CDA

Prevention

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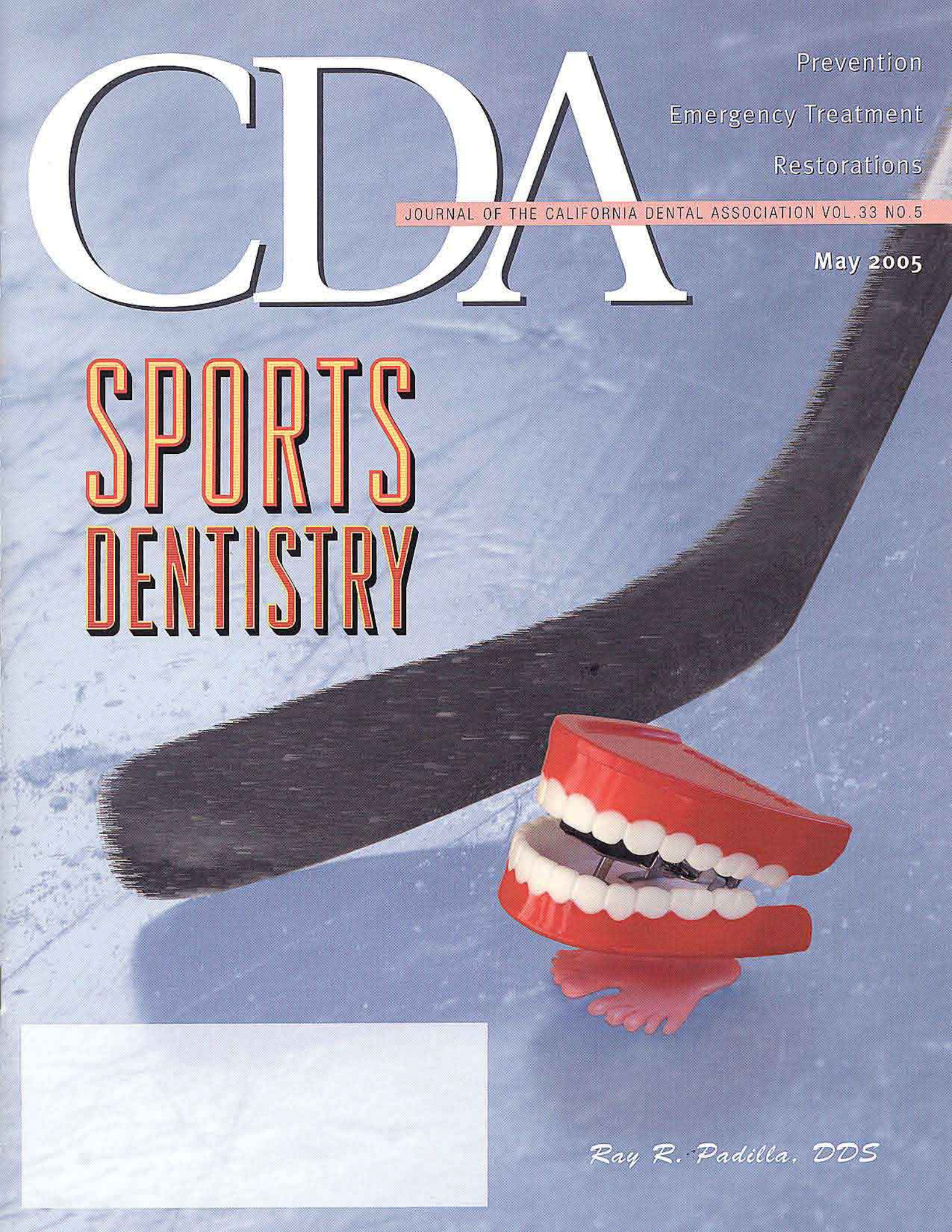
SPORTS DENTISTRY



Ray R. Padilla, DDS

OF THE CALIFORNIA DENTAL ASSOCIATION
Journal
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DEPARTMENTS

FEATURES

Alan L. Felsenfeld, DDS

Get Out of the Box

Two years ago, the American Dental Association created the Institute for Diversity in Leadership. This program was designed to expand the knowledge and ability of individual dentists to serve as leaders in their communities. It was the intent of the institute to select individuals who have been in practice for several years and who represent racial, ethnic and/or gender groups that have not traditionally provided significant numbers of leaders. The dentists who are accepted into the institute are educated in the skills that would enable them to have an effect on dental health programs in their community, their state professional association, and nationally. The program includes didactic education provided by professors from the Kellogg School of Management at Northwestern University and seminars at the ADA. Each participant develops a health care project to be designed and implemented within the year.

Many applications were received when the programs were initiated. Fortunately, a number of very qualified and highly motivated California dentists were accepted into the training. Each has taken on a different project and has been successful in the completion of their work. The CDA Executive Committee has been privileged to hear brief reports of the projects, progress and attitudes that these individuals had within the program. Each of them came from a different background with a different emphasis in their dental practice.

A busy prosthodontist in the Department of Veterans Affairs' hospital system and director of three affiliated dental clinics, John Jow recognized that a large segment of the homeless veteran population that did not receive dental care. In an effort to correct this and help alleviate dental disease in that population, his project was to coordinate dental screening and care at Stand Down health fairs for veterans. In cooperation with CDA and TDIC using the mobile dental van, his ability to coordinate care has been remarkable. This very successful program will be repeated semiannually.

Coming from a practice in Burbank with a focus on dental implants and esthetic dentistry, Jose-Luis Ruiz identified a limited participation of Hispanics in dentistry and dental hygiene. His project, in conjunction with the University of Southern California School of Dentistry, was in the development of the USC Hispanics for Dentistry program, which focused on mentoring Hispanic students to consider dentistry and dental hygiene as a career. He was able to coordinate a commitment from the school to take proactive measures to facilitate an increase in the numbers of Hispanic students entering the profession.

Gayle Kawahara is a general practitioner in Los Angeles. Part of her education in the program included classes in negotiation and sales training. Her interests were in the study of osteoporosis and its relationship to periodontal disease. As a result of her participation in the institute, she has been able to counsel her patients more appropriately, communicate these considerations through written columns in newsletters and presentations, and raise dental awareness of this pervasive and destructive condition.

Continued on Page 368

The dentists who are accepted into the institute are educated in the skills that would enable them to have an effect on dental health programs in their community, their state professional association, and nationally.

Continued from Page 366

This year, California is privileged to have two additional individuals participating in the institute.

Nava Fathi is an endodontist from Gilroy. She has a project to develop a mentoring program through the University of the Pacific Arthur A. Dugoni School of Dentistry. Her tasks include recruiting alumni mentors and pairing them with current students. The value of the program will be in affording opportunities for future employment and practice ownership for new graduates. In addition, this will let the mentors recruit and assess potential buyers for their practices as they retire. The education of these students in the reality of practice will be beneficial to their overall development. The project will begin with a day-long conference to be held at the school.

Access to dental care, long a problem in many areas of this state, has been the focus of a project by Brian Shue, who is a general dentist and dental director of the Clinicas de Salud del Pueblo in Brawley. He has undertaken a program that will promote awareness of the provisions of the licensure-by-credential regulations. The law states that a minimum of five years of experience is needed for application. However, with a minimum of two years experience in another state and a commitment to provide health care in a designated community health center, candidates can come to California earlier than five years. With appropriate marketing, he hopes to increase the number of dentists practicing in designated underserved areas.

At the conclusion of their projects, each of the current students will be invited to make a presentation to the CDA Executive Committee on the scope and findings of their efforts. We look forward to learning from them later this year.

Each of these courageous individuals was willing to sacrifice time from their already busy practices and personal lives to undertake a project that offered them a chance to blossom and grow. As we reviewed the results of their labors, we realized they had become enriched by the experiences they had in the process. The individuals in this program have grown as a result of the intellectual stimulation of a nonclinical dental-specific application of their knowledge and skills. Equally important, we, as a profession, have improved ourselves in the delivery of dental health care to our patients. Most significantly, our patients have benefited by the increased breadth of experiences these dentists have had. We applaud the efforts made by these individuals and the programs sponsored by the ADA, which enabled them to participate. It is to the betterment of dental care in America these programs continue to train our health professionals.

Dentists are capable of global thinking and providing health care on a widespread basis, as well as for individual patients.

As dentists we tend to focus on tiny parts of the anatomy and perform precision repair and treatment. Consistent with this is the cottage nature of our practices with most of us working in small offices or clinics treating one patient at a time. It is understandable that we can become somewhat myopic in our professional careers. We have much to contribute to our profession, the overall health of our patients, and to society. To paraphrase Dr. Kawahara, dentists work in a box; this type of experience offers an opportunity to get out of the box.

Dentists are capable of global thinking and providing health care on a widespread basis, as well as for individual patients. Projects like the Institute for Diversity in Leadership allow us to take the bright individuals who volunteer for participation and help them flourish into more productive leaders in dentistry. More of these types of programs, with emphasis on expanding our vistas, can only provide better care for patients. They are to be congratulated. CDA

Illustration: Matt Mullin

Public Split on Medical Record Privacy Issue

American adults are sharply divided about whether the potential privacy risks associated with a patient electronic medical record system outweigh the expected benefits to patients and society, according to Alan F. Westin, professor of Public Law and Government Emeritus at Columbia University and director of the new Program on Information Technology, Health Records and Privacy at Privacy & American Business.

Of the major findings, 48 percent of Americans said an electronic medical record system outweighs risks to privacy; 47 percent said the privacy risks outweigh the expected benefits; and 4 percent responded they weren't sure.

BETWEEN 62 PERCENT AND 70 PERCENT OF ADULTS ARE WORRIED THAT SENSITIVE HEALTH INFORMATION MAY BE LEAKED BECAUSE OF POOR DATA SECURITY.

Additionally, between 62 percent and 70 percent of adults are worried that sensitive health information may be leaked because of poor data security. They also reported there could be more sharing of medical information without the patients' knowledge; that computerization could increase medical errors; that some people wouldn't disclose necessary information to health care workers because of fear it become computerized data; and finally, that existing federal health privacy rules will be reduced for the sake of efficiency.

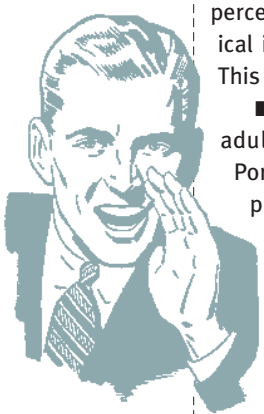
"I am convinced that how the public sees the privacy risks and responses from EMR managers will be absolutely critical to the EMR system's success — or will be a major factor in its failure," Westin said. "That is the reality that program advocates will need to consider, respond to, and overcome by implementing a range of laws, rules, practices, technology arrangements, privacy education, and positive patient experiences — if EMRs are to win majority public support and high patient participation."

Harris Interactive conducted the survey via within the United States from Feb. 8-13, reaching a cross section of 1,012 adults between the ages 18 and older. Information including age, sex, race, education, number of adults, number of voice/telephone lines in the household, and region were weighted where necessary to align them with their actual proportions in the population.

In what Westin called the most important policy input from the survey, more than 82 percent said that offering consumers tools to keep track of their personal information in the electronic medical records system and asserting their privacy rights is key to implementing the start of any such system. In the survey, 45 percent considered it very important; 17 percent replied it was not as important; and 1 percent weren't sure.

"I view this result as a powerful, publicly derived Privacy Design Specification for any national EMR system," Westin said. "It is a design approach that will be ignored, put off until a later time, or rejected as unworkable at the peril of any EMR system's entire future."

ADDITIONAL FINDINGS



- Representing 30 million Americans, 14 percent of the public believe their personal medical information has been released improperly. This figure is down from 27 percent in 1993.
- Two-thirds, representing 148 million adults, recalled receiving a Health Insurance Portability and Accountability Act notice. A surprising 32 percent said they never received a HIPAA notice; and 1 percent responded they weren't sure.
- Two-thirds who recalled receiving a privacy notice said their confidence in how their medical records are handled has increased "a great deal" (23 percent); "somewhat" (44 percent); "not very much" (13 percent); and "not at all" (18 percent).
- Representing 62 million American adults, 29 percent, said they had read or heard about a national electronic medical records program. Data indicated this group primarily had a better education, had higher incomes, and had used technology more frequently than their counterparts.

Westin recently testified before the National Committee on Vital and Health Statistics of the Department of Health and Human Services and provided several recommendations based on the survey findings. Among them: Create a "Privacy by Design Working Group" in the electronic medical records program now to conduct continuing Privacy Risk and Threat Assessments design and propose new privacy laws and regulations to accompany EMR roll-outs; identify system design elements that would enhance rather than defeat privacy interests; test and identify procedures to empower individual patients to access the electronic medical records systems

directly to assert their privacy rights and carry out their individual privacy choices; and create a privacy board with continuing problem-solving identification, investigative, and standards-recommending duties.

Westin is widely regarded as the country's leading expert on information privacy. Westin's previous work was in 1993-1995 on privacy in genetic information uses for the Ethical, Legal and Social Issues program of the Human Genome Project. He has been a privacy adviser to federal agencies such as the Social Security Administration, Census Bureau, Department of Commerce, and Office of Technology Assessment, and a privacy consultant to more than 100 companies and nonprofit organizations. The Westin program is an activity of the Center for Social & Legal Research, a nonprofit, nonpartisan public policy think tank exploring U.S. and global issues of consumer and employee privacy and data protection since it was launched in 12 years ago.

Preventive Dentistry Costs Less

Getting the kids to the dentist early may be a simple way to keep costs down on dental Medicaid.

The reasoning is because, that among high-risk, preschool-age children enrolled in the Medicaid program, those who have early preventive dental care are more likely to continue using preventive services. Their counterparts who delay going to a dentist, however, are far more likely to visit because of an expensive emergency or oral health problem.

According to a recent study, "Early Preventive Dental Visits: Effects on Subsequent Utilization and Costs," published in *Pediatrics*, the average cost for a dental visit before age 1 was $262. The figure more than doubled to $546 when a child's first visit was delayed until age 4 or 5.

"Our results support what the American Dental Association and the American Academy of Pediatric Dentistry have been saying for awhile: that for high-risk kids in the Medicaid program, getting them to the dentist earlier for preventive care is cost effective," says researcher Jessica Lee, DDS, MPH, PhD, of the University of North Carolina School of Dentistry in Chapel Hill. "Treatment can become very expensive as disease severity increases, even by age 5," Lee wrote. "A disproportionate amount of restorative or emergency care costs are seen in the hospital cost that comes with the dental care needed, because the young children are unable to sit in the dental chair and so might need the emergency or hospital operating room.

"These results have implications for the entire Medicaid program and even dental insurers in that, if you cover them early and they can get preventive care, it will save you money later on," Lee said.

The study also found that high-risk children from racial minority groups had more difficulty accessing dental care, as did those from rural areas with fewer dentists.

The average cost for a dental visit before age 1 was $262. The figure more than doubled to $546 when a child's first visit was delayed until age 4 or 5.

Survey: Dentists Mostly Happy

According to a new report published by the American Dental Association's Survey Center, dentists generally are happy with their current primary practice.

In the Dentist Well-Being Survey, 54.1 percent of dentists are "very satisfied" with their current primary practice and another 38 percent report they are "somewhat satisfied." Nearly 69 percent, however, responded to having a moderate level of stress at work.

The newly published report compared various aspects of the dentists' home, professional lives, as well as their health. Results are presented by gender and age group on a variety of topics, including from hours spent on child care to religious activity.

The report, catalog No. 5DWB, can be ordered by calling the ADA, (800) 621-8099, extension 2568; or the Survey Center, (312) 440-2568. The cost of the report is $40 for ADA members; $60 for nonmembers; and $120 for commercial firms, plus shipping and handling.

Guffawing Your Way to Health

Whether you chortle, titter or even downright giggle, any variation of laughter is beneficial to your body.

In an issue of the *Chicago Dental Society Review*, researchers explored the medical evidence that laughter has on one's body. Positive side effects range from reduced blood pressure and risk of heart disease, the release of the feel-good endorphins as well as an elevated level of cells that attack cancers and viruses.

According to the article, Elizabeth Giangrego, managing editor of the *Chicago Dental Society Review*, said encouraging humor in the workplace can be valuable. Of course, parameters must be followed such as never denigrating coworkers, joking about their appearance, race, or religion. Think a joke may go over as well as a lead balloon? It's likely not a good idea, and refraining from telling it would be a wiser choice.

The three categories of humor, researchers said, are incongruity, superiority, and relief.

When confronted with situations that typically are at odds, pointing out the irony can be humorous. Superiority relies on jokes made at someone else's expense, and walks a fine line between funny and hurtful.

The most spontaneous of the three is relief and usually develops in times of stress or challenging work.

Whatever the category, it is best to first determine if the situation is appropriate and cannot be misconstrued as cruel. Have a doubt, leave it out.

Diabetes Plan Highlights Prevention

A new step-by-step guide of resources and activities to fight a disease affecting more than 18 million Americans, concentrates on simple ways people can try to prevent diabetes.

"This action plan provides specific steps that everyone can take to fight diabetes," said Human Health Services Secretary Tommy G. Thompson. "The most effective way to bring this problem under control is for government, businesses, health care providers, schools, communities and the media, as well as people with diabetes and their families to work together."

"Diabetes: A National Plan for Action" focuses on specific, attainable action steps, such as, encouraging a reduced fat intake, using the stairs instead of an elevator, and getting screened for diabetes.

Places of businesses can provide healthy food in their vending machines and cafeterias, and turn some conference space into exercise rooms. Civic groups can install distance markers on sidewalks to encourage walking and create community gardens. Government agencies can develop evidence-based strategies to prevent, detect, and treat diabetes, as well as programs to implement them, such as Medicare coverage for diabetes screening, which took effect Jan. 1.

Thompson convened town hall meetings in Seattle, Little Rock, and Cincinnati last year to hear how diabetes impacts communities, as well as the steps the cities are taking to reverse this trend. Health care providers, those with diabetes, business community members, among others, provided information that resulted in the action plan.

Medicare to Help Beneficiaries Kick the Habit

The Centers for Medicare and Medicaid Services intend to provide new coverage to allow certain Medicare beneficiaries who smoke to obtain counseling service to help them quit.

"We're building on our efforts to help America's seniors help themselves to quit smoking and live longer," said Tommy G. Thompson, Human Health Services secretary. "This new benefit, focused on treating seniors' smoking-related diseases, will go a long way toward reducing their risk of dying prematurely. The combination of lives lost unnecessarily, and the cost of treating smoking-related diseases makes our investment in smoking cessation benefits all that more important. It's never too late to benefit from quitting smoking."

Approximately 440,000 people die each year from a smoking-related disease, with 300,000 of those deaths in those 65 and older.

In 2002, the Centers for Disease Control and Prevention estimated that 57 percent of smokers age 65 and over reported a desire to stop. About 10 percent of elderly smokers quit each year, with 1 percent relapsing.

"The evidence available fully supports the hope that seniors at risk of the diseases caused by smoking can quit, given the right assistance," said Mark McClellan, MD, PhD, administrator for the Centers for Medicare and Medicaid Services. "As we add the 'Welcome to Medicare' exam and other preventive benefits and drug coverage, this is another step in using the medical evidence to turn Medicare into a prevention-oriented program."

The proposal to cover smoking cessation counseling was in response to a June 2004 request from the Partnership for Prevention. The organization requested that the Centers for Medicare and Medicaid Services open a national coverage decision to consider coverage of tobacco cessation counseling as detailed in the Health and Human Services' Public Health Service 2000 Clinical Practice Guideline, "Treating Tobacco Use and Dependence."

Based on the evidence reflected in the guideline, the Centers for Medicare and Medicaid Services proposes to extend smoking cessation coverage to beneficiaries who smoke and have been diagnosed with a smoking-related disease, or are taking certain drugs whose metabolism is affected by their use of tobacco. This announcement builds on a series of the Health and Human Services' initiatives designed to help Americans quit smoking, including the opening of a new national quit line, (800) QUITNOW, and designating all HHS campuses tobacco-free.

To those who think that quitting at age 65 or older fail to enjoy the health benefits of tobacco abstinence, the U.S. surgeon general reported that the benefits of cessation extend to older ages. Smoking cessation in older adults leads to significant risk reduction and other health benefits, even in those who have smoked for years.

The proposal of coverage involves Medicare beneficiaries who have an illness caused or complicated by smoking, such as heart and lung diseases, cerebrovascular disease, weak bones, blood clots, and cataracts – the diseases that account for the bulk of Medicare spending today.

"IT'S NEVER TOO LATE TO BENEFIT FROM QUITTING SMOKING."

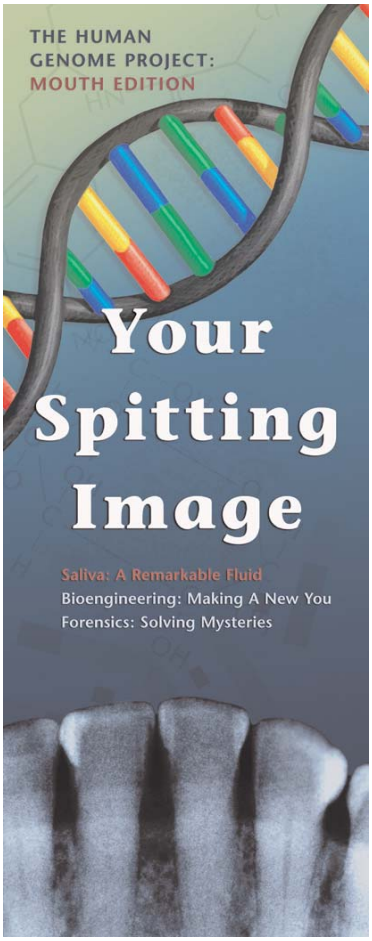
Honors

Richard Mayer

L. Stephen Buchanan, DDS, of Santa Barbara; **Donald Poulton, DDS**, of San Francisco; and **Craig Yarborough, DDS**, MBA, of Greenbrae, received this year's Medallion of Distinction Award from the University of the Pacific Arthur A. Dugoni School of Dentistry.

Presented annually by Dean Arthur A. Dugoni, the medallion is the highest honor bestowed by the organization and recognizes those who have made outstanding contributions to the School of Dentistry, research, dental education, or the community.

Ernest Newbrun, DMD, PhD, professor emeritus at the UCSF School of Dentistry, has been honored for 20 years of service on the Board of Directors of the Dental Health Foundation, including seven years as chairman.



Information Flows at Exhibit

The interactive computer programs, hands-on displays, and fascinating facts awaiting inquisitive individuals may be enough to make other museums drool.

"Saliva: A Remarkable Fluid," which opened March 2 at the Samuel D. Harris National Museum of Dentistry in Baltimore, is devoted to the studies of human DNA and its significance to dentistry. The exhibit, which will continue for several years, details discoveries in genetic research and saliva's importance to one's oral and overall health.

Video displays, computerized interactive programs, and hands-on activities take museum-goers on a tour through their mouths, teaching them about the beneficial properties of saliva, such as how it's produced, how it works throughout the body, and the detrimental effects if salivary glands don't function properly.

Interesting facts also include that saliva, which is made up of 99 percent water, benefits oral health in numerous ways. And, that the average healthy mouth produces 600 mL of saliva daily — equal to the content of a soft drink bottle from a vending machine.

"Saliva: A Remarkable Fluid" is the first component of "Your Spitting Image," a three-part exhibition. "Your Spitting Image" enables visitors to understand the connections between the human genome project and dentistry in three topical areas: bioengineering, forensics, and saliva.

Members of the project development team include Harold Slavkin, DDS, dean of the University of Southern California School of Dentistry; Christian Stohler, DDS, dean of the University of Maryland Dental School, and Bruce Baum, DMD, PhD, chief of the Gene Therapy and Therapeutics Branch Gene Transfer Section at the National Institute of Dental and Craniofacial Research. Patterson Dental Foundation, with additional support from Drs. Lawrence Johns and Robert Wilson, provided lead sponsorship for the exhibit, which is located in the Saccente Gallery on the museum's second floor.

Upcoming Meetings

2005

May 12-15	CDA Spring Scientific Session, Anaheim, (866) CDA-MEMBER (232-6362).
Aug. 17-20	Sixth Annual World Congress of Minimally Invasive Dentistry, San Diego, (800) 973-8003.
Sept. 9-11	CDA Fall Scientific Session, San Francisco, (866) CDA-MEMBER (232-6362).
Sept. 25-28	Pacific Coast Society of Orthodontists/Rocky Mountain Society of Orthodontists Joint Annual Session, San Diego, www.pscortho.org
Oct. 6-9	ADA Annual Session, Philadelphia, (312) 440-2500.

2006

April 27-30	CDA Spring Scientific Session, Anaheim, (866) CDA-MEMBER (232-6362).
Sept. 15-17	CDA Fall Scientific Session, San Francisco, (866) CDA-MEMBER (232-6362).
Oct. 16-19	ADA Annual Session, Las Vegas, (312) 440-2500.
Dec. 3-6	International Workshop of the International Cleft Lip and Palate Foundation, Chennai, India, (91) 44-24331696.

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) 554-5962.

Post 2005 Spring Scientific Session C.E. Information

Receiving Continuing Education Credits

On site attendees will be required to utilize their name badge to swipe in and out of each class and attend the entire class to receive credit. Arrival and departure times will be recorded and will be used to issue certificates of attendance once a survey is completed for each course.

To complete the survey, enter the CDA website at www.cda.org. All attendees can access the Online C.E. Pavilion from the Public side of the website. Please enter your first and last name as it appears on your badge. Then complete the survey for each of the classes you attended. Attendees should visit the Online C.E. Pavilion within 45 days after the show.

If you have any questions regarding the classes listed, please call the CDA Resource Center at (866) 232-6362.

E-mail: **SessionsCE@cda.org**

Fax: **(916) 554-5937**

Online: **www.cda.org**

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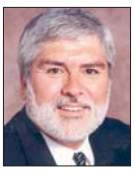
Preventing and Treating Orofacial Trauma

Ray R. Padilla, DDS

I would first like to thank the California Dental Association and Dr. Alan Felsenfeld, editor, for the honor and opportunity to be guest editor for the 2005 May and June issues of the CDA *Journal*. It is my goal to have these issues, dedicated to orofacial trauma, continue the tremendous history of serving the CDA with evidence-based information. I hope these issues will serve the membership with a solid reference for the prevention, diagnosis, and treatment of orofacial trauma.

It was very difficult determining which topics to include as we could only have a limited number of articles per issue. I did not want to leave out any specialty of dentistry as we are all so mutually dependent and supportive, and all very important in the treatment of trauma. So rather than choose topics, I selected several of the most influential dentists who have had a tremendous effect, inspiration, and stimulus on not only my academic life, but the lives of dentists throughout the world. Having the opportunity to publish and participate in sports dentistry at the amateur, collegiate (UCLA athletics) and professional levels, (Los Angeles Avengers arena football and the Los Angeles Galaxy soccer team); several Olympic Games and World Cups and Championships, I have been very fortunate to travel throughout the world and speak with many international dentists who have taught me a tremendous amount on the topic of trauma treatment and prevention. I would like to share these tremendously talented dentists with you.

Dr. René Fasel, Zurich, Switzerland, has been the International Ice Hockey Federation president since 1994. He is responsible for a closer contact with the professional organizations in North America and consolidated the relations between International Ice Hockey Federation and the National Hockey League. In 1998, he coordinated the NHL's top professional players to compete for the first time at the Olympic Games in Nagano. In 1995, Dr. Fasel was appointed the first ice hockey representative in history to the International Olympic Committee. In 1997, Dr. Fasel was commissioned by the International Olympic to compile a study on the dental treatment of Olympic athletes at the University of Barcelona, thus emphasizing the need for international recognition of sports dentistry. Most recently, Dr. Fasel was named the chairman of the 2010 Vancouver Olympics Coordination



Guest Editor / Ray R. Padilla, DDS, has practiced in the East San Gabriel Valley for more than 20 years. He has worked with athletes in both the professional and amateur levels as a dentist for the Los Angeles Galaxy soccer team, Los Angeles Avengers Football team, UCLA Athletics, and as a consultant for the U.S. National Soccer Team.

Committee, and by the prestigious 2003 Sport Intern Newsletter, listed as the 13th most influential sports personality in the world.

Dr. Paul Piccininni, Toronto, Ontario, Canada, is recognized as one of the top international sports dentists in the world. As a world lecturer and member of the International Olympic Committee Medical Commission and the International Ice Hockey Federation Medical Commission, he has introduced sports dentistry to the medical community on a global level. It is because of his and International Olympic Committee member Dr. René Fasel's influence that the International Society of Dentistry, Sport and Trauma was founded in 2002. The purpose of this organization is to spread the word of sports dentistry worldwide. Dr. Piccininni is a clinical associate faculty member at the Department of Oral Medicine and Oral Diagnosis, University of Toronto, and a medical staff member at York University Sports Injury Clinic, Toronto, Canada. He presently is on the medical staff for the Canadian Football League's Toronto Argonauts, and York University, and maintains a private practice in Toronto.

Dr. Helen Cornwell, Newcastle, Australia, is a pediatric dentist with a special interest in the prevention, management and long-term consequences of dental trauma. As part of her specialty training at the University of Melbourne, she was an honorary postgraduate dental officer at the Royal Children's Hospital. She worked the 2000 Sydney Olympic Games and is currently an Australian representative to the International Society for Dentistry, Sport and Trauma. She has also provided professional development for nondental groups, including emergency department staff, maternal and child health nurses, speech pathologists, and early intervention team members while at the University of Melbourne.

Dr. Dave Kenny, Toronto, Ontario, Canada, is director of Dental Research and Graduate Studies, and senior associate scientist at the Research Institute at The Hospital for Sick Children in Toronto. He is a professor of dentistry at the University of Toronto and research coordinator for dental services at the Bloorview MacMillan Children's Centre in Toronto. He is coauthor of "Wet Fingered Dentistry: Practical Advice from Experienced Dentists" published in 2002. An international lecturer, he has authored many articles on luxation and avulsion treatment. His most recent works are establishing new benchmarks in trauma research.

These two issues of trauma treatment and prevention will serve as a reference and update in our ever-growing attempt to provide the best dental care for our patients.

Dr. David Kumamoto, University of Chicago, received his dental degree from the University of Illinois, where he is currently a clinical associate professor in the Department of Restorative Dentistry and athletic team dentist for the University of Illinois at Chicago. Dr. Kumamoto is a fellow and past president of the Academy for Sports Dentistry. An international speaker, Dr. Kumamoto has authored many articles on trauma treatment and epidemiology of orofacial injuries. He is chairman of the university's Senate Committee on Athletics and Recreation and a member of the Chicago Sports Medicine Society. He is currently Chicago regional director for "Project Mouthguard." He has served as an emergency dentist for the U.S. Olympic Committee and the 1994 World Soccer Cup. Dr. Kumamoto maintains a general dental practice in Chicago.

Dr. Yoshinobu Maeda, Osaka, Japan, is professor and head of the Division of Interdisciplinary Dentistry, Osaka University Faculty of Dentistry, Japan. Dr. Maeda has published articles and lectured on the topic of trauma treatment and prevention at many conferences, and performs research on mouthguards, materials, and the epidemiology of sports related dental trauma. He is a member of the Japanese Academy of Sports Dentistry and the International Society for Dentistry, Sport and Trauma.

Dr. Pascal Magne, University of Southern California, was born in La Chaux-de-Fonds, Switzerland and received his doctoral dental degree in 1989 at the University of Geneva where he taught prosthodontics and operative dentistry until 1997. Awarded with major grants by the Swiss Science Foundation, the Swiss Foundation for Medical-Biological Grants, and the International Association for Dental Research, he spent two years as a full-time research scholar in biomaterials and biomechanics at the University of Minnesota between 1997 and 1999. Back at the University of Geneva, he received his PhD degree in 2002 and served as senior lecturer from 1999 to 2004. Since February 2004, he became associate professor at the University of Southern California where he also

serves as director of the Center for Esthetic Dentistry. An international speaker, he is the author of the textbook "Bonded Porcelain Restorations" as well as clinical and research articles on esthetics and adhesive dentistry.

Dr. Thomas von Arx, Berne, Switzerland, is on the medical faculty at the University of Berne, and has published more than 70 articles on endodontic surgery, guided-bone regeneration and dental traumatology. He is presently an associate professor and senior lecturer in the Department of Oral Surgery and Stomatology at the School of Dental Medicine at the University of Berne. He has been awarded the Kiwanis-Award for Dental Medicine from the University of Berne, and the Rudolf-Hotz Award from the Swiss Association for Pediatric Dentistry.

These two issues of trauma treatment and prevention will serve as a reference and update in our ever-growing attempt to provide the best dental care for our patients. Other sources we may seek in our search for knowledge are three organizations focusing on trauma treatment and prevention. These are the International Society for Dentistry, Sport and Trauma, the International Association of Dental Traumatology, and the Academy for Sports Dentistry. Each organization holds annual symposiums on trauma throughout the world. I invite you to seek out these organizations and further your knowledge of trauma treatment. Upcoming symposiums are planned this year in Miami, June 23-25 (http://www.sportsdentistryiasd.org/images/datesaver.pdf), and Montreal, Quebec, Canada, Aug. 26-28 (http://www.fdiworldental.org/microsites/montreal/congress4_26_eng.html, www.sportsdentistry.com). CDA

Treatment of Extended Anterior Crown Fractures Using Type IIIA Bonded Porcelain Restorations

Pascal Magne, DMD, PhD, and Michel Magne, CDT

Abstract

Novel-design bonded porcelain restorations, the so-called Type IIIA BPRs, represent a reliable and effective procedure when restoring large parts of the coronal volume and length in the anterior dentition. While traditional treatment approaches involve the removal of large amounts of sound tooth substance (with adverse effects on the pulp, gingivae and crown biomechanics, as well as serious financial consequences), the use of adhesive technology instead can provide maximum preservation of tissues and limited costs. Considerable advantages, such as the economical and noninvasive treatment of crown-fractured teeth, are inherent to Type IIIA bonded porcelain restorations, reducing the need for preprosthetic interventions (e.g., root canal therapy and crown-lengthening) and the use of intraradicular posts. This article, illustrated with cases with up to eight and 10 years' follow-up, sets the scientific foundations of this concept, as well as important considerations about function, strength, tooth preparation, laboratory technique, and bonding optimization.

It is generally agreed that bonded porcelain restorations such as porcelain veneers have matured into a predictable restorative concept in terms of longevity, periodontal response and patients' response.[1-6] Owing to intrinsic favorable esthetics in the marginal area, bonded porcelain restorations do not specifically require penetration into the gingival sulcus, which prevents potential damage to the periodontal tissues and biologic width violation. Feldspathic porcelain is also known as being less susceptible to accumulation of bacterial plaque in comparison to gold, resin or even to hard tooth structures.[7,8] The indications for the use of bonded porcelain restorations broadened significantly during the 1990s

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Disclosure / Pascal and Michel Magne maintain an intramural practice within the Oral Health Center at the University of Southern California School of Dentistry. The authors express their gratitude to Professor Terrence Donovan, chair, Division of Primary Oral Health Care, USC School of Dentistry, for reviewing the English draft.

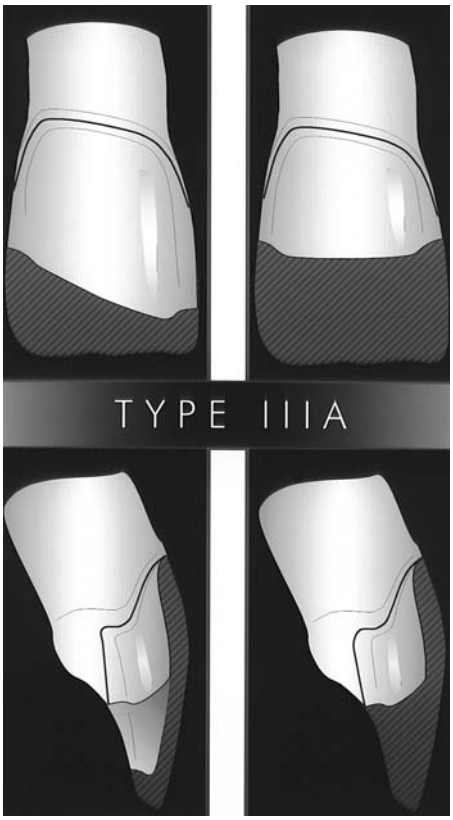

Figure 1. Indication Type IIIA represents a novel-design porcelain veneer for which the veneer includes the missing part of the incisal edge as well as the facial surface.

Table 1

Classification of Indications for Porcelain Veneers

TYPE I TEETH RESISTANT TO BLEACHING	
GROUP IA	Tetracycline discoloration of degrees III and IV
GROUP IB	Nonresponse to external or internal bleaching
TYPE II MAJOR MORPHOLOGIC MODIFICATIONS	
GROUP IIA	Conoid teeth
GROUP IIB	Diastemata and interdental triangles to be closed or reduced
GROUP IIC	Augmentation of incisal length and incisive prominence
TYPE III EXTENDED RESTORATIONS (ADULTS)	
GROUP IIIA	Extended crown fractures
GROUP IIIB	Extended loss of enamel by erosion and wear
GROUP IIIC	Generalized malformations and acquired deformities

as a number of researchers expressed confidence in these restorations.[9-14] As a result, innovative preparation designs emerged.[11,14,15] Internal stress distribution and the parameters responsible for postbonding cracks formation were investigated, and preparation design rationalized accordingly.[16-19] Unexplained craze lines, which initially deterred clinicians from using porcelain veneers, were understood and explored experimentally.[19-21]

Based on these considerations, restoration of extensive crown fractures (**Figures 1-3**) have been proposed amongst indications for bonded porcelain restorations, the so-called Type IIIA bonded porcelain restorations according to the classification by Belser and Magne[11] (**Table 1, Figure 1**). This approach, used by the author for more than 12 years, has to be considered with special attention because its success and reliability can result in considerable improvements, comprising both the medical-biological aspect (i.e., economy of sound tissues and maintenance of tooth vitality) and the socioeconomical context (i.e., decrease of costs when compared to traditional and more invasive prosthetic treatments).[22] Theoretical bases for such an indication have been documented by experimental and numeric studies demonstrating the sufficient strength and adequate biomechanical behavior of the tooth-restoration complex, provided that adequate design and thickness of the restoration are respected.[9,10,17,22,23] The clinical performance of these novel-design porcelain veneers was confirmed in a medium-term clinical trial.[24] Because traditional porcelain veneers are expected to last 10 to 15 years, these clinical results can be considered only as preliminary.[25] However, bearing in mind that 100 percent of the restorations survived over the average 4.5-year period, a very good prognosis can be anticipated for the new proposed indication. For those incisors with extensive loss of coronal tissues (**Figures 2, 3**), traditional treatment approaches would have involved the removal of large amounts of sound tooth substance, with adverse effects on the pulp, gingivae, and crown biomechanics, as well as significant financial consequences. Using adhesive technology instead of traditional mechanical retention can provide maximum preservation of tissues and limited costs, which also contributes to the absolute satisfaction of the patients. Using Type IIIA bonded porcelain restorations, fractured teeth that are vital before treatment can be kept vital during and after treatment despite considerable hard tissue breakdown. From the periodontal perspective, an additional significant advantage of bonded porcelain restorations is the avoidance of crown lengthening procedures because even very short clinical crowns can be restored (**Figure 2**).

Figure 2a.

Figure 2b.

Figure 2c.

Figure 2d.

Figure 2e.

Figure 2. Typical case of extreme fracture for indication Type IIIA (**2a**). Teeth are vital, and because of adequate treatment planning (additive wax-up technique), only a thin layer of the existing enamel was removed during tooth preparation (**2b**). Feldspathic porcelain restorations were fabricated with a refractory die technique using a significant core of opaque dentin covered with regular dentinoenamel porcelains (**2c**). Note the use of an opaque dentin build up, which proves essential in blending the unsupported porcelain edge with the remaining cervical part of the restoration. Clinical view after 10 years of successful service (**2d**). Note the excellent periodontal response, as well as the absence of detectable wear of the antagonistic dentition despite the restoration of significant guidance. The patient slightly overbleached the aging intact dentition using bleaching strips from her own initiative in order to maintain this result. There are some stains on the palatal surface (mainly on enamel), but no infiltration and no detectable decay (**2e**). Figures 2a and 2b, reprinted with permission from *Int J Periodontics Restorative Dent* 20(5):440-57, 2000.

Figure 3a.

Figure 3b.

Figure 3. Other case with similar approach as in **Figure 2**. The incisal edge span of porcelain in the mesial part of No. 8 is more than 5 mm (**3a**). Note the outstanding integration of the two bonded porcelain restorations even after eight years of clinical service (**3b**).

Further, the overall behavior of Type IIIA bonded porcelain restorations can be most predictable when adequate treatment planning is carried out. In this regard, high success rates in restoration survival and the patient's satisfaction are also certainly due to the use of additive wax-ups, silicon guides and corresponding diagnostic templates (acrylic mock-ups).[26,27] These strategic elements facilitate three significant steps of the procedure: (1) maximum respect of the patient's desire in the definition of the final functional and esthetic goal; (2) maximum respect of the remaining thickness of enamel during tooth preparation; and (3) restoration of the original enamel thickness and biomimetic recovery of the crown (see next section).

Considerations About Strength

In the veneer technique, the use of porcelain, instead of composite resins is instrumental in the way patients perceive the treatment as demonstrated in a clinical study by Meijering et al.[4] Additionally, porcelain also acts as the most "biomimetic" material when it comes to the replacement of significant amounts of tooth substance, perhaps because of its ability to simulate and restore crown rigidity.[28,29] Owing to their high thermal expansion and elasticity (dentin-like elastic modulus of 10-20 GPa), composite veneers are not able to achieve such goal, which seems to yield unfavorable esthetics, unstable

marginal integrity and decreased survival rate.[30-33] On the other hand, even traditional porcelains such as basic feldspathic materials (enamel-like elastic modulus around 70GPa), are able to compensate for structural tooth weakness. When used in the form of bonded veneers, they can contribute to the recovery of crown biomechanics, including nonvital incisors.[29] When pulpless teeth are treated with traditional prosthodontic procedures (instead of the more conservative veneering techniques), various types of dowels and cores are commonly recommended. This in turn may generate numerous complications, such as cracks and root fractures. It is now established that both the biomechanical properties and the moisture content of nonvital teeth do not differ significantly from those of vital teeth.[34,35] The loss of tooth structure thus becomes the primary cause of failure, not the effect of pulp removal per se. Except in cases of endodontically treated teeth with total breakdown of coronal tooth substance, there is currently no evidence that contraindicates veneering nonvital teeth with Type IIIA bonded porcelain restorations.

The extensive incisal edge span of the ceramic material represents the main challenge of Type IIIA indications. Wall et al. demonstrated that up to 2 mm of incisal edge span of ceramic could be created on lower incisors without affecting the ultimate coronal strength.[36] Andreasen et al. may have been the first authors to advocate the treatment of crown-fractured incisors with bonded porcelain restorations in the early 1990s using Dicor porcelain.[10] This in vitro investigation surprisingly claimed ultimate coronal strengths of restored teeth far exceeding that of intact teeth. This conclusion might be more accurate today considering the progress of dentin adhesives and new application modes (see section "Bonding Strategy").[28] It was clearly demonstrated that the potency of the concept lies in the design of the restoration, which is explained through favorable load configuration, geometry and tissue arrangement of upper incisors.[17,37] As a consequence, coronal strength has proven to be sufficient even when using feldspathic bonded porcelain restorations with extensive incisal edge spans of porcelain. Clinical data are supportive because no clinically relevant alterations have been detected up to 5.5 mm of average freestanding feldspathic material.[24] When compared to intact teeth, bonded porcelain restoration-restored crowns featuring extensive incisal edge spans of ceramics are characterized by their "low-stress" design and increased crown stiffness.[23]

It is now established that both the biomechanical properties and the moisture content of nonvital teeth do not differ significantly from those of vital teeth.

Tooth Preparation

Tooth preparations principles for Type IIIA bonded porcelain restorations do not differ much from those applied in traditional veneer preparations. The adhesive properties and physicochemical characteristics of the luting composites allow the tooth restoration interface to be subjected to substantial stresses. From this viewpoint, the geometric and mechanical parameters of the tooth preparation are of secondary importance. A minimum amount of preparation geometry however, is still required to facilitate placement and positioning of the ceramic workpiece during the final bonding procedure. In the cervical and proximal areas, the creation of a light chamfer margin without internal line angles is universally accepted. A new simplified porcelain laminate preparation driven by an acrylic mock-up was developed and can be applied to the remaining facial cervical third of the fractured tooth.[27] In all cases, an additive diagnostic waxup restoring the original volume of the tooth is used as a reference for tooth reduction. This basic principle will save a significant amount of sound tissue, not only enamel, but also the critical dentinoenamel junction.[26] It is essential to produce preparations without sharp angles, considering that the improved quality of both the preparations (sufficient clearance for the ceramic, smooth contours, absence of undercut) and the final impressions will significantly facilitate the work of the dental ceramist, leading to minimal use of die spacer and thus reducing the risk of postbonding cracks.[19,21,38]

The dilemma of Type IIIA bonded porcelain restorations lies in the fact that the palatal finish line is often localized in palatal fossa, which constitutes a zone of maximum tensile stresses.[37] In this context, the extent of tooth substance loss must be considered because it will significantly influence the location of the palatal finish line. Different patterns of stress are expected on the palatal margin of the veneer depending on the original level of the fracture line (e.g., moderate fracture through the palatal concavity versus extensive fracture through the tubercule of the cingulum).[17] In moderate fractures (incisal 1/3), a palatal mini-chamfer is contraindicated as it would extend the restoration margin in an area of high stress. In such a case, a butt margin limits the extension of the ceramic, thus reducing the amount of stress at the restoration interface and increasing the strength of the tooth restoration complex.[17,39] The use of a butt margin also provides the

margin of the restoration with a strong bulk of porcelain, instead of creating a thin marginal extension of ceramic as with a palatal chamfer. For severe crown fracture (incisal 2/3), the palatal margins are subjected to low tensile forces because they are located in the low stress area of the cingulum. The latter, with its smooth convexity, can be combined either with a butt margin or a mini-chamfer without generating harmful stresses.[17]

Bonding Strategy

Type IIIA bonded porcelain restorations can be placed according to the exact same protocol used for traditional porcelain veneers.[40] Conditioning of the tooth surface is generally limited to a 30-second etching procedure with 37 percent phosphoric acid if the prepared surface is essentially located within the thickness of enamel.

However, if a considerable area of dentin has been exposed during tooth preparation, it is suggested a dentin adhesive be applied strictly according to the manufacturer's instructions. The clinical significance of successful dentin bonding is particularly strong in the case of indirect bonded porcelain restorations, e.g. inlays, onlays and veneers, because the final strength of the tooth restoration complex is highly dependent on adhesive procedures. Long-term clinical trials by Dumfahrt and Friedman showed that porcelain veneers partially bonded to dentin have an increased risk of failure.[41,25] Recent advances in the knowledge database for dentin bonding agent application suggest these failures can likely be prevented by changing the application procedure of the dentin bonding agent. In fact, there are basic principles to be respected during the clinical procedure of dentin-resin hybridization, the most important of which are related to problem of dentin contamination and susceptibility of the hybrid layer to collapse until it is polymerized. These essential elements when considered within the frame of indirect bonded restorations, especially bonded porcelain restorations, lead to the conclusion that dentin should be sealed immediately after tooth preparation, the so-called immediate dentin

Figure 4a.

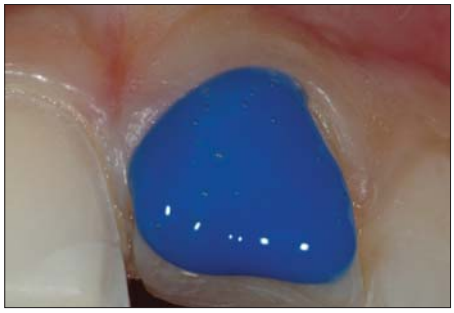

Figure 4b.

Figure 4c.

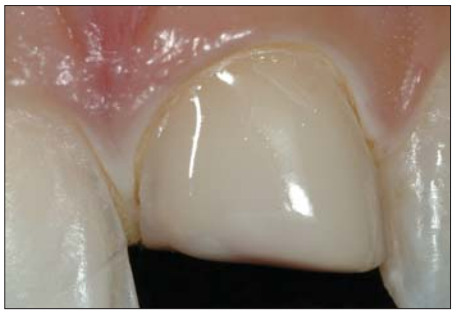

Figure 4d.

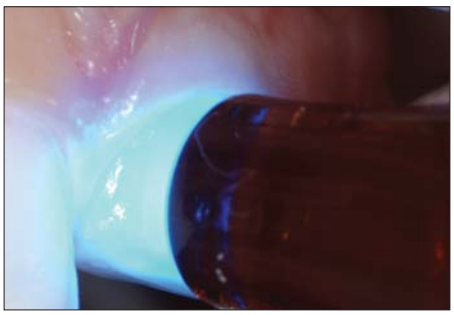

Figure 4e.

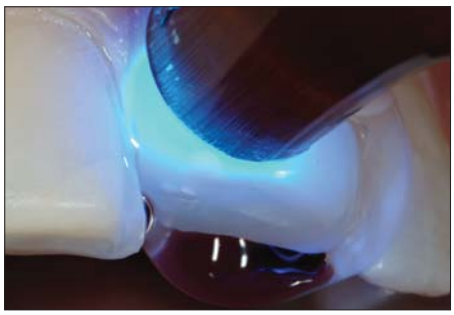

Figure 4f.

Figure 4g.

Figure 4. Clinical situation after preparation of teeth Nos. 8 and 9. Extreme prominence of tooth No. 9 led to a significant exposure of dentin at the facial axial level of the preparation. Margins are still located in enamel. The exposed dentin surface is decontaminated by roughening with a diamond bur (**4a**), then immediately etched for five to 15 seconds, depending on the adhesive system used. It is recommended to extend etching 1 to 2 mm over remaining enamel to assure further adhesion of eventual excess resin (**4b**). Following abundant rinsing, excess water is suctioned and the priming agent (hydrophilic monomer, e.g. Bottle 1 in Optibond FL) is applied to dentin with a gentle brushing motion for 30 seconds (**4c**). Several applications of fresh primer are recommended. The dentin surface is suctioned again to eliminate the solvent (e.g. alcohol in the case of Optibond FL primer) from the priming solution. One coat of adhesive (Bottle 2 in Optibond FL) is then applied, left to diffuse for 20 seconds (**4d**) and cured, first for 20 seconds (**4e**). A thick layer of glycerin jelly is applied to the sealed surface and beyond, and another 10 seconds of light curing is applied to polymerize the air-inhibited layer of the resin (**4f**). Glycerin can be easily removed by rinsing (**4g**) and impression can be carried out. Note the reattached fragment on tooth No. 8, which will be supplemented by the veneer restoration.

sealing (**Figure 4**), prior to impression taking.[42] Amongst the most reliable contemporary systems, OptiBond FL (Kerr, Orange, Calif.) is particularly indicated for immediate dentin sealing because of its ability to form a consistent and uniform layer and its cohesiveness with the final luting composite.[28] Although there is a tendency to simplify bonding procedures, recent data confirm that conventional three-step etch and rinse adhesives still perform most favorably and are most reliable in the long term.[43,44] Just prior to luting procedures (when placing the final restoration), the surface of the adhesive will be meticulously cleansed with pumice or microsandblasting. The entire tooth preparation surface then can be considered and conditioned as it would be done in the absence of dentin exposure: H_3PO_4 etch (30 seconds), rinse, dry and coat with adhesive resin.

There are several rational motives and other practical and technical reasons supporting immediate dentin sealing: Freshly cut dentin is the ideal substrate for dentin bonding.[45-47] Significant reductions in bond strength can occur when simulating dentin contamination with various provisional cements compared to freshly cut dentin. In practice, freshly cut dentin is present only at the time of tooth preparation (before impression).

Precuring of the dentin bonding agent leads to improved bond strength.[48,49] Applying and curing the dentin bonding agent immediately before the insertion of an indirect composite or porcelain restoration could interfere with the complete seating of the restoration. Eventual dentin exposures are therefore sealed immediately, the dentin bonding agent is applied and cured directly after the completion of tooth preparations, before the final impression itself, which was confirmed to generate superior bond strength and less gap formation.[50,51,28,52]

Immediate dentin sealing allows stress-free dentin bond development: Dentin bond strength develops progressively over time. In directly placed adhesive restorations, the weaker early dentin bonding is immediately challenged by the overlaying composite shrinkage and subsequent occlusal forces. On the other hand, when using immediate dentin sealing and indirect bonded restorations, because of the delayed placement of the restoration (intrinsic to indirect techniques) and postponed occlusal loading, the dentin bond can develop without stress, resulting in significantly improved restoration adaptation.[53]

Immediate dentin sealing protects dentin against bacterial leakage and sensitivity during provisionalization.[54-55]

Tooth preparations must be rigorously isolated with a separating medium (e.g., a thick layer of petroleum jelly) during fabrication of the provisional restoration. It is strongly suggested to avoid resin-based provisional cements, but provide mechanical retention and stabilization instead (e.g. locking the restoration through additions of liquid resin in palatal embrasures).

Figure 5a.

Figure 5b.

Figure 5c.

Figure 5d.

Figure 5. Comprehensive case of bonded porcelain restorations including a Type IIIA on tooth No. 9. All of the layering will be performed on a so-called soft tissue cast. Refractory dies have already been dehydrated, coated with the connecting porcelain, and fired (**5a**). The first bake will generate an opaque dentin core on the fractured tooth (**5b**). It is followed by the application of a core of regular dentins and more translucent incisal enamels. An inner translucent enamel skin covers this buildup (**5c**), and then the second bake can be carried out. A slight cutback should allow the application of superficial enamel stains followed by a low-temperature fixation bake. The final volume of the restoration can be accurately obtained through the application of a thin enamel skin (**5d**) and its subsequent firing. Glazing and mechanical polishing are then combined to obtain the final surface texture and gloss. The refractory material is removed by microsandblasting only after completion of surface finishing procedures.

Laboratory Recommendations

From the dental laboratory perspective, it is recommended to fabricate Type IIIA bonded porcelain restorations on refractory dies technique or using a foil technique. Ceramic fired over refractory die is the oldest and most widespread method for fabricating a porcelain piece.[56] Model making can be tedious because multiple dies are required (single dies, refractory dies, soft tissue model). The main advantages of this technique, however, lie in the fact that (1) no special equipment is required, (2) extremely sophisticated effects of color and translucency can be obtained through a full-thickness layering technique, and (3) traditional feldspathic porcelains can be used; and when combined with hydrofluoric acid etching and silanization, these porcelains demonstrate extremely reliable bonding to resins (see next section).[57]

From an esthetic standpoint, the refractory die technique will enable the use of modified opaque dentin as a core buildup during initial layering (**Figures 2c**, **5**). Type IIIA bonded porcelain restorations are characterized by lack of sufficient supporting natural dentin, which must be compensated by a special buildup of opaque dentin that reproduces a similar outline for all preparations (**Figure 5b**). The absence of opaque dentin would result in increased light absorption at the level of the missing natural dentin. Once the core dentin fired, the elaboration will continue with two consecutive firings: the dentinoe-

namel core firing (**Figure 5c**); and the "enamel skin" firing (**Figure 5d**). The final steps will be a glazing bake followed by mechanical polishing and deinvesting by microsandblasting with glass beads.

It is strongly recommended to avoid etching the restorations in the laboratory before the try-in. Etched porcelain is extremely sensitive to contamination. Clinical try-in procedures generally include verification of the marginal fit of the restoration and seating on the original stone dies as well as proximal contacts on a solid model. These procedures can generate significant die stone contamination and subsequent bond strength reduction.[58] Unlike saliva contamination, die stone contamination is not easily cleansable. In any case, one must avoid contact between the etched/ silanated porcelain veneers and stone models or tooth surfaces. Both porcelain and tooth surface conditioning should therefore be systematically carried out after try-in, not before.[57]

Bonding to Porcelain

Bonding to feldspathic porcelain can be achieved through etching (10 percent hydrofluoric acid gel during 90 seconds, followed by abundant rinsing) and cleaning. Cleaning the etched porcelain is a critical factor. During the etching process, dissolution of the glassy matrix ultimately leaves retentive holes and tunnels between the acid-resistant crystals. During rinsing, this extremely rough surface is immediately contaminated by ceramic residues and remineralized salts, leaving a typical whitish residue[59] (**Figure 6a**). The whitish area is often misinterpreted as a positive etching outcome. Ultrasonic cleaning, which can be preceded by phosphoric acid precleaning (**Figure 6b**), is essential to remove the residues, enlarging and enhancing access to the microretentive features.[60] Energy dispersive spectroscopy analyses have shown that the crystalline precipitates on the etched surfaces, which are not readily soluble in water, are the reaction products of sodium, potassium, calcium, and aluminum. The precipitates remain on the surface after HF acid application; they can be removed only by ultrasonic cleaning (**Figures 6c, 6d**), not by rinsing alone.[61]

The micromechanical bond generated through etching and cleaning can be enhanced by chemical coupling, i.e. silanization. Silane solutions contain a significant amount of solvent and must be evaporated for at least five minutes at room temperature (or one minute in a dry furnace at 100 degrees Celsius). This procedure allows the elimination of solvents and other contaminants and enhances the condensation of the silane on the ceramic surface.[57] That specific thermal treatment can also be carried out using a hair dryer.

Practitioners must be extremely prudent when conditioning other types of ceramics. They must be aware that the tensile fracture resistance of the composite-ceramic adhesion zones is controlled primarily by ceramic microstructure and ceramic surface treatment. Procedures that apply to traditional feldspathic porcelain might not apply to other materials, e.g. some pressed ceramics or alumina ceramics.[62,63]

Final Considerations About Function

A concern might be raised through the combination of large incisal edge of porcelain and anterior guidance requirements. There seems to be an association between the absence of anterior guidance (i.e. open bite) and temporomandibular disorders.[64] A key element in the development of harmonious occlusion is therefore by the incisal guidance the steepness of which is not important for neuromuscular harmony.[65,66] To minimize stresses during protrusive movements, some clinicians reduce the length of an esthetically correct tooth. This disastrous approach results in a reverse smile line and ages the patient many years.[66] As proven by clinical results, there should be no fear to rejuvenate the patient's smile by increasing the central incisors' prominence and length because ideal occlusion refers both to an esthetic and physiologic ideal.[24,65,67] Another reason to avoid distributing the anterior guidance over a maximum number of teeth, is the favorable mechanical behavior of bonded porcelain restorations discussed previously. In conclusion, the functional features of teeth restored by bonded porcelain restorations Type IIIA can be identical to those of intact natural teeth. Particular emphasis must be addressed to the maintenance or re-establishment of an adequate and functional anterior guidance regardless of whether this guidance involves the new restorations.

Conclusions

Considerable advantages, such as the economical and noninvasive treatment of crown-fractured anterior teeth, are inborn to Type IIIA bonded porcelain restorations, reducing the need for preprosthetic interventions (e.g. root canal therapy and crown lengthening), and the use of intraradicular dowels. The success of the concept lies in the combination of sound adhesive principles, adequate design of the restoration and favorable load configuration, geometry, and tissue arrangement inherent to incisors. Immediate dentin sealing is recommended in case of significant dentin exposure. In the laboratory, the refractory die technique allows the development of a progressive translucency that enhances the blending of the incisal part of the restoration with the remaining cervical aspect of the fractured tooth. Adhesion strength to the feldspathic porcelain can be optimized through specific postetching cleaning and silanization. Given the aforementioned adhesion principles and biomechanical facts, the functional features of teeth restored by bonded porcelain restorations Type IIIA can be identical to those of intact natural teeth. CDA

Figure 6a.

Figure 6b.

Figure 6c.

Figure 6d.

Figure 6. Internal view of bonded porcelain restorations after the ceramic has been etched with 10 percent hydrofluoric acid for 90 seconds and rinsed. Even abundant rinsing proves insufficient to clean the porcelain, which is often contaminated by a white residue or deposit (**6a**). The latter can be selectively removed with a brush and phosphoric acid (**6b**), followed by placing the restorations in an ultrasonic bath in distilled water for a few minutes (**6c**). The etched surface is now clean and ready for the application of the silane and subsequent heat treatment (**6d**).

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A Technique for Fabricating Modern Athletic Mouthguards

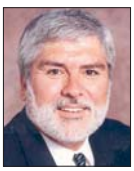
Ray R. Padilla, DDS

Abstract

The prevention and treatment of orofacial trauma is now a very important part of the general practice.[1,2] Children as well as adults are participating more in events where the probability of trauma is apparent. Attendance at health clubs and gymnasiums is on the rise. With the increase in sports participation comes an increase in orofacial injuries.[3] The general population is taking its health more seriously. Athletic participation is on the rise, and Title IX[4] has introduced increased female participation at all levels. This only increases the possibility that our patients will present themselves in our offices with the need for trauma treatment and also our opinions on the methods of preventing such traumatic experiences.[5]

The field of sports and trauma dentistry has come a long way in recent years. Dentistry is now represented on various medical commissions and organizations as a viable component of the total package of prevention and treatment of orofacial injuries. Internationally, dentistry is represented on the International Olympic Committee's Medical Commission and the International Ice Hockey Federation Medical Commission. In 1998, the International Society for Dentistry, Sport and Trauma was introduced as the need for international trauma dentists increased. In the United States, the Academy for Sports Dentistry was continuing to grow and provide insight on trauma treatment and prevention.

The general dentist is now being asked by their patients for their opinions on prevention of athletic injuries. In the past, patients would feel comfortable going to the local sporting goods stores to obtain mouth/dental guard protection. This is no longer the case. As the population becomes more and more educated on injury prevention and the



Guest Editor / Ray R. Padilla, DDS, has practiced in the East San Gabriel Valley for more than 20 years. He has worked with athletes in both the professional and amateur levels as a dentist for the Los Angeles Galaxy soccer team, Los Angeles Avengers Football team, UCLA Athletics, and as a consultant for the U.S. National Soccer Team.

availability of proven methods of prevention, the general dentist will be called on to provide a more viable responsible solution for orofacial trauma prevention. The medical/dental literature now provides many references for the probability and treatment of trauma.[6-12]

The numbers, incidences and severance of trauma leads us to contemplate ways of preventing such injuries. Presently, the use and acceptance of preventive mouthguards is gaining on the general dentist's list of priorities. More general dentists are now providing custom-made mouthguards to their patients. However, there are still a significant number of dentists who do not provide this service to their regular patients. Dentist's knowledge and attitudes toward providing protective mouthguards is well documented. Parental perceptions of mouthguards is an important issue that dentists needs to identify and manage.[13,14] Overcoming objections of cost, custom-made vs. store-bought, vacuum vs. pressure, and availability is critical to the education of dentists, staff and patients.[15] Patient education is essential to the success of trauma prevention. The dental hygienist here may play a critical role in this education during routine periodontal treatment.[16]

There are basically three types of athletic mouthguards presently available, all significantly different in fit, comfort and acceptance. Type I is the stock mouthguard available at sporting goods stores. These are the least desirable and acceptable. There is no attempt at fit. Remove from package and place in mouth. Type II refers to the common boil and bite mouthguard. These are also mostly of the store-bought variety and some attempt at fit is made by boiling the mouthguard and trying to mold it to the teeth. The instability and uneven distribution of material does not lend themselves to proper fit and protection. In a study by Dr. Andrew Greasley on the difference between various types of mouthguards, the custom-made mouthguards all performed better than the "boil and bite type which afforded only slightly more protection than no mouthguard at all."[17] Chapman and McNutt reported many occurrences of injuries while wearing the over the counter Types I and II variety of mouthguards.[18,19] In literature reviews by the author, there were no published data and support found for stock and boil and bite mouthguards after 1980. The literature makes it very clear that only custom-made mouthguards should be offered to patients.

The literature cites occurrences of injuries while wearing noncustom-made mouthguards.

Chapman in 1991 reported as high as 36 percent of the athletes who wore mouthguards while playing at the Second

Figure 1a. Old conventional vacuum internal adaptation.

Figure 1b. Pressure internal adaptation.

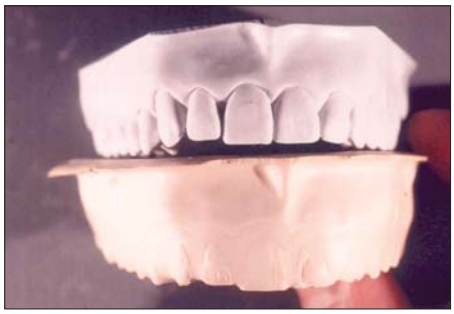


Figure 1c. Original and vacuum model.

Figure 1d. Original and pressure model.

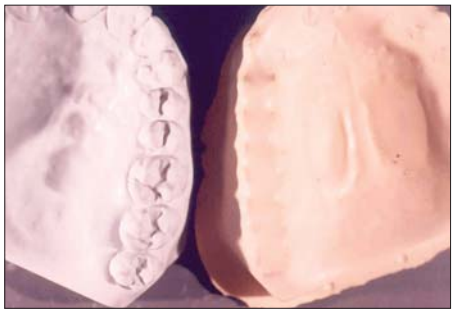


Figure 1e. Original and vacuum model.

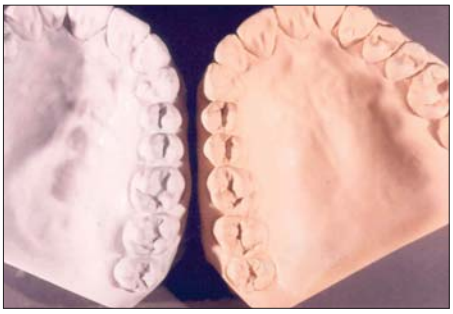


Figure 1f. Original and pressure model.

Figure 2a. Impression setup.

Figure 2b. Light body application to teeth.

Figure 2c. Light body application to vestibular areas.

Figure 2d. Heavy body seat with tray.

Figure 2e. Accu-Dent final impression.

Figure 3. Die stone model.

Rugby World Cup, sustained some type of orofacial injury.[20] McNutt in 1989 reported that of the 1,470 surveyed American Football players, 52 athletes were injured wearing mouthguards, and 53 were injured without a mouthguard. The injury rate is the same for those wearing mouthguards and those who were not wearing mouthguards. They were the same as wearing nothing.[21]

There are two types of Type III custom-made mouthguards presently available, those made with vacuum machines and those made by pressure machines. The difference between the old conventional vacuum machines and the new vacuum and pressure machines are significant and should be addressed. The internal adaptation difference is noteworthy due to the amount of heat and pressure/suction variances in each machine. While contemplating purchasing these machines, the internal adaptation for fit should be the prime focus of attention. A mouthguard will not be as protective if it does not fit properly. The better the fit, the better the protection, acceptance, and compliance.

Figures 1a-f. Note the difference in internal adaptation when comparing the old conventional vacuum machine to the newer pressure or vacuum machines. One can easily see the adaptation from their machine by making a mold from a 3 mm sheet of ethylene vinyl acetate material. Take out the original model and pour stone into the ethylene vinyl acetate material. The result will show you the adaptation of your machine. From there, decisions can be made on purchasing the newer varieties of vacuum machines or investing in the state of the art pressure machines.

The role of the dentist in trauma prevention is patient education, diagnosis and designing custom-made mouthguards, then choosing whether to fabricate them in office or send them to qualified laboratories. Minimum thicknesses and extensions are critical for trauma prevention. The suggested minimal thicknesses are labially 3 mm, palatal 2 mm, and occlusally 3 mm.[22] The mouthguards are designed according to the sport played, age of the athlete, and past history of trauma. The material of choice is ethylene vinyl acetate with a shore hardness of 80.

There are four parts to the fabrication of custom made mouthguards.

- Impression
- Fabrication
- Trimming and polishing
- Placement and occlusal equilibration

Figures 2a-e. The impression is critical to the end result. Similar to any restorative procedure requiring an impression; the better the impression, the better the appliance. It has been the author's experience that an excellent

Figure 4a. Vestibular margin outline.

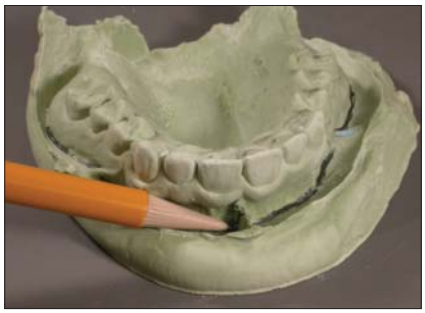


Figure 4b. Vestibular margin outline.

Figure 4c. Model trimming to vestibular margins.

Figure 4d. Model trimming maintaining vestibular borders.

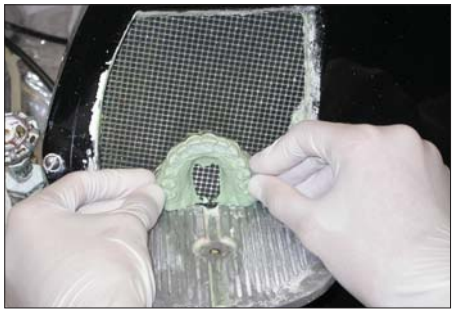


Figure 4e. Model trimming maintaining vestibular borders.

Figure 5. Soak model in ortho model soap.

Figure 6a. Drufomat

Figure 6b. Erkopress

Figure 6c. Biostar

method for impressions for mouthguard appliances is the Accu-Dent System II. The Accu-Dent multicolloid impression systems eliminate the need for custom-impression trays, allowing you to create master casts in a more efficient and profitable manner. The impression gels are formulated in two viscosities, a light-bodied syringe gel that captures soft tissues and a heavy body tray gel for hard tissue. Ideal for athletic custom-made mouthguards, the Accu-Dent System II can also be used for partials, immediate dentures, orthodontics, and splints. The light-bodied syringe gel is applied with a special tip to capture detail while eliminating air bubbles.

Figure 3. Once the impression has been taken, immediate pour-up with a hard die stone is recommended. Care is taken to capture all vestibular borders. A large base is not necessary as it will be taken off while trimming the model.

Figures 4a-e. After the model has become hard and set, usually about 45 minutes, mark the highest margins of the vestibular border with a pencil for reference during trimming. At the model trimmer, remove the excess stone carefully to these borders. By including these vestibular borders, the mouthguard will have more retention due to increased surface adaptation and will also help protect the alveolar bone for further protection from trauma.[23]

Figure 7a.

Figure 7b.

Figures 7a and b. A sheet of ethylene vinyl acetate is placed in disc positioning ring. A trimmed model is placed slightly off center toward the lingual.

Figure 8. A clamping ring locks sheet into place.

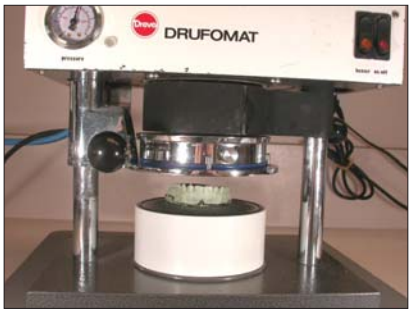


Figure 9a.

Figure 9b.

Figure 10.

Figures 9a, b and 10. Heater is used to obtain formable consistency.

Figure 11. Pressure is used on the first layer and timing is crucial to maintain pressure.

Figure 12. A proper cool-down period prevents distortion.

Figure 5a. Once the model has been properly trimmed and dry, it must be lubricated to allow easy separation after fabrication. The author's lubricant of choice is orthodontic model soap. Soak the model in the soap for approximately one hour, then dry and polish with a dry towel. The model is now lubricated for the life of the model.

The model is now ready for the fabrication of the mouthguard. This method of bilamination by thermopressure was previously described in 1999.[24] There have been a few changes and additions to the fabrication process.

Figures 6a-c. Note this process is not (suck down) vacuum. It is positive pressure. There are presently three pressure machines available for this process, and all must be connected to a compressor for air pressure. They are the Drufomat by Dreve (Unna, Germany, distributed by Raintree Essix, LLC, Metairie, La.,); the Erkopress by Erkodent, (Pfalzgrafenweiler, Germany, distributed by Glidewell Laboratories, Newport Beach, Calif.,) and the Biostar by Scheu Dental, (Iserlohn, Germany, distributed by Great Lakes Orthodontics, Ltd., Tonawanda, N.Y.). For the purposes of this paper, the Drufomat will be used.

A 3 mm to 4 mm mouthguard will be made. Two layers of 3 mm ethylene vinyl acetate will be laminated together. It is important that this process be done in two separate steps to allow for proper thickness in the incisal and occlusal surfaces. If done in only one step, the thickness in these critical incisal and occlusal areas will be compromised.[25] There is approximately 30 percent to 40

Figure 13a.

Figure 13b.

Figures 13a and b. Releasing the pressure in the chamber.

Figure 14. First layer is complete.

Figure 15a.

Figure 15b.

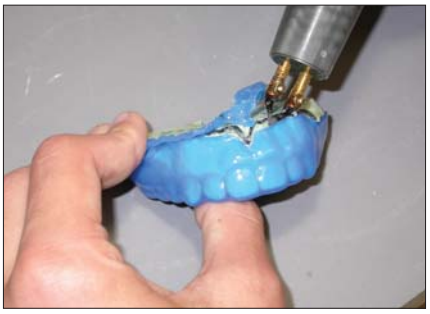


Figure 15c.

Figures 15a-c. Trimming the excess, using a hot knife, may begin once the material has cooled.

percent shrinkage of ethylene vinyl acetate material during fabrication, so two 3 mm sheets laminated together will form a 3 mm to 4 mm mouthguard.

Figures 7a-b. After the heater switch and machine power is turned on, a 3 mm sheet of ethylene vinyl acetate is placed in the disc positioning ring. The trimmed model with marked extensions is placed on the tray table slightly off center toward the lingual.

Figure 8a. The clamping ring is placed over the ethylene vinyl acetate sheet to lock it into position.

Figures 9a-b. The heater is placed into position over the model allowing the ethylene vinyl acetate material to heat and soften to formable consistency.

Figure 10. As the ethylene vinyl acetate material softens, it will begin to slump until it is touching the model. At this stage, the first layer is ready to be thermoformed by pressure.

Figure 11. On the upper left side of the Drufomat is a white button that activates the pressure. This button must be pressed at the same time the heater is removed from the ethylene vinyl acetate material. The pressure chamber will drop over the model and thermoform and pressurize the ethylene vinyl acetate to the model. A light will illuminate signaling the thermoprocess has begun and the hands can be removed from the machine. If the hands are removed prior to the light activation, the pressure will not be maintained.

Figure 12. The ethylene vinyl acetate material must now cool for a minimum of 10 to 15 minutes. The ethylene vinyl acetate material should not be manipulated and removed from the pressure chamber until it has completely cooled to prevent any distortion.

Figures 13a-b. Once the time has elapsed, the white button is depressed until the pressure indicator light shuts off releasing the pressure in the chamber. The heater lever is slowly pushed toward the cylinder. The pressure cylinder will rise.

Figure 14. The first layer is complete. It may be removed from the disc positioning ring and allowed to cool to room temperature before trimming to prevent distortion.

Figures 15a-c. Once the ethylene vinyl acetate material has cooled, excess material may be trimmed off using a hot knife. Care should be taken not to trim excessively. The lingual borders are trimmed 1 mm from the teeth, and the labial borders follow the penciled mucosal borders. The distal of the first molar is the minimal extension.

Figures 16a-d. The first layer is now ready for identification labels and logos. Any label machine may be used as long as it provides a small font (10 point maximum).

Figures 17a-c. The mouthguard is now ready for the second layer which will be laminated. A clear sheet of ethylene vinyl acetate of desired thickness (in this case, 3 mm) is placed in the disc positioning ring. The model with the first trimmed and labeled layer is placed on the positioning tray slightly off center toward the lingual. At this point, steps 8 through 13 (**Figures 8a-13**) are repeated. The clear second layer begins to melt to the desired formable consistency. It is very critical the second layer be allowed to become hot enough to predictably laminate to the first layer. It must heavily droop over the first layer. If not allowed to heat sufficiently, complete lamination will not occur and separation will take place in time. The pressure chamber is activated as in step 11 (**Figure 11**), and the model allowed to cool under pressure for 15 minutes. Steps 12-16 (**Figures 12-16**) are repeated.

Figure 18. The clamping ring is removed and the laminated mouthguard is allowed to cool to room temperature to eliminate any chance of distortion, thereby ensuring a perfect tight fit.

Figures 19a-b. The second layer excess ethylene vinyl acetate material is trimmed to proper extensions as in steps 15-16 (**Figures 15-16**).

Figure 20. The internal lingual extensions should be checked and marked with a pen to 1 mm from the teeth.

Figure 16a.

Figure 16b.

Figure 16c.

Figure 16d.

Figures 16a-c. First layer is ready for identification labels. A small font, 10 point maximum, is recommended.

Figures 21a-b. With a Dedico stone acrylic bur, the excess material is trimmed lingually to the marked extensions. The mouthguard is then placed back on the model and the margins are feather finished for comfort lingually, bucally, and labially. Any interferences with muscle attachments should be removed. It is key to finish and thin the lingual extensions to provide comfort and ease in speaking. The lingual area should not remain bulky.

Figures 22a-c. With Essix Scotch wheels, the mouthguard is further trimmed and smoothed to desired thickness. All frenum attachments are relieved with a lisco disc.

Figure 23. Final finish and polish is

Figure 17a.

Figure 17b.

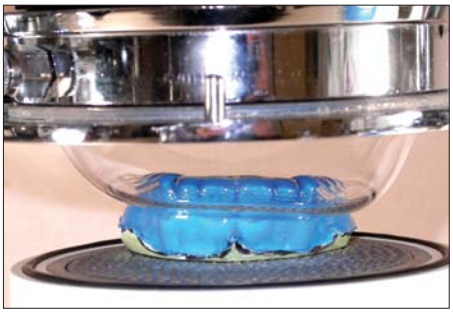


Figure 17c.

Figures 17a-c. The mouthguard is ready for a second layer.

Figure 18. With the clamping ring removed, the laminated mouthguard is cooled to room temperature.

Figure 19a.

Figure 19b.

Figures 19a and b. Trimming the excess from the second layer.

Figure 20. Internal lingual extensions should be checked and marked.

Figure 21a. Using a stone bur, excess is trimmed.

Figure 21b. Final trimming with a Scotch wheel.

Figure 22a.

Figure 22b.

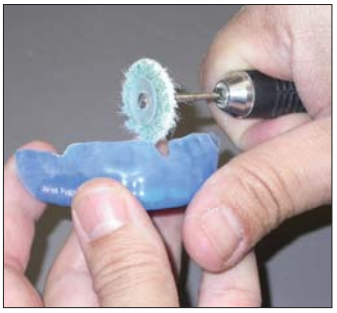


Figure 22c. Trimming frenum muscle attachments.

Figures 22a and b. Final trimming with a Scotch wheel.

Figure 23. Finish and polish is placed with wax remover.

placed with wax remover.

Figures 24a-d. The 4 mm custom-made pressure laminated mouthguard is now completed.

Figures 25a-d. It is now important to try the mouthguard in the patient's mouth and check for fit and comfort. Minimal adjusting may be necessary just as any other dental appliance insertion appointment. It is extremely important that a balanced occlusion be present. This is done by slightly warming the posterior occlusal surface of the mouthguard, taking extreme care not to overheat and distort, and placing the mouthguard in the patient's mouth and asking them to bite down very lightly and carefully until all posterior teeth occlude. Care should be taken not to bite down excessively as the occlusal separation of 3 mm to 4 mm must be maintained to ensure proper absorption of impact energy.

Figure 24a.

Figure 24b.

Figure 24c.

Figure 24d.

Figures 24a-d. Completion of the custom-made, pressure-laminated mouthguard.

Figure 25a.

Figure 25b.

Figure 25c.

Figure 25d.

Figures 25a-d. Minimal adjustments are needed to ensure fit and comfort.

Conclusion

The pressure-laminated mouthguard continues to be the mouthguard of choice and acceptance for athletes of all levels. The precise fit lends to an increased compliance and reduction of injuries. Athletes who have not been able to wear over-the-counter mouthguards in the past due to poor fit, bulkiness, and lack of retention are more prone to wear a mouthguard that is comfortable, non-bulky, and tight fitting. CDA

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Emergency Trauma: Treating the Unexpected

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Abstract

Patients expect their dentist to be capable of priority management of their dental injury. However, unless a dentist regularly attends emergency calls at a hospital or clinic, he or she may be "rusty" when faced with the unexpected arrival of an injured, upset patient. The dentist must deal with the schedule disruption, prioritize treatment or referral, deal with informed consent for minors and adults, and sort out contradictory treatment protocols that are often out of date and inconsistent with scientific evidence.

Most dentists keep themselves and their staff current on a wide variety of techniques and issues but may not have reviewed management of dental injuries for years. Nevertheless, patients expect dentists to be able to manage dental injuries efficiently and correctly. Even dentists who have predominantly adult practices can be faced with the injured grandchild of one of their best patients. Their patient's continued trust is dependent upon management of an injury the dentist may not have seen for a decade.

Because bookings are often filled weeks in advance, an emergency phone call or the arrival of a bloodied, upset preadolescent in the reception area can disrupt an otherwise predictable day. This scenario presents problems of scheduling, unfamiliarity with the injury, knowledge gaps and consent issues. Unlike routine dentistry, trauma cases often involve third parties such as private insurance carriers or lawyers. Consequently, the dentist's treatment decisions and management is more apt to be scrutinized and records subpoenaed when dealing with trauma.

Time Management

Most cases of trauma can be managed within a half hour if some preplanning has taken place.[1] If the initial contact is by telephone, staff can quickly determine the age of the (new) patient so that the dentist will know if the injury is to primary or permanent teeth. This will save disrupting the schedule for the bumped primary incisor of a 5- to 7-year-old that was due to exfoliate naturally. Parents often interpret the crown of the erupting permanent incisor as a piece of "broken tooth" due to the presence of mamelons on the incisal edge. The dentist can easily deal with such cases immediately by telephone, save the parent a trip to the office, or fit the child in for an observation and documentation appointment at a later date.

When an injured patient arrives at a dental office, the dentist has a responsibility to treat or refer. Referral should be to another dentist, a pediatric dentist, or oral and maxillofacial surgeon who will agree to treat the case. Simple injuries can be dealt with by supplying telephone numbers and a follow-up call the next day. However, simply supplying telephone numbers and dismissing patients with severe dental injuries could be interpreted as abandonment even if they are not yet patients of record. Initial registration and history can be completed by an assistant/ hygienist while the dentist pro-

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ceeds with scheduled patients. If the dentist needs radiographs for diagnosis before making the referral decision, then a release of information form must be signed, and the radiographs and records given to the patient to take to the referral dentist. Dentists may wish to stock double film sets for such situations so that both parties have original radiographs.

Prior to initiating specific dental treatment, the dentist should determine whether the patient requires medical attention for shock, or possible aspiration of tooth fragments, and make a direct telephone referral to a hospital emergency or dental department and talk doctor-to-doctor. As soon as a verbal agreement to treat is completed, it should be documented in the patient's chart and include the name of the doctor spoken to and description of radiographs sent with the patient. While most trauma cases can be dealt with within a half hour, even the simple ones and referrals require so much documentation and scheduling/referring time that it is rare to complete them in less than 30 minutes.

Severe permanent tooth luxations or avulsions usually take an hour to complete pre- and postoperative care, reduce/replant, and splint. If the dentist chooses to treat such cases, staff may identify a patient further down the day list and reappoint them.

Treatment Priorities

It is essential the dentist understand what is "emergent" treatment and what aspects of treatment can be dealt with later the same day, the next day, or next week. Patients who are in pain, distress, or are bleeding deserve immediate attention. However, the precise effects of treatment delay on periodontal and pulp pathosis are not clear. It appears that if treatment of luxations or root fractures is completed within three hours, the outcomes are unlikely to be affected.[2] Similarly, chipped or fractured teeth, with or without pulp exposure, can be treated up to 48 hours after injury without demonstrable effects on long-term outcomes.[2,3] One other aspect of "emergent" care is understanding how much treatment is required at the emergency appointment and what can be postponed until a future, if only the next day, appointment. While it may be enjoyable to restore a crown fracture completely at the time the patient presents, it is possible to temporize the tooth with calcium hydroxide, glass ionomer cement and a resin bandage, and reappoint the patient to a more convenient time slot.[4,5]

Evidence shows that delayed replantation (greater than five minutes) will invariably lead to root resorption and eventual loss of the tooth regardless of storage medium.

Textbooks generally describe injuries on a tooth-by-tooth basis, but most often, patients present with multiple dentoalveolar injuries, sometimes accompanied by lacerations. Each clinician must decide whether to repair facial lacerations or refer such cases after stabilizing the dentition. Local anesthetic, analgesics, some Steristrips, a good cleaning and debridement go a long way toward making the patient more comfortable and reducing the anxiety of all in attendance. The dentist can then secure informed consent that includes radiographs, replantation, reduction of luxations, splinting, photographs and the patient's follow-up responsibilities.

Clinical Outcomes and Consent

The most important determinant of survival of an avulsed tooth is immediate replantation at the accident site.[6-9] Furthermore, evidence shows that delayed replantation (greater than five minutes) will invariably lead to root resorption and eventual loss of the tooth regardless of storage medium.[6] Likewise, if the pulp is not removed and endodontic treatment completed, survival will be compromised by the likelihood of inflammatory resorption and rapid tooth loss.[10,11] Immature incisors have less root mass, so root resorption is more significant and immature apices complicate conventional root canal treatment.[12] Apexification with calcium hydroxide and definitive root canal obturation is required for roots with immature apices. If apexification is not successful it will affect survival.[12] Finally, if replantation is undertaken in a preadolescent or a youth who has not completed growth, replacement resorption and ankylosis will lead to apparent submergence and distortion of the gingival architecture with vertical jaw growth.[13,14] Young adults who have completed their skeletal growth have longer postreplantation survival rates but the long-term outcome is the same, eventual tooth loss as a direct result of the avulsion.[6,10,12]

Once a tooth has been out of the mouth more than 15 minutes, chances of regeneration of periodontal ligament over the root surface approach impossibility.[7-9] Consequently, healing will proceed by repair mechanisms that include root resorption and ankylosis.[10] In turn, there is no longer a need for the dentist to rush to replantation so it is possible to complete a conventional root canal treatment extraorally.[15] Evidence from investigations of periodontal ligament injury, still not widely disseminated to clinicians, make it clear that beyond 15 minutes, the use of storage media to preserve cell "function" becomes irrelevant.[7-9] This evidence will force a major change in both thinking and teaching. In order for periodontal ligament fibroblasts to repopulate the root, the progenitor cells must be vital, able to reproduce and differentiate into functional fibroblasts that can attach to cementum. Outcome studies have shown that periodontal regeneration only occurs if the

tooth is replanted within five minutes, and even then the chances are about 50 percent and reduce to 30 percent beyond five minutes.[6,16] A functional periodontal ligament is not assured even with immediate replantation.

Although outcomes are predictably poor in cases of delayed replantation, a dentist may be at greater risk of complaints by not replanting a tooth even if the tooth has been out of the mouth for an extended period. The reason is that failure of a replanted incisor may not happen for a number of months or years, but conflicting opinions on the dentist's management of the case can come rapidly. In fact, unlike the survival experience of replantations in preadolescents, such teeth may last many years in patients who have mature roots and have achieved their full jaw growth (youth and adults).[17] This is the area where anecdotal information, probability and clinical experiences lead to conflicting opinions that may cause parents to lose confidence in the clinician who recommended against replantation. Another dentist may correctly tell the patient/parent that he or she replanted a tooth that lasted many years but imprudently suggest that if the patient/parent had come to him or her, the tooth could have been '"saved."[10,16,17] Parents who search the Internet for information find avulsion guidelines that explain how to replant a tooth but lack information on *whether* to replant. Obviously, this can lead to the parent's immediate loss of confidence in the original decision not to replant.

The outcomes of severe intrusions (>6 mm), though predictable, are not encouraging either. This means the dentist must make the patient/parent aware that even if a severe intrusion (>6 mm) is reduced the tooth will never be the same as it was before the accident and will eventually be lost.[18,19] This information is important to the patient/parent because, in the case of avulsions and severe intrusions of permanent teeth, the alternate choice is not to replant the avulsed tooth or immediate (surgical) reduction, or extraction of a severe intrusion.

Parents and children faced with the situation of delayed replantation or severe intrusion must be given accurate up-to-date information on the likely outcomes of injury management. Then, without coercion or clinician bias, they must be left to make their decision based on the evidence and their child's specific risk factors. This means that dentists must remain critical and active consumers of the dental literature and patients/parents may elect more often to have avulsed teeth left out of the mouth when faced with the costs and prognosis of replantation now that single tooth implants have demonstrated their reliability and the first-year costs of replantation exceed $1,000.[20]

Treatment Protocols/Guidelines

Guidelines for replantation of avulsed teeth have been written by a number of authors and organizations, including the American Academy of Endodontists (based on and licensed from) the International Association of Dental Traumatology, and the Royal College of Dental Surgeons of England.[21-23] All of these guidelines fail to address the evidence that unless a tooth is replanted immediately ankylosis, root resorption and eventual tooth loss is inevitable. In addition, informed consent based on outcomes, responsibilities and the question of whether or not it is in the patient's best interest to replant a tooth are not described. Guidelines for dealing with intrusions are less well disseminated despite the experience that severe intrusions are more lethal than avulsions.[18,19,23]

Frustrated by information missing from published guidelines and the importance of securing informed consent from minors' parents, the members of the Toronto Dental Trauma Research Group produced a series of matching handouts for each specific luxation injury geared for patients/parents and for clinicians. The parents' handout describes things that can cause a tooth to fail, what is known about the injury, responsibilities of the dentist and responsibilities of the patient/parent. The matching handout for the clinician adds the pertinent literature and the methods used to treat each injury and to determine outcomes. This information is not provided in any of the conventional guidelines. These documents, available in PDF form and revised annually, are available from The Hospital for Sick Children website, www.sickkids.ca/ dentistry/default.asp and click on "Resources." Clinician handouts are under "Clinician information"; "Trauma Info" and laypersons' handouts are under "Parents/Caregivers Information."

Conclusion

With the exception of hospital dental departments and emergency or sports-associated clinics, the arrival of an injured patient can cause an unexpected and often unplanned disruption. Time management and some preparation will streamline the procedures of registration, treatment or referral, and consent issues. However, while actual management of such injuries is described in published guidelines, they fail to address research that clearly describes the dismal fate of rootside periodontal ligament cells that have been torn from the socket or sheared and compressed by socket bone. Healing proceeds by repair mechanisms that lead to root resorption, ankylosis, and eventual tooth loss if replantation occurs beyond five minutes or the tooth is severely intruded. The preadolescent and teen population, the age when most injuries occur, have the added complication of ankylosis and facial growth. The inevitable infraocclusion of maxillary incisors is frustrating to clinicians who plan orthodontic treatment or esthetic dental treatment years after the injury. This inevitability must be discussed with the patient/parent before treatment proceeds, as this is part of dealing with the unexpected but inevitable. CDA

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Splinting of Traumatized Teeth with Focus on Adhesive Techniques

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Abstract

Splinting of traumatized teeth is an important step in the treatment of periodontally injured teeth and a precondition of healing of the periodontal tissues. Although it has been shown in animal experiments that replanted teeth without splinting showed analogous healing outcomes compared to splinted teeth, the placement of a splint in dental trauma situations is warranted for medico-legal reasons, for the comfort of the patient, and for the avoidance of additional trauma during periodontal healing. Ideally, the splinting of traumatized teeth should be an easy and fast procedure for the dentist. Trauma splints should be comfortable and easy to keep clean for the patient. The splint should allow some physiologic mobility to promote healing of the periodontal tissues. The widely used and recommended wire-composite splint, with material variations, meets the ideal requirements of current splinting concepts in dental traumatology. Times of using destructive tissue-coverage splints are definitely gone. They are too rigid, compromise periodontal and gingival healing, and are uncomfortable to the patient. The objective of this article is to present the current concepts in splinting of traumatized teeth. The given recommendations about splinting techniques and splinting periods are based on experimental and clinical studies.

Dental trauma represents one of the few situations where dentists are called upon to make unscheduled diagnostic and treatment decisions in an area that is outside their routine experience.[1] Dental trauma includes injuries to the dental hard tissues, injuries to the periodontal tissues, or combinations of such injuries. While injuries to the dental hard tissues normally do not require tooth stabilization during treatment, tooth fixation is often indispensable in cases with injuries to the periodontal tissues.

Clinically, injuries to the periodontal tissues may be characterized by altered tooth mobility, tooth displacement, and bleeding from the sulcus. The current classification of injuries to the periodontal tissues includes concussion, subluxation ("traumatic loosening"), extrusive luxation, lateral luxation, intrusive luxation, and avulsion.[2]

Histologically, injuries to the periodontal tissues involve the root cementum, the periodontal ligament, and the alveolar bone. With regard to the periodontal ligament, stabilization is required whenever the tooth or the

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tooth fragment (in root fractures) has been traumatically displaced. An avulsed and replanted tooth is also subject for stabilization using trauma splints. In addition, traumatically loosened teeth may be stabilized when they are highly mobile, or for the comfort of the patient.

A dental trauma splint is defined as a device or compound used to support, protect, or immobilize teeth that have been loosened, replanted, or fractured.

Figure 1a. A rigid arch-bar splint that destroys the gingival tissues by direct pressure and accumulation of bacteriae.

Figure 1b. The arch-bar splint was removed and exchanged for a correctly placed titanium trauma splint.

Figure 1c. Three days later, the tissues have markedly recovered.

Figure 1d. The healed tissues eight months after replantation of the left central incisor.

Objective and Rationale of Splinting

The main objective of splinting a traumatically loosened or displaced tooth is to protect the attachment apparatus in order to allow repair or regeneration of the periodontal fibers.[3] Although it has been shown in animal experiments that nonstabilized teeth healed equally well or better compared to splinted teeth, the application of a splint is reasoned as follows:[4-6]

Medico-legal aspects. A severely loosened tooth without stabilization may be swallowed, aspirated, or knocked out accidentally.

PDL protection. Additional damage to the injured periodontal tissues must be avoided under all circumstances during the healing period; therefore, splint placement is warranted to reduce the risk of further damage to the periodontal ligament.

Patient comfort. Immediate masticatory function is readily achieved following splinting, and patients feel safer than without tooth stabilization.

The current requirements of dental trauma splints include the following:

Intraoral application. In order to speed up tooth stabilization and treatment time, the splint should be applied directly intraorally without additional impression taking for laboratory procedures.

Placement and removal. The splinting technique should not be a complex procedure in view of the emergency situation and the young trauma patient. In addition, the working field is often compromised with bleeding and lacerated tissues.

Tooth stabilization. The tooth must be adequately stabilized throughout the required splinting period, and untimely splint loss should be avoided.

Tooth physiology. Physiologic tooth mobility should be preserved following splint placement to allow for functional repair or regeneration of the periodontal fibers; semi-rigid or flexible splints are preferred to rigid splints to avoid dentoalveolar ankylosis.[7]

Occlusion. The splint should not interfere with jaw movements and occlusion.

Oral hygiene. The splint should allow proper oral hygiene. The splint should not be placed too close to the gingival tissues, thereby avoiding accumulation of debris and plaque in the sulcus[8,9] (**Figure 1**).

Endodontic access. The splint must allow access to the pulpal tissues once an endodontic treatment is indicated.

Splinting Techniques

Many different splinting techniques have been described in dental trauma articles. Since the introduction of enamel etching with phosphoric acid in 1955 by Buonocore, the majority of published studies have recommended the use of this adhesive technique in combination with resin and/or composite materials.[10] In general, this is a simple and fast procedure with materials readily available in the dental office. However, the acid-etch technique cannot be used in teeth having large restorations or artificial crowns. Yet, this is a rare finding in anterior maxillary teeth, particularly in children and adolescents. At the time of splint removal, residual composite resin is removed with a fluted, carbide finishing bur or with a fine diamond bur. Composite remnants are removed with abrasive or polishing disks. In some situations, this procedure may be postponed in order to avoid disturbance of healing of the gingival and periodontal tissues.

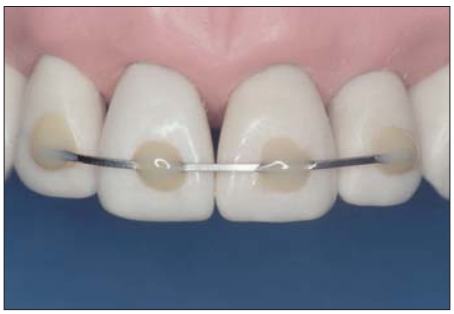

Figure 2a. A wire-composite splint bonded and fixed with the acid-etch technique.

Figure 2b. The occlusal view shows the low profile of this splint.

Figure 3a. This orthodontic splint was made with button brackets. A braided wire was slung around the button brackets, which were reinforced with composite.

Figure 3b. The occlusal view depicts the more voluminous configuration of such a splint.

Wire-composite splint

This technique includes the application of a soft wire that is adapted to the curvature of the dental arch. The wire is fixed to the teeth with adhesive composite[11] (**Figure 2**). Depending on the thickness and the memory effect of the wire, it is important to obtain a fully passive fit in order to avoid any orthodontic forces exerted by the splint. A slight modification is the use of orthodontic ligature wire that can be twisted together in multiple strands to provide a thicker wire.[12] Yet, another variation described the application of a thin flexible wire that was twisted around the teeth by means of a palatal loop.[7] After polymerization, the distal ends of the wire were cut and the palatal part of the loop was removed.

Orthodontic splint

A similar approach comprises the placement of brackets with the adhesive technique[13] (**Figure 3**). An orthodontic wire is subsequently bent and ligated to the brackets, or the wire is passed in figure-eight-loops from bracket to bracket.[14] However, this splinting method resulted in more irritation of the lips and increased speech impairment compared to other splinting techniques.[15] With this technique, caution must be exercised not to apply any orthodontic forces to the splinted teeth.[16]

TTS splint

A new splinting technique that offers improved comfort and handling to the patient and dentist alike, utilizes a specifically designed trauma splint

Figure 4a. The titanium trauma splint with only small fixation areas defined by the rhombic openings of the splint.

Figure 4b. The occlusal view demonstrates that this splint has a very smooth and low profile.

Figure 5a. In the resin splint, the composite material is used for connecting the teeth as well as for the proper splint fixation.

Figure 5b. The occlusal view depicts the voluminous aspect of the resin splint.

made of titanium (TTS, Medartis AG, Basel, Switzerland)[17] (**Figure 4**). The splint is fully adaptable by hand and preserves physiologic tooth mobility, but still allows adequate tooth fixation throughout the splinting period. Splint placement and removal is simple due to the small amount of composite required for fixation (spot etching and bonding), and it is particularly effective and easy to use.[18,19]

Resin splint

A different method of using the adhesive technique is the placement of a full resin splint to the tooth surfaces (**Figure 5**). This splint fully bridges the interdental spaces, and resulted in less comfort to the patient compared to other splinting techniques.[15] In addition, this method showed markedly decreased tooth mobility compared to a wire-composite splint in an experimental study.[20]

Kevlar/fiberglass splint

Yet another method using the adhesive technique involves nylon fibers, Kevlar bands or fiberglass to stabilize an injured tooth to noninjured teeth.[21] The fibers or bands are soaked in resin and placed to the etched tooth surfaces with subsequent polymerization. These splints are esthetically pleasing, and although of light construction, appear to have a low fracture frequency.[21]

Self-etching and bonding material

In contrast to the standard adhesive technique, a method using self-etching bonding material was recently presented.[22] Subsequently, a soft stainless-steel ligature wire that was twisted upon itself to make a double strand was fixed with small increments of a light-curing compomer material. The use of a self-etching adhesive bonding agent appeared to make splint application easier and faster eliminating the separate etching and rinsing steps. The authors also claimed that the compomer material is cut away more easily compared to resin-based composites.

Suture splint

Suture splints may be useful as temporary fixations, and in cases in which there are retention problems due to lack of adjacent teeth, such as in primary or mixed dentitions (**Figure 6**). However, the maximum life of a suture splint is only a few days.[7] The suture is passed from the labial to the lingual tissues with the thread crossing the incisal edge, thereby preventing the tooth moving from its socket. In addition, a small amount of resin may be placed to assure the retention of the suture.[23]

Splinting Times

Clinical healing of the periodontium takes place within the first seven days, and consequently cases with minor supporting tissue injuries should not be immobilized for a period of more than one week.[7] While it has been shown that prolonged and rigid splinting may lead to adverse effects, such as ankylosis and replacement resorption, there is current agreement in the dental trauma literature that splinting periods should be in accordance to the clinical and radiographic findings.[24,25] Since the periodontal ligament reaches its normal strength seven to 14 days following trauma, there are only few situations that merit longer splinting periods. Such situations include damage to the dentoalveolar bone, as may be present in intrusive or lateral luxation injuries with crushing of alveolar bone, and in cases with a fractured labial bone plate.

The International Association of Dental Traumatology has presented a series of articles about guidelines for the evaluation and management of traumatic dental injuries.[26,27] The suggested splinting times for luxated permanent teeth are as follows:

Figure 6a. The left central maxillary incisor was traumatically displaced in a lateral direction.

Figure 6b. A temporary splint suture was placed for tooth fixation since no adjacent teeth were present.

Figure 6c. After impression taking, a vacuum-formed removable splint was inserted.

Concussion/subluxation. A flexible splint — optional — can be used for the comfort of the patient for seven to 10 days, or according to trauma diagnoses of adjacent teeth.

Extrusion. Stabilize the tooth with a splint for up to three weeks.

Lateral luxation. Stabilize the tooth with a splint for up to three weeks. In case of marginal bone breakdown, usually observed radiographically after three weeks, add three to four weeks extra splinting time.

Intrusion. No splinting times were given following orthodontic or surgical repositioning; the author suggests at least three to four weeks of splinting time following surgical repositioning.

Avulsion. Apply a flexible splint for one week.

Experimental Studies on Splinting

Two in vitro studies analyzed the flexibility of various splinting methods.[28,29] The flexible wire-composite splint proved to allow greater vertical flexibility than the other splints tested and providing adequate horizontal support. In contrast, Kevlar and fiber splints might not give sufficient lateral support, whereas a rigid wire-composite splint (with the composite extended along the entire length of the wire) exhibited the lowest horizontal and vertical mobility measurements.

Another study measured the forces originating from orthodontic appliances for splinting of teeth.[16] The results demonstrated that square or round stainless-steel or cobalt-chromium wires exerted lower forces compared to rectangular or nickel-titanium wires. The study also showed that the construction of a truly neutral arch was difficult, and therefore the authors concluded that only dentists experienced in the handling of orthodontic appliances should use such materials for dental trauma splints.

Several experimental studies evaluating the effect of splinting upon periodontal healing following extraction and replantation were conducted in animals.[4-6,25,30] A consistent histologic finding was that teeth without splinting or with a short splinting period of only one week demonstrated normal periodontal healing to a higher degree compared to teeth with extended splinting periods.

Four different splinting methods were evaluated in an experimental study in 10 volunteers comparing a new dental trauma splint to a wire-composite splint, bracket splint and resin splint.[15,20] All tested splints appeared to maintain physiologic vertical and horizontal tooth mobility. However, the latter was critically reduced in resin splints. Bracket splints lead to a significantly higher irritation of the lips and the gingiva, and greater impairment of speech compared to the other tested splints.

Clinical Studies on Splinting

Oikarinen and coworkers evaluated 172 periodontally injured teeth with a mean follow up of 22 months.[31] They reported that the duration of immobilization was a more decisive factor for the occurrence of external replacement resorption than the stage of root formation or the type of injury.

In a large sample of 637 luxated teeth, the placement of orthodontic band and acrylic splints significantly increased the occurrence of pulp canal obliteration compared to acid-etch and composite fixation.[32]

Ebeleseder and coworkers demonstrated that a semi-rigid splint did not reduce lateral tooth mobility to a level below the mobility of the firmest tooth within the splint, thereby decreasing mobility of a traumatized, splinted tooth to within normal ranges, and that there was no benefit in extending the splint to more than one adjacent firm tooth.[33]

In a study comprising 84 reimplanted teeth with a minimum follow-up period of two years, significantly more replacement resorption was observed when teeth were splinted for periods longer than 10 days.[34] It was concluded that ankylosis might be minimized by limiting splinting to 10 days or less.

In a much larger study sample of 400 reimplanted avulsed permanent incisors, splinting periods of six weeks or longer resulted in a lower frequency

of periodontal healing compared to shorter splinting periods.[35]

Claar and coworkers analyzed the reliability of a wire-mesh splinting technique in combination with enamel etching and bonding in 207 patients.[36] A complete, premature loss of the splint was only observed in 2.2 percent of the treated cases, while a partial loosening of the splint was seen in 6.1 percent. In all instances, splint refixation was accomplished without interruption of the splinting treatment period.

In a retrospective study evaluating 400 intra-alveolar root fractures, Andreasen and coworkers reported that a certain flexibility of the splint and possibly also a nontraumatogenic splint application favored healing following intra-alveolar root fractures.[37] No beneficial effect of splinting periods greater than four weeks could be demonstrated.

A similar conclusion was drawn in another retrospective study about the outcomes for root fractured permanent incisors.[38] The authors suggested the use of a functional splint for two to three weeks that allowed physiological movement as an option for root fractured teeth. This would also simplify trauma teaching because the only scenario that would then require a rigid splint would be the dentoalveolar fracture.

Conclusions

When applying a dental splint to stabilize traumatized, repositioned or replanted teeth, three important aspects must be kept in mind by the practitioner:[37]

- Avoid additional trauma during splint application.
- Prevent bacterial invasion into the healing periodontal ligament by correctly placing the splint and allowing oral hygiene.
- Avoid complete immobilization of the splinted teeth.

The presented acid-etch techniques appear to fulfil the current requirements of dental trauma splints, and can be recommended for stabilization of traumatized teeth. CDA

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The Night (and Day) Shift

One of the most difficult concepts for patients to grasp is the fact that teeth move. This is because teeth are connected to the jaw bone, the jaw bone is connected to the skull bone, and the skull bone is ... you know. Man is a creature having a spinal column with most of the bone lumped at the top and as such, this lump and its infrastructures should not be subject to willy-nilly movements.

Is there a practitioner among us who doesn't believe 28 teeth would have been plenty?

As dentists, we know better. This whole tooth thing has been a fiasco since Day One. Meaning no disrespect, **but 32 teeth**! Is there a practitioner among us who doesn't believe 28 teeth would have been plenty? Teeth should have been a specialized part of the bone. This would have done away with the tooth pulp and the periodontal membrane, two signal screwups that have produced more mischief than all the religions of the world combined.

When a child grew, his jaws with their specialized ankylosed teethbones would have grown right along with him. But, of course, this didn't happen because that was a long time ago when you were a senior citizen at age 28 and looking at the wrong side of the grass at 30. The only reality show was

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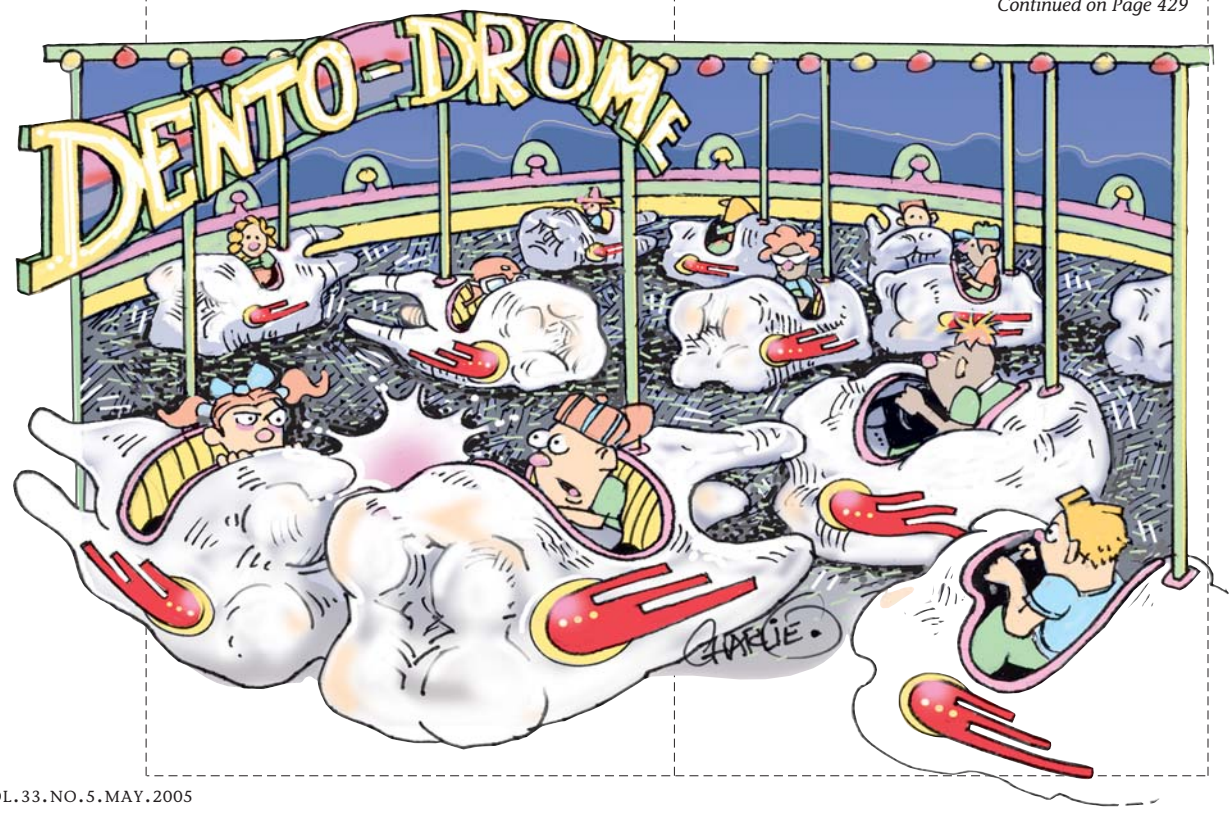

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life itself and the mania for the "perfect smile" had not yet been conceived as a marketing ploy. As a result, we have orthodontists whose livelihood depends on teeth that move, and their patients have retainers to discourage teeth from repopulating the old neighborhood.

That's why endodontists have canals and pulps to play with and curse the occasional evolved tooth that has a nicely calcified canal. It's why exodontists are able to remove an individual tooth without taking all of its companions with it. Periodontists spend way too much mind-numbing time explaining why their patients' teeth are moving to the point of falling out. It's why partials won't fit after being in a sock drawer for a couple of weeks, and why a crown won't seat if the temporary crown is lost, strayed or swallowed, and not replaced.

Teeth move. Why is it so hard for people to believe this? It's because the world appears to be going to hell in a handbasket and nothing appears stable anymore. If there is one thing folks would like to hang onto, it is the notion that their teeth, at least, are always going to be right where they were last week, last year, back when they were 20 and the Golden Years were a millennium away.

Dental marketing is not going to tell them it's not so. Dental marketing is so obsessed with the cosmetic side of dentistry that the idea of white teeth moving is simply not cost effective and downright counterproductive.

Teeth move. Why is it so hard for people to believe this?

It will be interesting when an advanced alien culture finally arrives on our planet at some more metropolitan locale than Roswell, N.M. With luck, and perhaps a promise of a Starbucks franchise, we can study what they've done about teeth. Odds are they will have only two teeth; one big maxillary tooth that extends from the distal of No. 2 around to the distal of No. 15, and a singular mandibular tooth running from the distal of No. 18 to the distal of No. 31. No interproximal spaces, no pulps, no PDMs. They'll be solid bone with the density of a bowling ball. I foresee nicely serrated edges like a bread knife, no substandard dentin, easy maintenance, and more effective than a piranha on steroids.

I can see it now and you could too if you aren't part of the orthoperioendoexo cartel that thrives on tooth movement. You cosmetic mavens who like to be in the avant garde of dentistry, bond all of your B1 veneers together and give evolution a jumpstart.

Meanwhile, dentists will simply have to tell patients that teeth move. They drift, they extrude, and they migrate. That's the way it is, and it's not your fault — or mine. CDA