillings) in all of the teeth except the upper central incisors. She expressed unhappiness with the way her mouth looked and wanted a long-term, natural appearing esthetic solution that would make her appear more youthful. Upon evaluation, it was determined she had decay on almost all of her teeth and under her old restorations, necessitating a full-mouth rehabilitation. The patient was examined thoroughly from an extraoral, intraoral, and radiographic aspect. The objectives of treatment were to create a functionally, mechanically, and biologi-

Figure 12. A facial view of the patient at presentation.

Figure 13. With the lips at rest, the patient showed 5 mm of tooth structure.

Figure 14. The smile revealed a disharmony in the arch form and the occlusal plane.

Figure 15. From an intraoral view, the gingival imbalance due to recession was visible. The arch form was V-shaped due to the lingual position of the canines. The canines were short relative to the occlusal plane. All of the teeth except the central incisors were stained and dark due to previous restorations.

Figure 16. Although the teeth were proportional relative to each other, the recession and wear created a lack of proportion of the teeth individually, necessitating gingival correction and lengthening of the worn teeth.

cally sound rehabilitation while making the patient look better and more youthful. All ceramic Procera crowns were planned for the posterior teeth and porcelain veneers for the incisors.

The **esthetic evaluation** revealed the following:

Incisal edge position

At rest, the patient showed approximately 5mm of tooth structure with wear on the distals of the centrals (**Figure 13**). This created a V-shaped incisal edge relationship between the central incisors that the patient did not like. The distal aspects of the centrals were subjectively determined to be the correct length for the future incisal edge position because the centrals were actually a bit long relative to the width.

Occlusal Plane

When the patient was asked to smile, the occlusal plane was evaluated (**Figure 14**). Although the posterior aspect of the occlusal plane was fairly adequate, both canines were short relative to the occlusal plane (**Figure 15**).

Facial Plane of the Incisors

The facial plane was nearly perpendicular relative to the occlusal plane.

Midline

The upper midline was vertical and hence adequate in positioning (**Figure 12**).

Gingival Health and Balance

From an intraoral view, it was evident that the patient had generalized moderate amounts of gingival recession (**Figure 15**). Because the teeth were long already and because the canines needed to be lengthened to level the occlusal plane, the need for a root coverage procedure was indicated to create proportional width/length ratios. Another indication for root coverage was that the centrals and laterals were going to be restored with veneers. In order to create a finish line in enamel, root coverage was essential.

Arrangement

The arch form in the cuspid area did not flow with the posteriors aspect of the arch because both canines were tipped palatally on both sides while the first bicuspids were slightly buccal (**Figure 15**). This gave the illusion of a V-shaped arch rather than the desired U-shaped arch.

Tooth Dimension and Proportion

The distance from the distal aspect of the incisal edge of the central incisors up to the CEJ's created a proportionate dimension and dominance to the central incisors. Both lateral incisors were worn and although the upper left lateral was an appropriate length it was not appropriately shaped. The upper right lateral incisor was too short relative to the left. The canines needed to be lengthened to correct the occlusal plane (**Figure 16**).

Figure 17. Intraoral evaluation of the provisionals revealed a more harmonious tissue contour, tooth contour, dimension, occlusal plane, and arrangement.

Figure 18. An evaluation of the provisionals with a smile revealed a more harmonious arch form and symmetry.

Figure 19. The length of the final restorations at rest were appropriate for the patient.

Figure 20. The occlusal plane was made level to the eyes.

Figure 21. The occlusal plane was radial in relationship to the lower lip.

Figure 22. The facial plane of the incisors was perpendicular to the occlusal plane. The incisal edge configuration along with the incisal embrasures gave a feeling of youthfulness.

Tooth Contour and Incisal Embrasures

Because the teeth were worn, the incisal edges were flat, creating an older appearance to the teeth. (**Figure 16**). As a result of wear, the embrasures were small as well. The objective was to create a more youthful smile and therefore, rounder incisal edges and larger incisal embrasures would be appropriate.

Color and Character

All of the teeth other than the two centrals were dark in color due to previous restorations and decay (**Figure 15**). Due to the severity of the decay, the posterior teeth needed crowns. The lateral incisors and the centrals were restorable via the use of porcelain veneers.

From the esthetic evaluation, a wax up with all of the proposed changes was made. The patient went to see the periodontist for connective tissue grafting of the upper and lower arches (wherever needed) along with a coronally positioned flap to cover the exposed root surfaces. After three months of healing, a wax up was completed on a new diagnostic model reflecting the improved tissue relationship. The provisionals were made using the matrix made from the diagnostic model and evaluated functionally and esthetically (**Figures 17 and 18**). With the patient's approval, the final impressions were taken and the case was finished.

From the final photographs, one can see the esthetic objectives were achieved to create a harmonious and balanced smile:

- At rest, the patient showed an adequate amount of tooth structure creating a youthful look (**Figure 19**).
- When smiling, the occlusal plane was made level to the eyes with a radial relationship to the lower lip (**Figures 20 and 21**).
- The facial plane of the incisors was maintained perpendicular to the occlusal plane (**Figure 22**).
- There was a healthy, pleasing, and balanced symmetry to the soft tissue creating teeth of the same length on either side of the midline (**Figure 23**).
- The arch form was widened in the anterior segment. The canines were brought out facially and the bicuspids lingually to create a smooth transition from the anterior segment to the posterior segment of the upper arch (**Figure 21**).
- The teeth were made proportional with a pleasing symmetry (**Figure 21**).
- The incisal edges of the centrals

Figure 23. A facial view of the soft tissue revealed a healthy, balanced, and harmonious gingival contours along with a pleasing symmetry in arrangement. The teeth were made brighter while still maintaining a realistic appearance by incorporating internal effects and translucency in the porcelain.

Figure 24. Lateral view of the final smile.

and lateral incisors were made rounder, hence more youthful and delicate (**Figures 23 and 24**).

- The Incisal embrasures were opened to create individuality and a sense of reality to the restorations (**Figure 22**).
- The teeth were made whiter, brighter and hence more youthful (**Figure 23**).
- Translucency and crack lines were incorporated into the restorations to create an illusion of reality (**Figure 23**).

Conclusion

Esthetic predictability in any restorative procedure can make our dental careers much more enjoyable and rewarding. It would be nice to be able to predictably fabricate beautiful restorations. By consistently following a step-by-step protocol, the chances of success are greatly enhanced. Skipping an important step such as the wax up and provisionalization will ultimately lead to failure. Of critical importance is that knowledge, ability, and artistic flair of the laboratory technician. Not only should he or she know how to transfer all of the vital information obtained from the mouth (provisionals) via indexes, but be able to create a life-like replica in the ceramics. It goes without saying that long-term success demands that the esthetic alterations should fall within the function, mechanical, and biologic principles. CDA

Acknowledgment / Many thanks for the laboratory aspect of treatment to Mr. Harald Heindl. Without his exquisite artistic abilities and understanding of functional and mechanical principles, the case presented would never be the same.

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Diagnostically Generated Anterior Tooth Preparation for Adhesively Retained Porcelain Restorations: Rationale and Technique

John C. Kois, DMD, MSD, and Steve McGowan, CDT

ABSTRACT

A diagnostically based protocol for anterior tooth preparations for adhesively retained porcelain restorations offers dentists and laboratory technicians new options to approaching these restorations. Rather than designing a preparation and restoration based more on the needs of the products used than on the preservation of the remaining tooth structure, practitioners can enhance the predictability of these restorations by concentrating simultaneously on three distinct zones of the tooth (incisal, middle, and cervical) and four diagnostic categories (periodontal, biomechanical, functional, and dentofacial). The result of following the technique presented in this article is achieving an individualized design that offers a predictable option with minimal risks to the remaining tooth structure.

Although technically demanding and product-dependent, porcelain laminate veneers offer a predictable option for creating a successful restorative treatment that also preserves a maximum amount of tooth structure.[1-5] The risk of failure, however, has been shown to increase when primarily bonding to dentin rather than enamel, when the functional relationships are not managed properly, or when the tooth structure to be restored is very dark.

Concepts of anterior tooth preparation for these restorations continue to evolve, creating confusion among restorative dentists and laboratory technicians. Unfortunately, this confusion tends to result based more on the needs of new and innovative products, which is commercially biased, rather than on concern about remaining tooth structure.

In contrast, a rationale that is diagnostically based provides the opportunity to create a framework of understanding that will enhance the predictability of these restorations in tandem with the improvements and benefits from new technologies. To create a restoration that exceeds patients' expectations with minimal compromise to remaining or existing tooth structure, the parameters of anterior tooth preparation are focused on three distinct zones: incisal, middle, and cervical.

Within each zone, the tooth preparation is generated by simultaneously understanding the biomechanical behavior of the tooth structure, functional requirements, dentofacial parameters, and the periodontal concerns of the patient. Therefore, the ultimate design of the tooth preparation is minimized by the needs dictated by product thickness and maximized to benefit the final restorative result (**Figures 1 through 6**).

Incisal Zone

Representing the initial starting point, restoration of the incisal zone is based primarily on the functional and esthetic requirements of the individual patient. If the incisal edge position is correct in the face and in harmony with the smile, no vertical tooth reduction is necessary. This, unfortunately, does not provide the laboratory technician any flexibility to modify shape, position, or incisal translucency.

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Figure 1. Preoperative facial view of teeth Nos. 7 through 10 shows significant discoloration and incisal edge fracture on tooth No. 8.

Figure 2. Radiograph of teeth Nos. 7 through 10 shows large endodontic access opening and fill in tooth No. 8, which is a high biomechanical risk.

Figure 3. Preoperative lingual view. Note extent of fracture and position of lingual finish line.

Figure 4. Final tooth preparation on No. 8. There is excessive reduction of the incisal edge on the mesial (dictated by fractured), butt-fit margin design, and a more excessive cervical reduction (0.7 mm) because of the high dentofacial risk and low periodontal risk.

Figure 5. Preoperative facial view of teeth in occlusion.

Figure 6. Final view in occlusion. The veneer on tooth No. 8 is adhesively retained primarily to enamel, which is not perfect esthetically. However, maximum preservation of tooth structure for a predictable long-term result was accomplished.

Figure 7. Preoperative facial view of teeth Nos. 7 through 10 shows hopeless prognosis for tooth No. 8 and discolored interproximal composites.

Figure 8. Preoperative incisal view of functional relationship shows slight malposition of teeth Nos. 9 and 10, low functional risk.

Vertical reduction is not desirable, however, if the functional risk is high. If functional risk is low, the dentist has more flexibility to develop incisal reduction based on esthetic dentofacial veneers (**Figures 7 and 8**).

Reduction Considerations

Ideally, the vertical incisal reduction is 2.0 mm from the desired position, where it does not create a biomechanical compromise to the remaining tooth structure. It also offers minimal functional risk to the porcelain extending beyond the incisal edge, and gives the laboratory technician esthetic options to alter tooth form and build incisal effects in the porcelain. In addition, strict guidelines about not reducing the incisal zone more than 2 mm vertically as discussed in previous arti-

Table 1

Incisal Zone

Key: Develop optimal incisal position of esthetics and function

Objective: 2.0-mm vertical reduction

Margin Design: Butt
Lingual finish line in enamel

Instrumentation: 330 Mw[α]
KS 0 Medium[α]
KS 7[α]

Consider Alteration of Incisal Zone Reduction When:

Example 1 Use less reduction if:
Low-risk dentofacial
High-risk function

Example 2 Use more reduction if:
High-risk dentofacial
Low-risk function

[α]Brasseler USA, Savannah, GA 31419; 800-841-4522

cles are not supported by clinical findings. Unsupported vertical incisal porcelain even greater than 4 mm is predictable if the angle of anterior guidance and envelope of function are controlled (**Table 1**).

Margin Design

Most practitioners recommend a lingual chamfer margin design, which is acceptable, although it is not ideal.[6] It appears more prudent to develop a butt margin design incisally, with its lingual component in enamel and its facial axial line angle rounded. This allows the technician an opportunity to blend the porcelain so that the outline of the preparation will never be visible facially. In addition, the technician and dentist will then have multiple paths of insertion, for simplicity (**Figures 9 through 12**).

Middle Zone

The key concern for this zone is performing minimal facial reduction that retains tooth structure comparable to the retained enamel to optimize the limitations of composite technology. This will provide a unique blend of stiffness vs. flexibility and preserve the biomechanical behavior of the original tooth.[7-12] Unfortunately, this must be balanced by the need to create sufficient porcelain thickness, which is required for optimum esthetic development.

Figure 9. The Brasseler tooth preparation kit system (Brasseler USA, Savannah, Ga.) includes all of the burs necessary for tooth preparation and insertion of indirect restorations.

Figure 10. Facial view of tooth preparation technique for adhesively retained porcelain restorations. Step 1, incisal zone. Incisal edge reduction depth cuts with a 330 MW.

Figure 11. Facial view, step 1, incisal zone. Gross reduction using a KS 7 (Brasseler USA, Savannah, Ga.) bur.

Figure 12. Facial view, step 1, incisal reduction complete. Note that the vertical reduction is slightly less than the ideal 2 mm because of the need to increase the length of the final result based on dentofacial parameters.

The mean facial enamel thickness in the middle zone is 0.8 mm to 0.9 mm.[13] Therefore, while facial reduction less than this amount is desirable, maintaining the thickness of porcelain less than this amount will create many challenges for the laboratory technician and eliminate options for any core-supported systems.

Reduction Requirements

To maintain enamel facially and recreate the original biomechanical behavior of the tooth, a 0.5 mm to 0.7

Table 2

Middle Zone

Key: Maintain enamel
Minimal structural compromise

Objective: 0.5-mm to 0.6-mm – normal-colored teeth reduction
0.7-mm to 0.9-mm – darker-colored teeth reduction
Bevel facial incisal edge
Proximal finish lines in enamel

Margin Design:

Option 1 Maintain contact point if no proximal restorations

Option 2 Open contact point if previous caries restorations or to change tooth form

Instrumentation:
KS 0 depth guide = 1/2 Diameter 0.5 mm
KS 7 – gross reduction
KS 0 – complete remaining preparation

Consider Alteration of Middle Zone Reduction When:

Example Dark-colored tooth
High-risk biomechanics
High-risk function
High-risk dentofacial
Use 0.6-mm to 0.7-mm facial reduction

mm reduction is ideal. Interproximal finish lines should be terminated in enamel to minimize microleakage, and all sharp corners should be eliminated to minimize stress concentration in the porcelain as well as seating concerns for the restoration. Based on functional relationships, as much lingual enamel as possible should be preserved to minimize opposing wear. Dentofacial parameters contribute to significant concerns based on a preference for using only a clear resin-luting agent to develop imperceptible restorations.

For normal-colored teeth providing one or two levels of shade change (e.g., A3 to Al), reduction requirements of 0.5 mm to 0.7 mm are sufficient. However, for tetracycline-stained or very dark teeth, the maximum reduction of 0.8 mm to 0.9 mm is more prudent.

As usual, and especially in these situations, the individual talents of the laboratory technician are far more important than the specific brand of porcelain used. An understanding of the layering techniques, fluorescence, and optical properties of the materials used is essential.

In addition, the clinician must decide whether to maintain or eliminate the proximal contact from a dentofacial perspective. This decision may be based solely on the need to alter the tooth form or shape. This allows proper space distribution and the creation of teeth in proper proportion. From a biomechanical perspective, previous proximal restorations will necessitate more significant reduction to allow the finish line location that terminates on enamel lingually (**Table 2**).

Margin Design

The facial incisal aspect of the preparation must be rounded and beveled slightly to create an invisible transition of porcelain to the incisal edge and to eliminate stress concentration and seating concerns. All other aspects maintain a butt type of finish line (**Figures 9 and 13 through 15**).

Cervical Zone

The key concerns in this zone are similar to those in the middle zone except that the enamel is only 0.3 mm to 0.4 mm thick. In addition, the periodontium complicates the management. The preferences to maintain enamel, control color, alter tooth form, minimize flexure, and preserve biologic width combine to provide additional unique challenges to the laboratory technician and clinician.

Reduction Requirements

To preserve enamel, ideal reduction should be no more than 0.3 mm to 0.4 mm. This minimizes microleakage resulting from more predictable enamel bonding and minimizes the biomechanical compromises to the remaining tooth structure. This is especially critical with endodontically treated teeth. The larger the access opening and the greater the removal of internal tooth structure, the more critical the concerns for cervical reduction. This is especially a concern for a high-risk functional patient where tooth flexure is potentially greater.

Biomechanically and functionally, the minimal cervical reduction requirements are often at odds with the dentofacial concerns. When the teeth are normal color, a 0.3-mm reduction remains ideal for the porcelain to perfectly blend in, creating the contact lens effect. This is only true, however, with clear luting cement. Unfortunately, when teeth are darker than A3 and the requirements for the patient dictate using A1 or B1 shades, more re-

Figure 13. Lateral view, step 2, middle zone. Facial reduction depth guide using a KS 0 medium bur. Note that this is approximately half the 1.0 mm diameter.

Figure 14. Facial view, step 2. Completion of facial depth guide using a KS 0 medium bur. Note that this step does not include the cervical zone.

Figure 15. Lateral view, step 2, middle zone. Gross reduction using a KS 7 super-coarse bur.

Table 3

Cervical Zone

Key:	Preserve enamel
	Esthetics requirements
Objective:	0.3-mm reduction requirement for normal-colored tooth
	0.6-mm to 0.9-mm reduction for dark- to very dark-colored teeth
Margin Design:	
Option 1	Supragingival margin location • Normal tooth color • Minimal change in tooth form
Option 2	Intracrevicular location • Dark color • Change shape • Close gingival embrasures
Instrumentation:	KS 0
Consider Alteration of Cervical Zone Reduction When:	
Example 1	High-risk periodontal High-risk dentofacial Low-risk biomechanics Low-risk function Axial reduction 0.3 to 0.9 mm Intracrevicular margin location May be primarily in dentin
Example 2	High-risk biomechanics High-risk function Low-risk function Low-risk periodontal 0.3-mm supragingival margin location Will be in enamel

duction is necessary. As a general guideline, an additional 0.2 mm of reduction is necessary for each additional shade change.

Obviously, these increased reduction requirements compromise the biomechanics and functional concerns of the teeth. Therefore, the dentist must decide where to develop the most appropriate compromise. The priority in this decision is dictated by the individual tooth and patient concerns, not by the needs of the restorative material (**Table 3**).

Margin Design

From a periodontal perspective, supragingival margins are ideal. Concepts of intracrevicular tooth preparation have been previously discussed[14,15] and are not any different for these restorations. From a biomechanical perspective, the actual configuration of the finish line exhibits little influence on stress variation in the porcelain. The most significant factor in minimizing marginal failure is ultimately the luting layer (**Figures 9, 16, and 17**).[16,17]

Summary

This article presented a diagnostically generated protocol for anterior tooth preparation for adhesively retained porcelain restorations. This approach eliminates a standardized design based solely on the requirements of restorative materials. By shifting the focus to three distinct zones of the tooth and four diagnostic categories of periodontal, biomechanical, functional, and dentofacial parameters, the clinician can create an individualized design. Therefore, this design is deter-

Figure 16. Occlusal view, step 3, cervical zone. Reduction with KS 0. Previous restorations were removed. The implant healing abutment is visible on tooth No. 8.

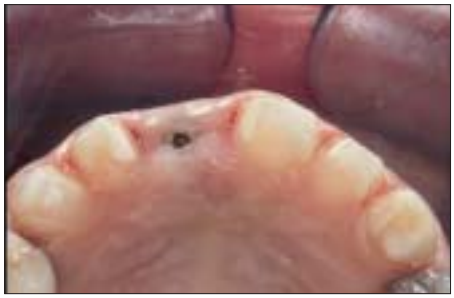

Figure 17. Occlusal view, step 3, cervical zone. Reduction is complete, and all restorations are replaced. Note that all margins terminate in enamel.

Figure 18. Facial view of teeth Nos. 6 through 11, at time of delivery from the lab. The implant restoration on tooth No. 8 was fabricated with a custom abutment and the metal-ceramic crown was veneered with Duceram (Ducera Dental GmbH and Co. KGJ, Germany) to match the adjacent feldspathic Duceram veneers.

Figure 19. Facial view of teeth Nos. 6 through 11, final result. Note adhesively retained porcelain restorations on teeth Nos. 6, 7, 9, 10, and 11. The implant-retained metal-ceramic crown on tooth No. 8 was completed simultaneously.

mined based on the need to minimize risk in the highest risk categories. With this approach, dentists can achieve the best possible result with minimal risks to the remaining tooth structure and the best chance for longevity (**Figures 18 and 19**). CDA

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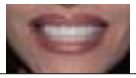

A Simple and Predictable Direct Technique for Esthetic Provisional Veneers

Careen W. Young, DDS, MSD

ABSTRACT

There are a number of different techniques for fabricating provisional veneers. There are direct and indirect techniques involving acrylic or composite resin veneers made with or without a vacuform matrix. This article describes a direct technique for fabricating removable provisional veneers using an auto-polymerizing urethane dimethyacrylate resin and a thermoplastic matrix that may later serve as a stent to be worn with the provisional veneers.

The fabrication of provisional veneers has generally been regarded as a difficult and time-consuming with many disadvantages.[1-4] While there has been a trend in restorative dentistry toward fabricating provisional restorations to provide a blueprint for the definitive restoration,[5,6] this has not been the case with veneers since many clinicians prefer not to provide their patients with provisional veneer restorations.[4,5,7,8,9] Problems associated with utilizing provisional veneers have included: the frequent inconvenience of patients returning with fractured or de-bonded provisionals since the restorations are thin; the increased incidence of gingival inflammation which may complicate the seating of definitive restorations; and the additional time and lab expense involved. Meanwhile, veneer preparations are often within enamel or extend minimally into dentin, often do not involve broken interproximal contacts, often have supraginigival margins, and rarely affect the occlusion.

However, the fabrication of provisional veneers has been found to be a valuable and frequently necessary step in the treatment of patients with porcelain laminate veneers from an esthetic and comfort standpoint. Although many of the preparations do lie within the enamel layer, patients are often displeased with the appearance of their prepared teeth and the associated initial increase in tooth sensitivity. Provisional veneers are valuable in maintaining patients' physical and social comfort.[7] Furthermore, when carefully made to resemble the definitive restorations planned, provisional veneers permit the patient and dentist to preview the esthetic changes planned, and provide diagnostic information about how the changes in the length, width and/or shape of the teeth may affect esthetics, phonetics and occlusion. [1,3,7,9,10] This way, the patient may better understand the how their desires to lengthen their incisal edges may be limited by their occlusion and vertical dimension and why it may be necessary to restore their posterior teeth. Once the patient approves the esthetics, the provisional veneers may also communicate the esthetic goals to the ceramist. Establishing the correct length before fabricating the definitive restorations is essential to an optimum result. It is only when the ceramist knows the correct length of the veneer that the porcelain may be properly layered to create incisal effects in the defini-

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Figures 1 and 2. Pre-treatment views of a patient who desired esthetic changes to her maxillary anterior teeth. The patient felt her existing veneers looked short, wide and dark. They had been placed 10 years earlier to mask interdental spaces. The veneers required replacement due to interproximal marginal decay and leakage.

Figures 3 and 4. The patient's pre-treatment smile. Her smile does not appear very full because her teeth do not fill her smile. The patient felt her teeth appeared short, wide and dark. A dental facial evaluation was completed and shows the incisal edges of the central incisors are shorter than the mid-point between the upper and lower lips when she smiled and the canines and maxillary left posterior teeth hang down longer than her central incisors. Her occlusal plane is not flat and the incisal edges of the teeth do not parallel the curvature of her lower lip.

tive veneers, such as halos and translucent areas.[10,11] Provisional veneers may also prevent the eruption of mandibular teeth when there is incisal reduction or minor shifting in the alignment of teeth, when tooth contacts are broken.[7]

There are a number of different techniques for fabricating provisional veneers. There are direct and indirect techniques involving acrylic or composite resin veneers made with or without a vacuform matrix. This article describes a direct technique for fabricating removable provisional veneers using an auto-polymerizing urethane dimethyacrylate resin and a thermoplastic matrix that may later serve as a stent to be worn with the provisional veneers. The conception of the technique follows the use of the Essix appliance in implant dentistry for the replacement of missing teeth.[12,13]

Case

A patient presented with six maxillary anterior veneers that were placed 10 years earlier to mask the interdental spaces present between her teeth. Interproximal decay was present and the patient wanted the veneers replaced with veneers that were longer and whiter (**Figures 1 and 2**). She wanted to bleach her lower teeth, but knew she could not unless she changed her maxillary veneers. She also felt her teeth looked short and wide and wanted a fuller smile. A facial esthetic evaluation, including an assessment of her incisal edge position, was completed. (Refer to Dr. Tal Morr's paper, "Understanding the Aesthetic Evaluation for Success.") The incisal edges of the existing veneers fell short of the midpoint between the upper and lower lips when the patient smiled or said "eeee" (**Figure 3 and 4**), confirming that her maxillary anteriors were too short. A diagnostic mock up was completed by first curing composite resin onto the incisal edges of the two central incisors without etching or adhesive. Next the canines were lengthened and then the lateral incisors (**Figures 5 through 7**). The purpose of the mock up was to give the patient an idea of how her smile may be improved by lengthening her teeth and to help her determine how many teeth she wanted to have treated. From the mock up, the patient saw the possible improvements to her smile and realized a better result with a more gradual transition of her occlusal plane could be obtained by involving her right and left premolars.

An idea of how much to lengthen the teeth may also be obtained. However, the desired length is fine-tuned later with the wax up and provisional restorations when adjustments for occlusion, phonetics, esthetics and function may be made.

In this case, it was determined that that the central incisors should be lengthened approximately 1.5 mm, not quite as long as the mock up. For this patient, the overall treatment plan involved bleaching the lower anteriors, placing a single tooth implant to replace the cantilever bridge that currently replaced the missing maxillary right first premolar and replacing the maxillary six veneers with new veneers that extended to the maxillary left second premolar. For improved esthetics, the new veneers were to be 1.5 mm longer at the central incisors with the canines matching in length. The resulting occlusal plane was to be flat and level with the patient's inter-pupillary line so that the incisal edges of the maxillary anteriors paralleled the curvature of the lower lip. The treatment plan was accepted.

Figures 5 through 7. A composite mock up was completed to determine how much the maxillary anterior teeth should be lengthened. **Figure 5** shows the patient's pre-treatment smile. First, the length of the two central incisors was assessed. **Figure 6** shows composite resin added to the central incisors until the incisal edge position fell below the midpoint between the upper and lower lips when the patient said "eeee." Once the length of the two central incisors was established, the canines were lengthened so they were level with the central incisors. Then the laterals were lengthened so that they were slightly shorter than a line connecting the central incisors and canines. **Figure 7** shows the patient's smile with the completed mock up on her six maxillary anterior teeth. After viewing the mock up, the desired length of the new veneers was confirmed. The patient also decided to have the first and second premolars treated.

Figure 8. The matrix utilized as a preparation guide to gauge the amount of reduction needed or completed. These are the patient's teeth immediately upon removal of her previous veneers, prior to any preparation. The preparations extended into dentin and the preparations wrapped interproximally to give the technician more flexibility in the contour to close the interdental spaces the patient had had.

Figure 9. The matrix and provisional veneer immediately upon removal from the patient's teeth, showing the flash present.

Figure 10. A completed provisional veneer.

Figure 11. Diamond disks (Brassler, Savannah Ga.) and ⅞-inch Moore sand paper disks are used to shape the provisional veneers, open up embrasures and refine the gingival margins.

Figure 12. The palatal view of patient's provisional veneer restoration showing the interdental tags of resin. With the teeth splinted around the arch, the proximal surfaces of the teeth and the interdental tags help to retain the provisional restoration.

Method

Preliminary study casts are made of the patient's existing dentition. When a diagnostic composite mock up has not already been done clinically to determine the length, width, contour and occlusal plane, a diagnostic wax up may be completed. A thermoplastic shell matrix (.040 mm clear matrix material, Raintree Essix, Metairie, LA) is made on a cast of the provisional wax up or mock up. The matrix is trimmed with a straight edge, 1 to 2 mm from the gingival margins. During tooth preparation, the matrix may be used as a preparation guide to evaluate the amount of reduction. **Figure 8** is a photo of the preparation guide on the patient's teeth immediately upon removal of the patient's previous veneers. The patient's preparations from her previous veneers extended into dentin and the preparations wrapped interproximally to give the technician greater flexibili-



Figures 13 through 15. The completed provisional veneers are esthetic and patients are happy to have teeth that look pleasing. The provisional veneers provide an immediate esthetic improvement over her previous veneers. They are longer, better proportioned and follow the curvature of her lower lip. These photos were sent to the laboratory to communicate the desired esthetics.

ty in the contour, to close the interdental spaces that she had had. (Refer to Dr. John Kois' paper "Diagnostically Generated Anterior Tooth Preparation for Adhesively Retained Porcelain Restorations: Rationale and Technique.")

Upon completion of the tooth preparations and final impression, the matrix is utilized to fabricate the provisional veneers. Luxatemp Automix Plus (Zenith DMG, Englewood, NJ), a hybrid, autopolymerizing dimethacrylate resin, in the correct shade, is dispensed via a cartridge-mixing tip and injected into the incisal edges of the matrix. Care is exercised to avoid the formation of air bubbles. A small amount is also injected onto the patient's bib to yield a sample drop which may be used to monitor the setting reaction of the resin. The loaded matrix is then seated firmly over the teeth and held in place until the resin has started to set. The matrix, along with the resin veneers, is then removed (**Figure 9**). If there are many undercuts present or interdental spaces, such as when the contacts have been broken, the resin veneers may remain on the teeth when the matrix is removed. The provisional restoration may be gently teased off with a plastic instrument to avoid fracturing it, but one must be careful to do so quickly before the resin has set completely to avoid locking in the restoration. Some of the interdental tags of resin may fracture off, but usually enough remain enabling the resin veneer to be placed back onto the teeth securely. One should attempt to maintain the provisional restoration in one piece when multiple teeth are involved because the additional units may enhance the retention of the provisional restoration on the teeth (**Figures 9 and 10**). The resin veneer is permitted to set completely before the excess resin is trimmed.

The flash is usually very minimal on the facial surface and slightly greater on the palatal (**Figure 9**). It may be broken away quickly by hand. Then the provisional restoration may be trimmed and shaped. The facial margins and excess may be trimmed using a friction grip diamond bur (KS-6, BrasslerUSA, Savannah, GA) or sand paper disks (⅞-inch, E.C. Moore Company, Inc., Dearborn, MI) and lab hand piece. Diamond finishing disks (918B-220 or 911MF-2290, BrasslerUSA, Savannah, GA) may be used to further refine the facial and incisal embrasure spaces (**Figures 10 and 11**). One should attempt to maintain the provisional restoration in one piece when multiple teeth are involved because the additional units may enhance the retention of the provisional restoration (**Figure 11 and 12**). There should be minimal trimming of the palatal surfaces and the interdental tags which will help retain the restoration (**Figure 12**). The trimmed veneers are placed onto the patient's teeth to evaluate fit, esthetics, phonetics, function and occlusion in centric relation, lateral and protrusive excursions (**Figure 13 through 15**) and the necessary corrections made. Sometimes small adjustments may need to be made to the incisal edges or length. Small porosities may be filled in with composite resin. Characterization of the veneers, if desired, may be achieved by cutting out small areas from the facial surfaces and laying in different shades of composite resin. This is generally not necessary, however. The completed provisional veneers may be polished on a lathe with pumice and high shine. A beautiful set of provisional veneers may be completed in as little time as 15 minutes. These provisional veneers are not cemented or bonded to the teeth and remain removable.

When the finished provisional veneers are evaluated and the patient and dentist pleased with the appearance, an irreversible hydrocolloid impression is made to obtain a study cast of the provisional restorations. The cast and photographs of the patient's face, smile and teeth with the restorations, are sent to the laboratory with the final impressions and provide the technician with a guide when making the definitive veneers (**Figures 13 through 15**). The casts of the provisional restorations are cross-mounted with the master cast so that the provisional restorations may serve as a blueprint for the definitive veneers. At times, the provisional restorations, provided they are of adequate thickness and proper contour, may be a saving grace when the technician says

Figures 16 through 19. Photos of a second patient who had his maxillary incisors prepared for veneers. He chose to wear his provisional veneers with the stent. The photos show him wearing the provisional restorations with and without the stent. Figure 16 shows healthy gingival tissues despite having worn the provisional veneers for eight weeks. His provisional veneers look a little yellow because he did not decide to whiten his teeth until after the veneers were prepared. His treatment was delayed so that shade selection could occur after his bleaching was completed.

Figure 16.

Figure 17.

Figure 18.

Figure 19.

the desired esthetics are unachievable.

The patient is instructed upon the insertion and removal of the provisional veneers and the process rehearsed a number of times under supervision. He or she is informed that the provisional veneers are for esthetics only, that they are thin and susceptible to fracture, and eating and sleeping with them is discouraged. The author has found, however, that patients do tend to eat with them on and have done so successfully. With other techniques, matrices are normally discarded at this point. However, with this technique, patients are instructed that the matrix may be worn as a protective stent. The provisional veneers may be inserted into the matrix and the two worn together to provide the provisional veneers an extra level of protection and stability, particularly if the patient insists on eating with them. **Figures 16 through 19** are of another patient who had his four maxillary incisors prepared for veneers. The photos show him wearing the provisional veneers with and without the stent. From clinical use, this brand of thermoplastic material seems to be more flexible and resistant to wear and breakage. The provisional veneers may be secured in the matrix with cyanoacrylate glue. Most patients find the provisional veneers have adequate stability and retention to be worn without the stent and many patients have preferred to do so to obtain the maximum level of esthetics. This is particularly true where multiple units are involved. A single veneer is more likely to be worn with the matrix. Regardless, patients are happy to have the assurance of knowing they have the matrix as a back up in case the additional stability is necessary. Once the matrix has been wet with saliva, its appearance is not as obvious. The matrix may also be used again to replace a lost or fractured provisional veneer.

The patient is instructed to remove the provisional veneers and brush and floss normally, as regularly as possible to maintain the health of the teeth and gingival tissues. The provisional veneer and stent may be maintained by soaking in denture cleaner and brushing. At the delivery appointment, the clinician may find the health of the gingival tissues to be optimal because the oral hygiene procedures are unobstructed and there are no rough, overhanging or unsealed margins to maintain (**Figures 16 and 20**). In **Figure 16**, the gingival tissues appear healthy despite wearing the provisional veneers for eight weeks. In **Figure 20**, the patient wore the provisional veneers for 12 weeks. Additionally, there are no bonded restorations to pry off and no adhesive on the enamel or dentin surface to be concerned about.

Discussion

This technique has many advantages. It is quick and simple, involves very little advance preparation, minimal material expense, and results in a provisional restoration with excellent esthetics from which the patient may preview the planned restoration and esthetics. An effective provisional restoration can be the key to preventing unwanted surprises and esthetic failures and facilitates the fabrication of the definitive veneers. The incisal edge position, length, width and shape of the definitive restorations in **Figures 21 and 22**, mimic that of the provisional veneers in **Figures 14 and 15** and were communicated to the ceramist.

Many authors[1,5,7,9,14] have recommended either cementing or bonding the provisional veneers or curing the direct provisional veneer onto the tooth surface (with or without etching and adhesives)

Figure 20. This photo shows the health of the gingival tissues and preparations of the first patient, after wearing the provisional veneers for 12 weeks. Note that the preparations are not conservative because the patient's previous preparations were not conservative and decay had been present under her previous veneers.

Figures 21 and 22. Photo of the teeth positioned end to end showing the patient's new definitive veneers which match her bleached lower teeth. The length, width, shape and alignment of the new veneers mimic the esthetics previously worked out with the patient in the provisional restoration.

Figure 23. With her new veneers, the patient's smile appears more radiant. Her maxillary teeth are longer and now appear to fill her smile.

and then trimming and finishing the provisional restoration without removing it from the tooth. The removable provisional veneer has the following advantages: Since finishing of the veneer may occur outside of the mouth, there is no risk of damaging the preparation finish lines or injuring the gingival tissues. The provisional veneers may also be shaped and polished ideally. This provisional veneer is not bonded to the tooth, so there is no risk that the fitting or bonding of the definitive veneers may be affected. The health of the gingival tissues may be optimized because the patient's oral hygiene efforts are unobstructed.

The material utilized is an auto-polymerizing bis-acryl resin. This material has the advantage of being more translucent, color stable and resistant to staining than methyl methacrylate resin. It has excellent polishability and is compatible with light-cured composites so that the latter may be used for repairs or characterization. The material is self-curing and sets gradually with little dimensional shrinkage and little exothermic reaction, so it may be allowed to cure directly on the tooth surface to yield a tight fit, with little fear of "locking on" the provisional. Although composite resin is the material of choice for a number of authors,[1,5,9] this technique, is not compatible with light cured composite resins because the interdental resin, once light cured, would cause the restoration to be "lock on" the teeth.

Conclusions

This method of fabricating provisional veneers is simple, quick and reasonably inexpensive. It provides an esthetic restoration that may make the patient more happy, secure and comfortable and provide the patient, dentist and ceramist an effective way of evaluating and communicating the esthetic goals. The advantages of this method of fabricating provisional veneers outweigh the disadvantages. CDA

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Robert E. Horseman, DDS

Say Yes to Sirtuin; No to Lamp Shades

The Pinot Noir Society of New York is planning a party. From all indications, this is going to be *the* soirée of the year, if not the millennium. Unfortunately, your chances of being invited are less than your attending a barbecue in the Oval Office. Look who is on the A-list:

Dr. David A. Sinclair of Harvard Medical School

Dr. Konrad T. Howitz of Biomol Research Laboratories

Ed Cannon of Elixir Pharmaceuticals of Cambridge, Mass.

Dr. Mark Tatar of Brown University

Dr. Leonard Guarente of MIT

Jef Boeke of Johns Hopkins School of Medicine

Dr. David Finkelstein of the National Institute of Aging

Dr. Toren Finkel of the National Heart, Lung and Blood Institute

In addition to these luminaries, there will be a select assortment of mice, fruit flies and yeast cultures. An RSVP from a gaggle of rhesus monkeys is expected. There will be an open bar with unlimited access to flagons, indeed, barrels of red wine, a substance that is the raison d'etre for this whing-ding. Besides being the progenitor of some awesome headaches, this beverage has long been credited with the ability to lower the risk of heart disease. What appears to you to be a derelict lying comatose in the gutter clutching a bottle of $1.98 Chianti in a brown paper bag, could very well be a well-preserved individual who is likely well into his late 90s thanks to a marvelous enzyme of the sirtuin (pronounced sir-TOO-in) class called resveratrol. Yes! This is the anti-aging ingredient that has biologists and scientists of every persuasion, including Phyllis Diller and Elizabeth Taylor, all a-twitter.

Continued on Page 197

This is the anti-aging ingredient that has biologists and scientists of every persuasion, including Phyllis Diller and Elizabeth Taylor, all a-twitter.

Continued from Page 198

"It's looking like these sirtuins serve as guardians of the cell," said Dr. David Sinclair of Harvard Medical School. He spoke from a conference in Arolla, a small village in the Swiss Alps. This is a scientific destination favored by scientists for its attractive income tax deductions. "These enzymes allow cells to survive damage and delay cell death," claimed Sinclair. So the race is on, he said, to find the most potent sirtuin stimulators, or create synthetic ones. Initially the benefits, if any, will fall on cells of flies and worms, mice and monkeys and, eventually, humans if the red wine they've consumed hasn't left them disinterested in anything but hair of the dog.

There's a gold mine out there awaiting the team that perfects a drug or nutritional supplement that can fool the body into thinking it's living on a radically reduced caloric diet. The red wine has already fooled them into thinking they are having a good time, so the next step is allow them to have their cake and eat it, too.

Although the experiments have not yet been completed, already compounds have shown evidence of extending the life spans of two organisms: the soil-dwelling nematode worm known as *C. elegans* (for the dignified way it emerges from its soil home to predict another six weeks of winter if it spies its shadow) and the common—but still elegant in its own way—fruit fly.

Unqualified approbation, as usual, is not unanimous. David Finkelstein, for one, suggested caution in taking the resveratrol results too literally. He's an expert in metabolic regulation at the National Institute of Aging. "Tell people to eat a healthy diet," he said with the religious fervor one associates with a recent Jenny Craig convert.

He doesn't exactly pooh-pooh the red wine theory, but rains a little on the parade by mentioning the inevitable weight gain and the possibility of having your picture taken wearing a lamp shade.

A gerontologist at the University of Wisconsin, Richard Weindruch, probably won't be getting an invite to the party. He questions the relevance of all the yeast experiments, which, strictly speaking, he pointed out, don't mean diddly-squat because they measure not the life span, but the number of times a yeast cell could divide and produce daughter cells. Jef Boeke, a yeast geneticist at Johns Hopkins echoed this feeling. "Let's face it," he argued, "aging isn't the same in humans and yeast." This is the sort of stuff you learn at Johns Hopkins and why high school career counselors should be prepared for a flood of applications to enter this line of work.

Regardless of the outcome, it appears that white wine just doesn't have the sirtuin potential of extending your hangover for as long as the reds. Coffee isn't in the running at all. Perhaps if you get invited to parties often, it's best to only accept those that are plainly announced as BYOB.

The dead worm (obviously not a *C. elegans*) in the tequila is another story and will be thoroughly investigated at a scientific conference to be held in Rio, Monaco, St. Tropez or some other venue with favorable currency exchange rates. **CDA**