

esthetic & restorative dentistry

material selection & technique, *second edition*



Quintessence Publishing Co, Inc

Chicago, Berlin, Tokyo, London, Paris, Milan, Barcelona, Beijing, Istanbul,
Moscow, New Delhi, Prague, São Paulo, Seoul, Singapore, and Warsaw

First published as *Odontoiatria Estetica E Ricostruttiva: Selezione Dei Materiali e Delle Tecniche* [in Italian] in 2012 by Quintessenza Edizioni s.r.l., Milan, Italy.

Library of Congress Cataloging-in-Publication Data

Terry, Douglas A.

[Odontoiatria estetica e ricostruttiva. English]

Esthetic and restorative dentistry : material selection and technique / Douglas A. Terry and Willi Geller. -- 2nd ed.

p. ; cm.

Rev. ed. of: *Aesthetic & restorative dentistry* / Douglas A. Terry, Karl F. Leinfelder, Willi Geller. 1st ed. Stillwater, Minn. : Everest Pub. Media, c2009.

Includes bibliographical references and index.

ISBN 978-0-86715-573-0

I. Geller, Willi. II. Terry, Douglas A. *Aesthetic & restorative dentistry*. III. Title.

[DNLM: 1. Esthetics, Dental--Atlases. 2. Dental Implantation--Atlases. 3. Dental Materials--Atlases. 4. Dental Restoration, Permanent--Atlases. 5. Dentistry, Operative--Atlases. WU 17]

LC Classification not assigned

617.6'93--dc23

2012032705

5 4 3 2 1



© 2013 Quintessence Publishing Co Inc

Quintessence Publishing Co Inc

4350 Chandler Drive

Hanover Park, IL 60133

www.quintpub.com

All rights reserved. This book or any part thereof may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without prior written permission of the publisher.

Editor: Leah Huffman

Production: Sue Robinson

Printed in China

Douglas A. Terry, DDS

Willi Geller, MDT

Nitzan Bichacho, DMD

Alejandro James, DDS, MSD

Markus B. Blatz, DMD, PhD

Mark L. Stankewitz, DDS, CDT

Olivier Tric, MDT

Pinhas Adar, MDT, CDT

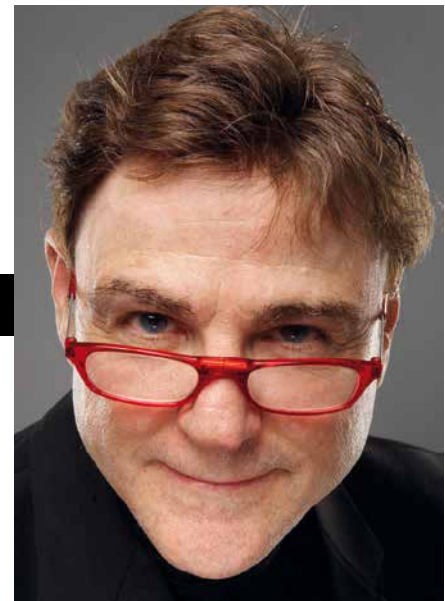
John O. Burgess, DDS, MS

John M. Powers, PhD

Dr Terry received his DDS in 1978 from the University of Texas Health Science Center (UTHSC) Dental Branch at Houston, where he is an assistant professor in the Department of Restorative Dentistry and Biomaterials. He is an accredited member of the American Academy of Cosmetic Dentistry, an active member of the European Academy of Esthetic Dentistry, and an honorary member of the Indian Academy of Restorative Dentistry. He has served as a research associate for REALITY Research Lab and a clinical associate for REALITY Publishing, and he is a member of the International Association for Dental Research. Dr Terry has received a number of professional

Douglas A. Terry, DDS

awards as well as fellowships in the American and International College of Dentists, the Academy of General Dentistry, and the International Academy of Dental Facial Aesthetics. He is a member and the US vice president of Oral Design International. Dr Terry is also an editorial member of numerous peer-reviewed scientific journals and has published over 230 articles on various topics in esthetic and restorative dentistry and has authored the textbook *Natural Aesthetics with Composite Resin* (Montage Media, 2004). He has lectured both nationally and internationally on various subjects in restorative and esthetic dentistry. Dr Terry is the founder and CEO of design Technique International and the Institute of Esthetic and Restorative Dentistry. He maintains a private practice in Houston, Texas.





Mr Geller is a master ceramist and dental technician from Zurich, Switzerland. Through the visionary power of his dental restorations, he has significantly influenced esthetic awareness in dentistry for an entire generation of dental technicians and dentists. He has created revolutionary rules and guidelines in dental esthetics for technicians as well as dentists at a time when it was not in vogue. Mr Geller has developed the lateral segmental layering technique, the ceramic shoulder, the "Geller-wing" technique, the Geller cutback technique, and Creation porcelain. He is recognized in the dental field as "Maestro," the true teacher, and his ideas and concepts are followed and dis-

Willi Geller, MDT

seminated by outstanding international technicians and clinicians. Mr Geller is the founder of Oral Design International, a group of leading technicians and clinicians chosen by him to disperse new knowledge and information around the world. He has received numerous awards from international professional institutions for his outstanding professional achievements and contributions to esthetics, laboratory communication, and dental technology. He maintains an Oral Design laboratory in Zurich, Switzerland.

editors

Dr Bichacho is the head of the Ronald E. Goldstein Center for Aesthetic Dentistry and Clinical Research at the Hebrew University Hadassah Faculty of Dental Medicine, Jerusalem, and holds the post of expert in prosthodontics at the rank of professor. He is the former president and a life member of the European Academy of Esthetic Dentistry (EAED) and a diplomate of the International Congress of Oral Implantologists

Nitzan Bichacho, DMD

(ICOI). He also serves on the editorial boards of leading international dental journals. Dr Bichacho is the inventor and creator of novel techniques, materials, and systems that have become widely used around the world. He publishes and lectures extensively worldwide in the fields of dental implant therapy, fixed prosthodontics, interdisciplinary treatments, and innovative treatment modalities in esthetic dentistry.



Dr James received his DDS from the Universidad del Bajío "La Salle" in León, Mexico, in 1990. He subsequently completed a residency in prosthodontics and a fellowship program in implant dentistry at the UTHSC Dental Branch at Houston. There he served as a director of the implant program. He has participated in many postdoctoral courses and seminars and is a graduate of the Orogathic Bioesthetic Institute. Dr James has published numerous scientific articles on esthetics, implantology, periodontal plastic surgery procedures, occlusion, and restorative dentistry. He currently

Alejandro James, DDS, MSD

serves as an associate editor for the Spanish language version of *Dental Dialogue* and as a faculty member for the Orogathic Bioesthetic Institute. He lectures nationally and internationally on numerous topics related to esthetic and restorative dentistry and consults on product development for industry manufacturers. Dr James maintains a private practice in León, Mexico.





Dr Blatz graduated with a DMD and received an additional doctorate as well as a postgraduate certificate in prosthodontics from the University of Freiburg, Germany. He is currently a professor of restorative dentistry and chairman of the Department of Preventive and Restorative Sciences at the University of Pennsylvania School of Dental Medicine. He formerly was chairman of the Department of Comprehensive Dentistry and Biomaterials, assistant dean of clinical research, and director of the Master of Sciences in Oral Biology program at Louisiana State University Health Sciences

Markus B. Blatz, DMD, PhD

Center School of Dentistry in New Orleans. Dr Blatz is a diplomate of the German Society of Prosthodontics and Material Sciences. He is the associate editor of *Quintessence International* and *Quintessence of Dental Technology* and an editorial board member of several recognized peer-reviewed scientific dental journals. He is also a member of multiple professional organizations, including the European Academy of Esthetic Dentistry and Omicron Kappa Upsilon National Dental Honor Society. Dr Blatz has published and lectured extensively on various facets of restorative dentistry, implantology, and dental materials.



Dr Stankewitz received his DDS from the UTHSC Dental Branch at Houston in 1983. He subsequently obtained his board certification from the American Board of Prosthodontics in 1989. He has over 20 years of experience in all phases of dental laboratory technology and is a master technician in the area of porcelain esthetic restorations on both natural teeth and osseointegrated implants. Dr Stankewitz is a member

Mark L. Stankewitz, DDS, CDT

of numerous professional organizations and is the president of design Technique International. He is also a fellow of the American College of Prosthodontics. He has published and lectured nationally on esthetics, implant dentistry, and advanced laboratory techniques. Dr Stankewitz maintains a private practice in Houston, Texas, where he also owns and operates a dental laboratory.

Mr Tric first studied in France at the College of Leonardo Da Vinci and the University of Pharo while beginning his apprenticeship in dental technology. He has 15 years of experience in all phases of dental laboratory technology and has spent these years studying the secrets and principles of esthetics. He specializes in the many facets of porcelain esthetic restorations on both natural teeth and osseointegrated implants. Mr Tric is a member of Oral Design International and has a center for Oral Design in

Olivier Tric, MDT

Elmhurst, Illinois. He serves on the editorial board of *Spectrum* and has authored numerous scientific articles on ceramic layering techniques and esthetic dentistry. Mr Tric has lectured and given numerous hands-on courses to dentists and technicians throughout the United States and Europe. He is also a consultant in the area of new product development and clinical testing of materials for dental manufacturers and laboratories. Mr Tric currently owns and operates a dental laboratory and an educational center in Elmhurst, Illinois.

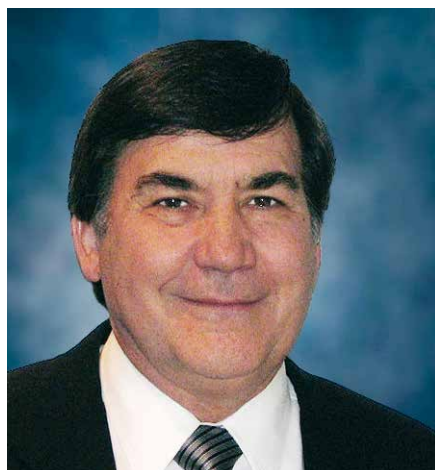


Mr Adar first studied in Tel Aviv, Israel, and then with Willi Geller in Zurich, Switzerland. With 30 years of experience in all phases of dental laboratory technology, he specializes in porcelain esthetic restorations on both natural teeth and osseointegrated implants. Mr Adar is the president of Adar International, an active member and on the executive board of the American Academy of Cosmetic Dentistry, an active member of the American Academy of Esthetic Dentistry, and the vice president of the Georgia Academy of Cosmetic Dentistry. He is also a member in the NADL and SCDL and is the

Pinhas Adar, MDT, CDT

US coordinator of Oral Design International and has a center for Oral Design in Atlanta, Georgia. Mr Adar is on the advisory board of the Amara Institute and is a guest presenter at the Harvard School of Dental Medicine. He is on the editorial advisory board of the *Quintessence Yearly Journal*, the *Journal of Esthetic Dentistry*, the *Journal of Collaborative Techniques*, *Spectrum Dialogue*, *Everest Publishing Media*, and *Inside Dentistry*. Mr Adar is an international lecturer on various topics on esthetic and implant dentistry.





Dr John O. Burgess is a graduate of Emory University School of Dentistry. He received his MS in biomedical sciences from the UTHSC at Houston and completed a 1-year general practice residency and a 2-year general dentistry residency in the US Air Force. Currently the assistant dean for clinical research at the University of Alabama at Birmingham, Dr Burgess served as a military consultant in general dentistry to the Air Force Surgeon General. He has received certification from the American Board of Dentistry and is a diplomate of the Federal Services Board of General Dentistry. He is

John O. Burgess, DDS, MS

a member of the American Academy of Esthetic Dentistry, the Academy of Restorative Dentistry, the American Dental Association, the American Association for Dental Research, and the Academy of Operative Dentistry. Dr Burgess received the Hollenbeck Award for outstanding work in Operative Dentistry in Biomaterials in 2010 and is a fellow of the Academy of Dental Materials and the American College of Dentists. A prolific researcher, he has published more than 400 articles, abstracts, and book chapters. He is a member of the editorial board for *Inside Dentistry*, served on the executive board for the American Association for Dental Research, and served as a consultant to the American Dental Association's Council on Scientific Affairs. He is a member of two ADA committees on specification development for materials and devices. He lectures extensively nationally and internationally and has presented more than 900 continuing education courses.



Dr Powers graduated from the University of Michigan with a BS in chemistry in 1967 and a PhD in dental materials and mechanical engineering in 1972. He received an honorary PhD from the Nippon Dental University in 2011. Dr Powers is the senior editor of the *Dental Advisor* and a clinical professor of oral biomaterials in the Department of Restorative Dentistry and Prosthodontics at the UTHSC at Houston. Dr Powers has authored more than 1,000 scientific articles, abstracts, books, and book chap-

John M. Powers, PhD

ters. He is a coauthor of the textbook *Dental Materials: Properties and Manipulation, Eighth Edition* (Mosby, 2003) and a coeditor of *Craig's Restorative Dental Materials, Thirteenth Edition* (Mosby, 2011) and *Esthetic Color Training in Dentistry* (Mosby, 2004). He serves on the editorial boards of many dental journals. He has given numerous scientific and professional presentations in the United States, Mexico, South America, Europe, and Asia.

contents

introduction.....	XVI
foreword.....	XVII
preface	XVIII
acknowledgments.....	XXI
international editorial members	XXII

chapter 1

diagnostic and communication concepts	1
photography.....	3
shade determination and diagramming.....	4
diagnostic models	6
clinical techniques.....	8

chapter 2

principles of tooth preparation	39
historical review.....	40
clinical objectives of modern restorative dentistry.....	42
biomaterial selection defines tooth preparation design.....	43
tooth preparation considerations for CAD/CAM technology	46
clinical techniques.....	50

chapter 3

composite resins.....	77
introduction.....	78
integration of composite resin with natural tooth structure	79
infrastructure of the composite resin system	79
polymerization shrinkage	81
current developments in nanotechnology.....	85
conclusion.....	87
clinical techniques.....	88



chapter 4

ceramic materials	143
composition of dental ceramics	145
historical perspective	145
properties of ceramic materials.....	146
classification of all-ceramic systems	147
current developments in biomaterials and technology.....	153
characteristics and properties of zirconia	154
methods for fabrication of zirconia blanks	155
methods for fabrication of a zirconia single-coping or FPD framework.....	156
scanning methods of different systems.....	157
3D scan and coping design (Lava software)	158
clinical performance of contemporary all-ceramic restorations	162
clinical techniques	163



chapter 5

the impression process.....	253
selection of impression material.....	256
polyether impression materials.....	258
polyvinyl siloxane impression materials.....	258
vinyl-polyether hybrid impression materials.....	262
impression technique.....	262
criteria for an accurate impression	262
tissue management.....	263
clinical suggestions for impression techniques	264
conclusion.....	265
clinical techniques.....	266



chapter 6

contemporary adhesive cements	279
historical progression of luting cements	281
classification of contemporary adhesive cements	282
mechanisms of adhesion	285
surface treatment of all-ceramic restorations for adhesive resin cementation	286
surface treatment of laboratory-processed composite restorations for adhesive resin cementation	288
conclusion	289
clinical techniques	290



chapter 7

provisionalization	317
clinical objectives of the interim restoration	318
clinical requirements for developing an optimal interim restoration	319
clinical considerations for provisional materials	321
fabrication techniques: direct, semidirect, and indirect	322
consideration factors in cement selection	323
clinical techniques	326



chapter 8

esthetic post systems.....	371
considerations for the selection of restorative materials.....	374
direct fiber-reinforced post and core system.....	378
clinical techniques.....	380



chapter 9

mechanisms of adhesion	405
characteristics of enamel.....	406
characteristics of dentin.....	408
biomodification and adhesion to dental tissue substrates.....	410
adhesion at the restorative interface	413
conclusion.....	415
clinical techniques.....	416



chapter 10

finishing and polishing esthetic restorative materials.....	443
finishing and polishing composite resins	446
finishing and polishing porcelain.....	447
maintenance of esthetic restorations.....	448
conclusion.....	449
clinical techniques.....	450

chapter 11

dental photography	475
historical review.....	476
digital camera systems.....	477
clinical applications of digital photography	478
camera system: integrated components	482
reflective exposure metering.....	487
exposure compensation.....	488
exposure modes	489
incident exposure metering.....	490
filmless imaging: viewing, transmission, and storage	491
guidelines for selection and application of digital camera systems	492
conclusion.....	492
clinical photographic techniques	493

chapter 12

periodontal plastic surgery	513
crown lengthening procedures	514
mucogingival surgical procedures	519
conclusion.....	523
clinical techniques	524

chapter 13

interdisciplinary implantology	593
historical review.....	594
contemporary implant dentistry.....	596
interdisciplinary diagnostic evaluation and treatment planning.....	597
interdisciplinary presurgical strategy	598
implant selection and placement.....	602
interdisciplinary surgical strategy.....	603
clinical techniques.....	606

chapter 14

biomodification of tooth discoloration	677
extrinsic origin.....	678
intrinsic origin.....	679
conservative tooth color correction treatments.....	680
bleaching (tooth whitening).....	680
enamel microabrasion	683
clinical techniques.....	684

index.....	715
------------	-----



introduction

The dental profession has devoted most of its history to restoring the effects of dental disease. The last two decades have evidenced a paradigm shift in this philosophy that has been guided by a greater understanding of science. During this evolution, restorative dentistry has adopted a medical model for decision making in the treatment of dental disease that allows clinicians to individualize and evaluate all components of the process for a proper treatment strategy. This process also educates and involves the patient in treatment decisions, which results in acceptance of appropriate preventive and restorative strategies and improved compliance and oral health.

The public's interest in health and beauty has become an engine that continues to drive the demand for cosmetic dental procedures. In the past, achieving a beautiful smile required submission to extensive invasive procedures and expensive fixed dental prosthetic restorations. Advancements in restorative material formulations and adhesive technology have expanded the treatment possibilities for the clinician and technician. In addition, these advances have increased the myriad opportunities available to discriminating patients and have provided solutions to many of the restorative and esthetic challenges faced by clinicians. Also, this changing technology allows the clinician to treat many esthetic and restorative challenges through more simple, conservative, and economical methods. This evolution in philosophy and science has resulted in a change in the trend for dental treatment. There has been a shift from patients seeking disease-related treatment to elective cosmetic enhancement.

This edition of *Esthetic & Restorative Dentistry: Material Selection & Technique* was compiled to explain and teach esthetic dental procedures through illustrations of everyday clinical situations. It is not designed to advocate one restorative material as the best or prescribe to clinicians which materials to use. Instead, its purpose is to illustrate how a selected material and/or instrument should be used with a specific and thorough protocol to achieve the highest level of excellence for that material and clinical situation. The editorial team members were selected from different areas of the world for their scientific knowledge and clinical and laboratory expertise. This international group encompasses many facets of esthetic and restorative dentistry, including biomaterials, laboratory technology, operative, prosthetic, periodontal, and implant dentistry. This combination of input will provide clinicians, technicians, and auxiliaries with the proper information to make improvements in their work while maximizing their productivity and providing improved oral health care to their patients.

foreword



In this second edition, Dr Douglas Terry, a member of the faculty at the University of Texas Health Science Center, has gone to great lengths to assemble an international core of experts from quite diverse dental fields, where the prerequisite was to put together a sequential series of monographs addressing those very issues that we as clinical dentists encounter in our day-to-day practices. These range from the initial phase of diagnosis and communication through the essentials of different clinical procedures, such as the different forms of tooth preparations, through impression making, provisionalization, and the actual restorative modality.

A chapter is devoted toward the complex but all-important issue of cementation, be it for a veneer, partial denture, porcelain-fused-to-metal crown, or an all-ceramic restoration. He also includes a chapter on the all-too-often-neglected aspect of clinical documentation and photography, as well as some of the essentials on esthetic post systems, periodontal plastic procedures, and implant dentistry.

The esthetics-driven decade in dentistry requires an ever-increasing body of knowledge essential to the process of clinical decision making for beautiful smiles or esthetic restorations. Since the publication of the first edition of *Esthetic & Restorative Dentistry: Material Selection & Technique*, this international forum evolved, but it continues to provide global information from a multitude of different countries. The new editors for this second edition extend from Dr John Powers from Michigan and Dr John Burgess from Alabama to Dr Nitzan Bichacho from Israel. Updated clinical, laboratory, and scientific concepts were provided by Dr Jussara Bernardon and Dr Luiz Baratieri from Brazil; Dr Tetsuji Aoshima, Dr Yoshihiro Kida, and master technician Jungo Endo from Japan; master technician August Bruguera from Spain; and myself, the representative from South Africa. No corner of any continent was left unturned seeking out the most appropriate teachers for the task at hand.

David Garber

preface



The last 50 years have witnessed an unimaginable amount of change in restorative dentistry. The evolution of materials and techniques has been so great that it has become virtually impossible for the clinician to keep abreast. Silicate cement and acrylic resin have been completely replaced by composite resins. Major improvements in physical and mechanical properties, particularly wear resistance, have permitted a general substitution of composite resins for silver amalgam in posterior teeth. Just a short time ago, the average annual wear rate of posterior composite resins was 100 microns. Today, this value has been decreased to approximately five microns. Furthermore, the development of adhesion techniques coupled with modified cavity preparations has gone a long way to reduce the potential for secondary caries.

The introduction of adhesive dentin bonding agents has reduced not only the need for mechanical retention but also the size of the cavity preparation. The traditional concept of "extension for prevention" has been modified to the point that commonly it is not a pressing issue. The buccal and lingual extensions of the Class II preparation into the proximal region, for example, need not be broadened beyond the proximal surfaces unless dictated by the presence of caries. The need for extending the proximal portion of the preparation to the limits recommended for amalgam is appreciably diminished due to a lowered caries rate as well as the potential for bonding to tooth structure.

Another area of major change has been the ceramic restoration. The first breakthrough came about with the introduction of the porcelain-fused-to-metal restoration. The ability to fire and fuse porcelain against gold alloy or base metals considerably extended the use of ceramic materials. Suddenly it was possible not only to generate single units of porcelain for anterior and posterior teeth but also to fabricate extended partial dentures. It is important to note that ceramic veneering of metal crowns or copings resulted in changes not only to the ceramic material but also to the casting alloys themselves. By using metal substrates with a higher casting temperature and a ceramic material with a lower fusion range, highly esthetic and durable restorations could be developed. This method of restoring missing teeth continues to play a very important role in the field of prosthodontics.

The concept of injection molding of glass ceramics such as IPS Empress contributed greatly to the generation of highly esthetic ceramic restorations for anterior teeth. Containing a higher concentration of leucite crystals, the restoration is more resistant

to crack propagation and fracture. While highly accepted for use in the anterior region of the mouth, the injection-molded ceramic agent usually is not considered for use in the molar-premolar region.

Still another area of advancement in recent times has been the development of the aluminous core material. Essentially, the alumina core is a ceramic agent containing sufficient alumina to produce high strength and opacity when used as a single-unit restoration. The core is then veneered with the usual type of glass ceramic material. The concept of using alumina was further enhanced by the introduction of techniques that permitted the infiltration of glass into slightly sintered aluminous porcelain cores. As a result, the range of uses for prosthodontic purposes increased appreciably.

More recently, the sintered zirconia core has been introduced as a substitute for the alumina core. The zirconia material commonly exhibits twice the flexural strength compared with its counterpart, the alumina-based restoration. Interestingly, the zirconia offers another advantage: It readily stops the propagation of small cracks once initiated. Because of the high strength and excellent esthetics of veneered zirconia-based ceramic systems, they can be employed for essentially the same purposes as the traditional porcelain-fused-to-metal systems. Finally, a possible solution for the porcelain's potential for abrading antagonist tooth structure has been advanced. In "low-fusing" porcelains, the level of leucite formation is considerably lower than its high-fusing counterpart. The natural forming process of leucite from feldspar is reduced by using ceramic agents that fuse approximately 200°C lower than normal.

Cements have been part of clinical dentistry for well over a century. Zinc phosphate cement has been the material of choice for cementation of prosthetic restorations, as well as many other uses including orthodontics and the restoration of individual teeth. Although considered a minor player, it is still used by many clinicians for the cementation of crowns and partial dentures. The first adhesive luting agent was polycarboxylate, which was introduced in the late 1960s. It has been used interchangeably with zinc phosphate cement and is usually credited with exhibiting less post-operative sensitivity than zinc phosphate cement.

Throughout the last few decades, however, a number of other luting agents have been added to the clinician's list. These include composite resin, glass ionomers, resin-modified glass ionomers, and self-adhesive or self-etching cements. The introduction of composite resin cements brought about a major competition for their traditional predecessors. They provided a greater potential for shade matching, higher compressive strengths, and an appreciably enhanced resistance to fracture when used in conjunction with ceramic restorations. This characteristic was made possible by the ability of the luting agent to bond both to the surface of the restoration as well as to tooth structure itself. In addition, this class of cements was characterized by a significant reduction in solubility, improved marginal wear resistance, and less micro-leakage.

The glass-ionomer luting agents provided a physiochemical adhesion to tooth structure as well as to nonprecious alloys. In addition, they exhibited higher compressive strengths than either zinc phosphate or polycarboxylate cements. They also undergo a fluoride ion release with a potential for caries prevention, improved resistance to dissolution, and a coefficient of thermal expansion that is closer to tooth structure. The addition of a polymerizable resin component made it possible to en-

hance a number of its physical and mechanical properties. Furthermore, resin modification made it possible for the cement to cure at a considerably faster rate.

The most recent addition to the list of luting agents is the so-called user-friendly self-adhesive cement systems. This novel luting agent is easier and simpler to use because of a reduced number of bonding steps. Furthermore, it is capable of adhering to a wide variety of restorative agents, including gold and base metal alloys, resins, and ceramic materials as well. Generally, it combines the benefits of glass-ionomer and composite resin cements without any special treatment of the prepared tooth surfaces. These self-adhesive systems are appreciably different than conventional composite resin or glass-ionomer cements. Although the composition varies somewhat from one material to another, some of them do not contain Bis-GMA. They may, however, contain UDMA, 4-MET, and a fluoro-alumina-silicate glass. Their relatively low acidity causes a superficial elimination of the apatite crystal or mineral phase, which in turn creates the potential for hybridizing the tooth structure. It is probably for this reason that the postoperative sensitivity associated with its use is minimal to nonexistent. Finally, this class of material offers good radiopacity and a low film thickness.

Another restorative agent undergoing appreciable change is the endodontic post. In the past, it was assumed that a post with high flexural strength and modulus of elasticity resulted in the best clinical performance. Recent studies, however, have demonstrated that root fracture is considerably reduced by the use of posts that exhibit a modulus of elasticity closer to that of root structure. Currently, the glass-fiber post is creating an impressive acceptance by the clinician. While the elastic modulus of carbon-rod and glass-rod posts is similar, the carbon post is far less esthetic. Furthermore, because of a potential incompatibility between the dual-cured cement and the bonding agent, there is a trend toward the use of light-transmitting posts.

Currently, there are a number of publications that describe the relative physical and mechanical properties of the various restorative materials used by the clinician. Some information also is available about their relative clinical behavior. This publication is different and unique from others. It is based on the concept that optimum clinical results are best obtained through the proper utilization of a material. The use of each material and technique covered in this text is depicted in detail using high-quality photography. Furthermore, a materials science background is presented for each of the materials addressed clinically.

Karl L. Swartzfelder

acknowledgments

The inspiration for writing and sharing our experiences in dentistry can be attributed to the stimulus of our colleagues and students around the world. The questions and suggestions shared in presentations, hands-on courses, letters, and emails indicated a desire for a medium to provide knowledge and illustration for the “wet-handed” dentist and technician. There were two basic underlying themes from the input of these colleagues that were identified as to which materials one uses for specific clinical situations and how to use them. These clinicians and technicians shared concern about how to achieve accuracy and consistent, predictable results and still maintain efficiency and profitability with dental procedures.

After reviewing numerous dental educational resources and their methods for selecting and utilizing restorative materials, it was decided that an international editorial team from different educational backgrounds would provide a better source for solutions to these questions. This editorial team was selected from private practice and university faculty around the world and includes biomaterial research scientists, technicians, general dentists, orthodontists, oral surgeons, prosthodontists, and periodontists. It was the consensus of our editorial team that selection of a restorative biomaterial would not involve rating a dental material or product but would show how to use any selected biomaterial so it achieves the most optimal result and longevity for a specific clinical situation. This concept was reflected in a statement I made several years ago: “It is not which biomaterial you use but how you use it that improves the esthetics and longevity of the material.” This concept has become the catalyst to ignite this editorial project—*Esthetic & Restorative Dentistry: Material Selection & Technique*.

The initial spark began in the winter of 2002 in Zurich, Switzerland, when Willi Geller suggested that I organize a “special group” of colleagues from around the world and call them dTI—design Technique International. The group has evolved in the last 5 years to include master technicians, clinicians, and biomaterial scientists from every corner of the world. The members’ participation in this project has included not only “words and techniques” but discussions, encouragement, critique, advice, inspiration, and most importantly, camaraderie and friendship.

Of special significance, the authors, editorial team, and members of dTI would like to express our gratitude to our families, friends, patients, staff, and colleagues for their patience, commitment, and time they have shared and not shared with us to allow this project to be completed.

Finally, of special significance is Sue Terry, who is not only my mother but has been adopted and given the name “mom” by our team. This project would not have been possible or as organized without her wisdom, inspiration, dedication, comforting conversations, ability to persuade patients to come back for photographs, and her fabulous midnight “culinary delights.”







clinical and laboratory contributors
and scientific reviewers



clinical and laboratory contributors

Giuseppe Allais, DDS
Jussara K. Bernardon, DDS, MS, PhD
August Bruguera, CDT
Victor E. Castro, CDT
Theodore P. Croll, DDS
Jungo Endo, RDT
Jean-Marc Etienne, MDT
David A. Garber, DMD
Gregg Helvey, DDS
Yoshihiro Kida, DDS, PhD
Cobi J. Landsberg, DMD
Ernesto A. Lee, DMD
Jack E. Lemons, PhD
Chuck N. Maragos, CDT
Ole H. Mathiesen, CDT
Charles Moreno, CDT, MDT
Susana B. Paoloski, DDS
Juan José Gutiérrez Riera, DDS, MSD
Giuseppe Romeo, MDT
Maurice A. Salama, DMD
Alex H. Schuerger, CDT
Kevin T. Tran, CDT
Francisco Zárate, DDS, CDT

clinical and scientific reviewers

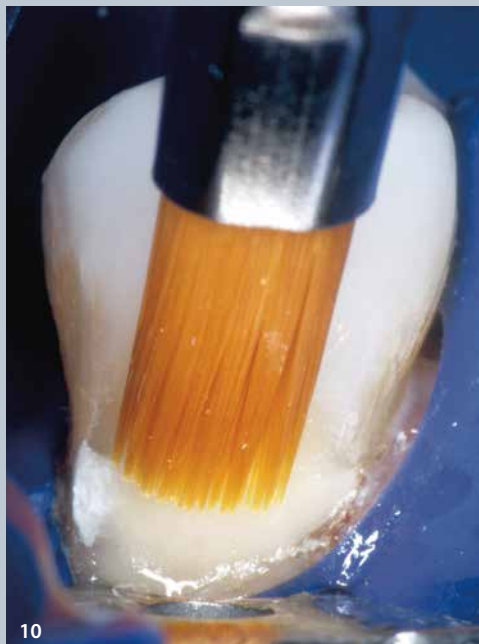
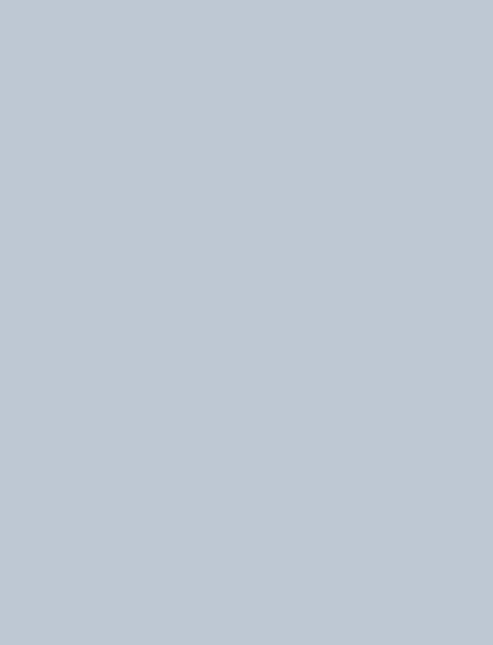
Irfan Ahmad, BDS
Harry Albers, DDS
Tetsuji Aoshima, DDS
Luiz N. Baratieri, DDS, MS, PhD
Danuta Borczyk, DDS
Fabio Cosimi, MD, DDS
Nicolas Elian, DDS
Kostis Giannakopoulos, DDS
Galip Gürel, DDS, MSc
Jeffrey Hoover, DMD, MS
David Klaff, BDS
Sergio G. Kohen, DDS
Fritz R. Kopp, DDS
Constantinos Kountouras, BDS, MSc, PhD
Gerard Kugel, DMD, MS, PhD
Karl F. Leinfelder, DDS, MS
Michel Magne, MDT
Robert Margeas, DDS
Edward A. McLaren, DDS
Juergen Mehrhof, MDT
Masashi Miyazaki, DDS, PhD
Hien Ngo, BDS, MDS
Rafi Romano, DMD, MSc
Arturo Godoy Senties, DDS, CDT
Patrick A. Simone, DDS
Richard J. Simonsen, DDS, MS
Bodel Sjöholm, CDT
Stephen R. Snow, DDS
Carsten Stockleben, DDS, PhD
Edward J. Swift, DMD, MS
Esam Tashkandi, BDS, MS, PhD



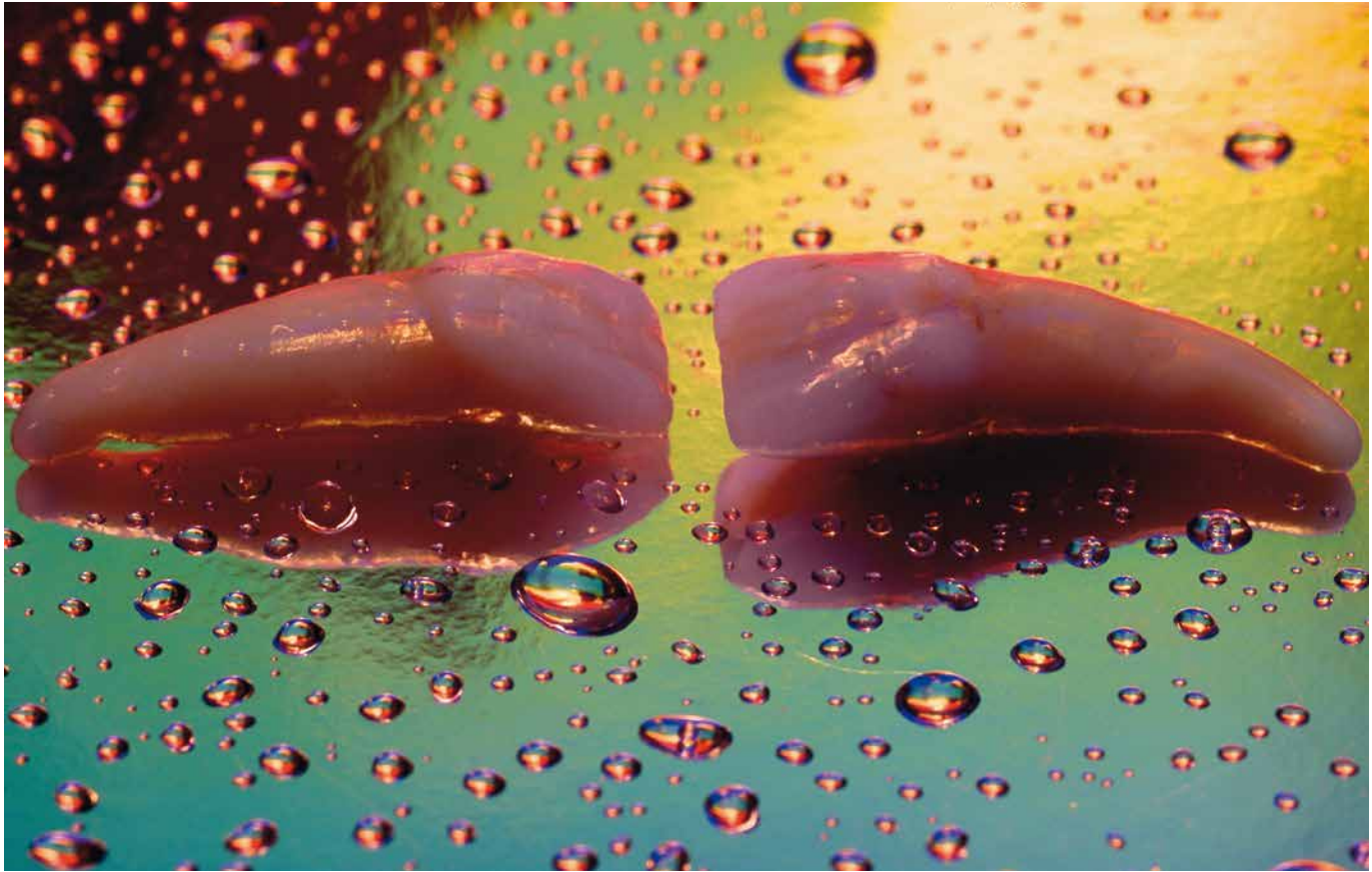
closed sandwich technique resin modified glass-ionomer/composite resin

Figure 1 shows the preoperative view of a wedge-shaped carious cervical lesion on the mandibular right second premolar. These lesions occur from tensile forces. The initial caries control procedure provided removal of the infected dentin and placement of a resin-modified glass ionomer to provide a seal of the lesion while remineralizing the affected dentin (Fig 2). A chamfer was placed along the occlusal margin (Fig 3). A 0.5-mm scalloped bevel was placed in enamel to interrupt the straight line of the chamfer and to reduce the potential for microleakage (Fig 4).

The preparation was cleaned with a premixed slurry of pumice and 2% chlorhexidine (Consepsis) (Fig 5). The preparation was rinsed and lightly air dried. A two-component self-etching system (UniFil Bond, GC America) was used. The self-etching primer was applied to the preparation and allowed to set for 20 seconds and dried gently for 5 seconds (Fig 6), and the bonding agent was applied to the enamel and dentin surfaces and light cured for 10 seconds (Figs 7 and 8). The initial enamel layer of opacous A4-shaded composite resin (Gradia Direct, GC America) was applied to the occlusal half of the preparation with a long-bladed composite instrument (Fig 9), contoured, and smoothed with a #2 sable brush (Fig 10). A second opacous increment was placed in the gingival half of the preparation (Fig 11), smoothed with a #2 sable brush, and light cured.



ceramic materials



Photography courtesy of Irfan Ahmad, BDS.

Ceramics, derived from the Greek word *keramos*, was the ancient art of fabricating pottery. This word may have originated from a Sanskrit term meaning burnt earth because the main constituents were clays excavated from the earth, which were heated to form pottery.^{1,2} Although the methods of acquiring, purifying, and fabricating these raw materials into ceramic objects have significantly changed, some of the basic materials and techniques are still the same. Traditional ceramics uses clay as one of its primary components, in combination with other metal oxides including feldspar ($K_2O \cdot Al_2O_3 \cdot 6SiO_2$), alumina (Al_2O_3), potash (K_2O), and soda (Na_2O). Ceramic objects are still fabricated by pulverizing these raw materials into fine particles and powders and adding water to help keep the particles together during sculpting and shaping. The “green” (unbaked) object is dried and placed into an oven (kiln) and heated to a specified temperature that allows the individual particles to coalesce into a solid mass. The process of coalescence of the particles is called *sintering*, and it usually re-

sults in shrinkage and strengthening of the solid mass. These traditional ceramics include stoneware (tile), earthenware (pottery), porcelain (tableware and china), electrical insulators, bricks, and sanitary ware (sinks and toilets).³

COMPOSITION OF DENTAL CERAMICS

Dental ceramics are chemical mixtures of nonmetallic and metallic elements that allow ionic and covalent bonding to form periodic crystalline structures. The most common dental ceramics are composed of metal oxides (SiO_2 , Al_2O_3 , K_2O) and other traditional ceramic materials. Most dental ceramics are semicrystalline, silicates, oxides, and derivative structures. The simple structures are usually bonded ionically, whereas the complex structures generally involve ionic and covalent bonding.⁴

In theory, the basic constituents for fabricating conventional dental ceramics are similar to those for traditional ceramics. These compounds include feldspar, silica, and kaolin (refined as clay). However, the major difference between the porcelain used in dental ceramics and other traditional ceramics is the proportion of the main ingredients. Dental ceramics are composed mainly of feldspar, while traditional ceramics are composed mainly of clay. Feldspar is a gray, crystalline material, and its chemical composition is potassium aluminum silicate ($\text{K}_2\text{O Al}_2\text{O}_3 6\text{SiO}_2$). Other constituents found in feldspar include mica and iron, and these are removed mechanically by splitting the feldspar rock and during later stages by using strong magnets. The pure feldspar pieces are ground and milled into a powder.¹

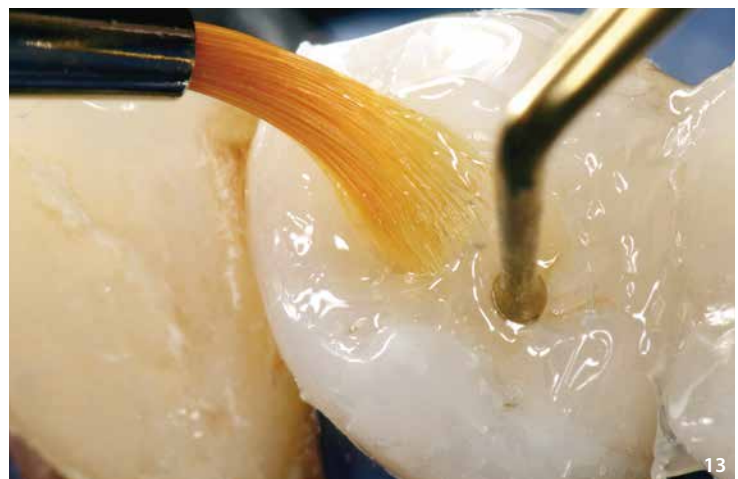
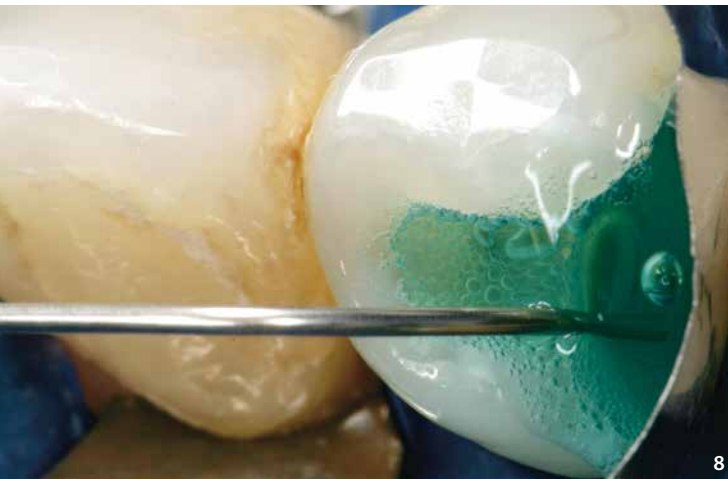
Quartz crystals are the main source of silica (SiO_2), and they are heated and quenched in cold water to split into smaller pieces. These smaller quartz pieces are ground and milled into a fine powder, and any iron impurities are removed with magnets. Dental porcelain is comprised of approximately 15% quartz powder.¹ The quartz powder is infusible at the firing temperature of porcelain and is surrounded by fusible ingredients. It is this crystalline layer of quartz that contributes to the dispersed phase and is surrounded by a continuous amorphous phase. This crystalline layer is responsible for the translucent optical properties of porcelain and limits shrinkage during firing.

Kaolin is a natural form of clay obtained from riverbeds. The clay is washed, dried, and screened into a pure, fine powder. In dental porcelains, kaolin is used in small concentrations (ie, 4%) as a particle binder. The kaolin coats the nonfusible particles and becomes sticky, holding the wet porcelain particles together. This allows the technician to control the form of the restoration by manipulating the powder-liquid mass.¹

To render porcelain restorations tooth colored, small quantities of coloring agents are added to porcelain powders. These pigments are derived from metallic oxides that are ground and mixed with feldspar powder. This mixture is then fired, fused to glass, and then reground to a powder. These oxides include iron oxide for brown shading, copper oxide for green shading, titanium oxide for yellow shading, manganese oxide for purple shading, cobalt oxide for blue shading, and tin oxide for opaquing. Furthermore, rare earth elements can be added in small quantities to provide fluorescence.

HISTORICAL PERSPECTIVE

The evolution of ceramic materials in the last century has been a result of an interplay between function and esthetics. Historically, concerns for strength compromised



After the preparation was cleaned with 2% chlorhexidine (Consepsis), the preparation was etched for 15 seconds with 32% phosphoric acid (Uni-Etch with BAC, Bisco), rinsed with water for 5 seconds, and lightly air dried (Fig 8). An adhesive (All-Bond 3, Bisco) was applied, air thinned, and light cured for 40 seconds (Figs 9 to 11). The composite resin cement (Illusion, Bisco) was injected into the preparation (Fig 12), and the inlay was positioned and held firmly in place using a ball-tipped instrument. The excess resin cement was removed with a sable brush, leaving only a residual amount at the margin to compensate for polymerization shrinkage, and light cured for 40 seconds (Fig 13).



The residual cement was removed with a scalpel blade (#12 BD Bard-Parker), and a thin application of glycerin was applied to all the margins to prevent the formation of an oxygen inhibition layer on the composite resin cement (Fig 14). The restoration was polymerized from all aspects—buccal, occlusal, lingual, and proximal surfaces—each for 40 seconds. Final polishing at the restorative interface was achieved with pre-polishing and high-shine polishing points (DC1M, DC1, CeramiPro Dialite, Braseler USA) (Fig 15). The postrestorative occlusal view illustrates an optimal and durable interfacial adhesion between the tooth and ceramic biomaterial that can be attained from utilizing a thorough adhesive protocol (Fig 16).

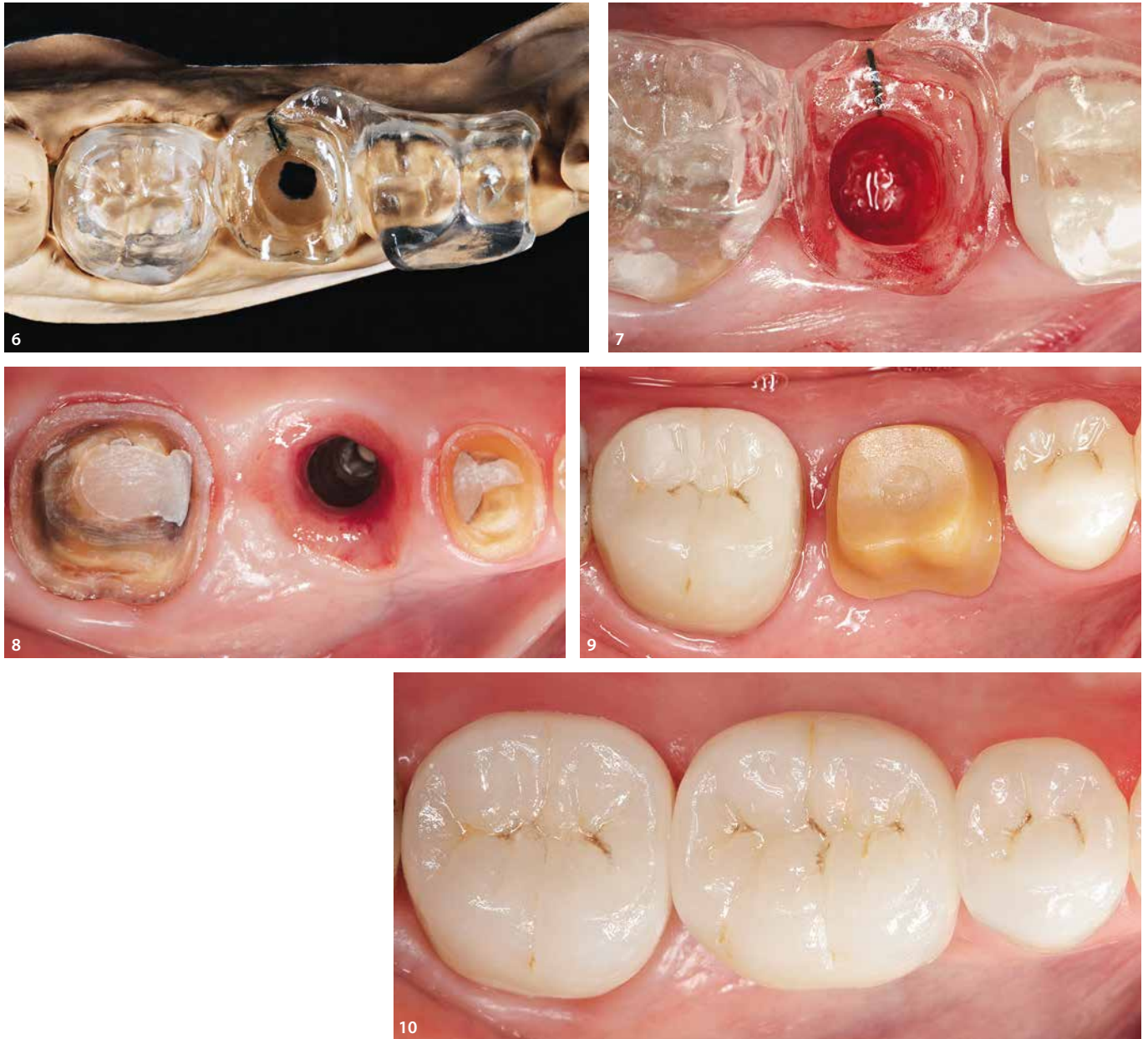
Laboratory courtesy of Alex H. Schuerger, CDT.



anatomical morphologic design of the peri-implant zone

Biointegration refers to the biologic impact the implant, abutment, and prosthetic contours have on the peri-implant tissues. Although the principal determinant of the esthetic potential for any implant prosthesis is the osseous anatomy, the esthetic outcome of the definitive restoration requires the creation of biologic balance between the implant fixture, the restoration, and the peri-implant tissues while developing a natural emergence profile that mimics the adjacent dentition. Natural esthetics can be achieved when the anatomical cross section of the peri-implant region has an anatomical contour similar to that of the root structure of the tooth that is to be replaced. This requires selection of the proper implant diameter, and the implant placement design must ensure that the configuration of the abutment will mimic the cervical configuration of the natural tooth when it reaches emergence. The geometric concept of tooth anatomy described by Wheeler¹⁵⁰ can provide insight for developing the peri-implant zone. This anatomical morphologic design concept creates the form and contour necessary to optimally support the biologic volume of the peri-implant tissues. Success in implant dentistry has metamorphosed from a time when osseointegration and function were a main concern to an era of peri-implant morphology that requires an anatomical morphologic thinking process.

Figure 1 shows the preoperative evaluation of a failing mandibular right first molar. Periodontal assessment reveals an osseous buccal defect from a root fracture. A diagnostic wax-up was developed to visualize the interrelationship between the definitive restorations and the oral structures before the surgical procedure was performed (Fig 2). This presurgical three-dimensional diagnostic communication tool can be shared by the interdisciplinary team prior to treatment to provide precise information essential for diagnostic and presurgical planning. In this staged implant placement



procedure, the tooth was extracted and a bovine bone graft (Bio-Oss, Osteohealth) with a barrier membrane was placed to correct the defect. During this staged implant protocol, the cervical configuration of the natural tooth should be the guide for implant selection and placement, abutment contours, and the volume of peri-implant tissue that is maintained and developed (Fig 3). The composite provisional restoration was designed from the diagnostic wax-up, and it can be used to develop and preserve the gingival architectural form of the peri-implant region (Figs 4 and 5).

After careful radiographic evaluation, the surgical guide can be fabricated from the diagnostic wax-up (Figs 6 and 7). This guide can provide precise and predictable implant orientation with consistent esthetic results. The ideal position of the implant fixture in relation to the adjacent teeth confirms the preplanned position. This philosophy of an anatomical morphologic design of the peri-implant zone requires that the final form of the abutment is a direct derivative of the cervical configuration of the natural tooth. This preplanned concept allows for a precise placement of the implant fixture while managing the volume and morphologic contour of the peri-implant tissue for an optimal esthetic result (Figs 8 to 10).

Laboratory courtesy of Victor Castro, CDT.



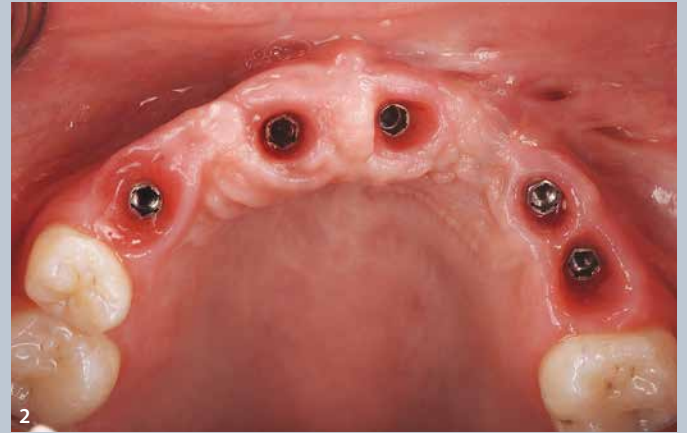
restoring the anterior alveolar ridge deficiency using the oral stratified porcelain buildup technique

Prosthetic rehabilitation of the deficient anterior alveolar ridge can be critical and challenging because of the esthetic demands and the potential requirements.^{153,154} The ridge deformities are characterized by deficiencies in the amount of alveolar bone and/or gingival tissue volume as classified by Seibert¹⁴⁸ and Allen et al.¹⁴⁹ The etiology of these type of defects can be attributed to trauma, tooth extraction, periodontal disease, tumors, and congenital developmental disturbances.¹⁵³ These isolated anterior edentulous regions present difficult challenges in prosthetic reconstruction for esthetics, phonetics, and function. Periodontal plastic surgical procedures have been described in the literature to restore and maintain alveolar and soft tissue architecture for these deficient edentulous regions.^{7,12,18,19,23,28-31,133-136,139-141,144-149,153,155-159}

In addition, prosthetic treatment alternatives can vary significantly according to a multitude of factors. These factors include alveolar bone and soft tissue augmentation requirements, periodontal biotype, alveolar bone quality, selection of implant system design and size, anticipated prosthetic design, experience and training of the interdisciplinary team, patient expectations, and cost considerations.¹⁵⁷ Predictable and optimal treatment results with these complex clinical dilemmas require advanced surgical and prosthetic training, detailed pretreatment planning, and a high level of interdisciplinary communication.

The patient had endured trauma to the anterior segment of the maxillary arch at age 4 years. Several periodontal plastic surgeries had been performed to attempt to restore the deficient maxillary anterior ridge to a normal anatomical morphology of the oral tissues. The patient presented at age 21 years with sufficient bone volume to receive implants, but optimal alveolar bone and gingiva could not be obtained (Fig 1); therefore, gingival and alveolar replacement with metal ceramics was selected. The patient was dissatisfied with the esthetics of the existing removable partial denture and was referred to an interdisciplinary team for a functional and esthetic solution (Figs 2 to 4).

The diagnostic wax-up is an essential component for evaluating and determining tooth length, form and incisal edge position, interdental papillae position, gingival architectural contours, emergence angle, incisal embrasures, lip position, occlusal and esthetic planes, smile analysis, phonetic considerations, and personal patient input. The prototype wax-up try-in technique is a removable wax-up that allows each of these parameters to be assessed intraorally prior to developing the provisional restoration. This technique provides insight into the detection and elimination of potential challenges while evaluating the future success of the definitive prosthetic therapy. This diagnostic wax-up is a schematic for the laboratory design and creation of the definitive restorations. In addition, this wax-up model provides visualization for the patient and the interdisciplinary team and communicates extensive details concerning the treatment plan. It also provides additional preprosthetic surgical planning of hard and soft tissue augmentation or elimination, as well as fabrication of the provisional restorations and development of the definitive restorations. The diagnostic wax-up should be completed and approved by the patient and the interdisciplinary team prior to finalization of the treatment plan.





index—

Page numbers followed by "t" denote tables

A

Abraded natural tooth structure, 452–453
 Abrasion effect, 683
 Abrasive grinding, 161–162
 Acid etching
 adhesives, 413
 of enamel, 410–411
 Acrylic resin provisional restoration, 344–351
 Acrylic surgical guide, 624
 Addition-reaction silicones, 259
 Adhesion
 criteria for improving, 414–415
 definition of, 413
 description of, 285–286
 at restoration interface, 413–415
 Adhesive cements. *See* Cements, adhesive.
 Adhesive resin cements
 description of, 283, 285
 indications for, 284t
 self-, 285–286
 Adhesive restorations
 adhesive cementation for, 283
 tooth preparation for, 40, 49
 Airborne-particle abrasion, 161
 All-ceramic crown
 cementation of. *See* All-ceramic crown cementation.
 fractured, total-etching technique for rebonding of, 416–417
 All-ceramic crown cementation
 resin-reinforced glass-ionomer cement for, 290–291
 self-curing resin cements for, 308–311
 All-ceramic restorations
 case study of, 226–245
 clinical performance of, 162
 interdisciplinary development of, 226–245
 laboratory and clinical procedures effect on, 161
 surface treatment of, for adhesive resin cementation, 286–288
 tooth preparation for, 46
 All-ceramic systems
 feldspathic, 148, 151
 infiltrated, 150, 152
 machinable, 148–149, 151
 overview of, 147–148
 pressable, 149–150, 152
 Altered passive eruption, 525
 Aluminum oxide
 description of, 151
 finishing strips, 191

Alveolar ridge
 deformities of, 522t
 preservation of, 606
 Alveolar ridge augmentation
 anterior
 delayed ovate pontic development for, 572–587
 immediate ovate pontic development for, 566–571
 implants for, 608–611
 oral stratified porcelain buildup technique for, 658–667
 description of, 521–523
 Anatomical contours, 450–451
 Anterior ceramic restorations, finishing and polishing of
 case study of, 462–463
 in gingival/incisal/lingual regions, 466–469
 Anterior metal-ceramic crowns with a circumferential window, 198–204
 Anterior metal-ceramic partial dentures with a circumferential window, 212–217
 Anterior teeth
 double-cord gingival displacement technique in, 270–275
 fiber-reinforced post system
 direct, 382–385
 prefabricated, 386–389, 394–400
 Aperture, 486, 489

B

Bases, 81–82
 Bioactive materials, 595
 Biointegration, 597, 646
 Biologic width, 516, 553
 Biomaterials
 current developments in, 153–154
 tooth preparation design based on, 43–46
 Bis-acryl composite resins, 232, 320–321
 Bleaching
 carbamide peroxide, 680, 682
 definition of, 680
 nonvital
 description of, 682–683
 walking bleach technique for, 682, 692–695
 tooth sensitivity to cold caused by, 680–681
 trays, 687–689
 vital
 custom tray technique for, 684–691
 description of, 681–682
 Bonded porcelain laminate veneers, 63

C

CAD/CAM systems

- ceramic restoration design using, 148–149
- description of, 44–45, 153
- hardware, 157–158
- scanning uses of, 157–158
- tooth preparation considerations for, 46–48
- zirconia single-coping and fixed partial denture framework fabrication using, 156–157

Camera, digital. *See* Digital camera.

Canines, preparationless veneer for, 194–197

Carbamide peroxide, 680, 682

Carbide burs, 446

Carbon fiber posts, 373

Castable glass ceramic, 149

Cavity configuration, 44

Cavosurface gingival margins, 67

Cementation

- adhesion mechanisms, 285–286
- luting cements for. *See* Luting cements.
- provisional restorations, 323–325, 360–363
- silica-based ceramic restorations, 286–287

Cementoenamel junction, 520, 525, 548, 599

Cements, adhesive

- bond strength of, 325
- composite resin cements. *See* Composite resin(s), cements.
- description of, 280–281
- excess, removal of, 216, 243
- future of, 286
- glass-ionomer cements, 282–283, 284t
- history of, 281–282
- indications for, 284t
- provisional, 323–325, 360–363
- removal of, 323
- surface treatment of restorations for, 286–289

Ceramic butt margin, 69

Ceramic inlays, 66–67, 148

Ceramic materials

- coloring agents added to, 145
- composite resins and, bond between, 183, 286
- composition of, 145
- current developments in, 153–154
- description of, 144–145
- digital technology effects on, 153
- finishing of, 447–448
- flexural strength of, 147
- fracture toughness of, 147
- grinding of, 160–161
- history of, 145–146
- improvements in, 146
- mechanical properties of, 146–147
- modulus of elasticity of, 147
- polishing of, 447–448
- polymerization shrinkage of, 147
- properties of, 146–147
- surface grinding effects on, 161
- surface treatment of, 288
- zirconia-based, 146–147

Ceramic onlays, 66–67, 148

Ceramic restorations

- CAD/CAM design of, 148–149

- fracture resistance of, 146

- high-strength, 287–288

Ceramic shade guides, 4

Ceramic systems. *See* All-ceramic systems.

Ceramic veneers, 200

Cervical horizontal defect, 613

Cervical resorption, 692

C-factor, 44, 83

Chamfer, 58

Characterization and surface texture evaluation, 12–17

Charge-coupled device, 157, 477

Chlorhexidine

- description of, 206

- tooth stains caused by, 679

Circumferential window

- anterior metal-ceramic crowns with, 198–204

- anterior metal-ceramic partial dentures with, 212–217

Closed sandwich technique, resin-modified glass ionomer/composite resin, 122–125

Coefficient of thermal expansion, 147

Cold isostatic pressing method, for zirconia block fabrication, 156

Color management, of maxillary central incisors, 210–211

Color measuring systems, 6

Color perception, 4

Coloring agents, 145

Color-mapping device, 5

Communication

- diagnostic models for, 6–7

- photography for, 3–4

- shade determination and diagramming, 4–6

Composite resin(s)

cements

- composite resin onlay cementation using, 302–303

- description of, 283

- indications for, 284t

- porcelain inlay cementation using, 304–307

ceramic materials and, bond between, 183, 286

clinical performance of, 78

closed sandwich technique, 122–125

definition of, 79

enamel macroabrasion/microabrasion and, 704–709

fillers, 79–80

finishing of, 446–447

future of, 87

history of, 78

hybrid, 80

indirect, 84–85

infrastructure of, 79–81

laboratory-processed, 288–289, 321

low-shrinkage, 83

microfill, 80–81

microhybrids, 84

natural tooth structure and, integration between, 79

onlay, dual-cured resin cement for cementation of, 302–303

optical properties of, 375

particle size, 79–80

polishing of, 446–447

provisional restorations

- case study of, 352–360

- fixed partial dentures, 326–335

second-generation, 84

- silica-based ceramic material bond with, 170
 spot-bonding technique, for provisional veneer cementation, 360–363
 surface treatment of, 288–289
 veneers
 case study of, 126–135
 total-etching technique, 430–431
- Composite restorations
 bonded, 58
 Class I
 duo shade placement technique, 88–89
 stratified oblique layering technique, 90–93
 Class II
 minimally invasive technique for, 94–97
 oblique layering technique, 100
 self-etching technique, 436–439
 simplified duo shade technique for, 98–103
 total-etching technique, 428–429
 Class III, simplified layering technique for, 104–105
 Class IV
 complex layering technique for, 108–113
 simplified layering technique for, 106–107
 Class V, duo shade placement technique for, 114–117
 direct composite resin veneers, 126–135
 fractured, total-etching technique for repair of, 422–427
 maintenance of, 448
 margin quality and strength, 82
 physical properties of, 44
 placement techniques for, 44
 polishing of, 448
 posterior, finishing and polishing of, 454–455, 459
- Composite surface sealant, 102
- Condensation-reaction silicones, 259
- Connective tissue grafting
 Class I recession-type defect treated with, 544–547
 Class II recession-type defects treated with, 556–561
 Class III recession-type defects treated with, 548–555, 562–565
 Class IV recession-type defects treated with, 562–565
 description of, 164, 520–521
 tunneling technique for, 562–565
- Connective tissue pedicle grafts, 522
- Contact angle, 256
- Contouring, 445
- Contours, anatomical, 450–451
- Coping, 158–162
- Copy milling, 47, 156
- Core. *See* Post and core systems.
- Crown(s)
 all-ceramic. *See* All-ceramic crown cementation.
 anterior provisional, 336–339
 metal-ceramic. *See* Metal-ceramic crowns.
- Crown lengthening procedure
 anatomical considerations for, 515
 biologic width, 516, 553
 classification system, 518–519, 519t
 clinical considerations for, 519
 conventional approach for, 524–531
 description of, 514–515
 diagnostic considerations, 517–518
 esthetic uses of, 517–518
 gingival margin predictability, 516–517
 gingival/osseous approach, 518
 indications for, 515
 osseous/gingival approach, 518, 532–537
 surgical guide used for, 538–543
 therapeutic guidelines for, 516
 treatment methods, 518–519
- Curing light, low-intensity, 82
- Custom cast posts and cores, 372–373
- Custom tray technique, for vital bleaching, 684–691
- ## D
- Delayed placement, of implants
 bilateral maxillary anterior implants, 612–615
 description of, 603–604
 single posterior implants, 632–645
- Densely sintered high-purity aluminum oxide, 151
- Dental bleaching. *See* Bleaching.
- Dental ceramics. *See* Ceramic materials.
- Dentin
 adhesion to, 411, 414
 biomodification of, 411
 characteristics of, 408–409
- Dentin powders, 237
- Dentinoenamel junction, 406–408
- Depth of field, 486
- Diagnostic models
 description of, 6–7
 fabrication of, 24–28
- Diagnostic wax-up, 29–35, 131, 221, 326, 659, 661–662
- Diamond grit, for abrasive grinding, 161–162
- Diastema closure, proximal adaptation technique for, 118–121
- Digital camera
 aperture, 486, 489
 automated exposure modes, 489
 body of, 486–487
 description of, 6, 477–478
 electronic flash systems, 484–485
 exposure compensation feature of, 488–489
 exposure modes, 489
 f-stop setting, 486–487
 incident exposure metering, 490–491
 lens, 482–484
 lighting for, 484–485
 manual exposure mode on, 490, 492
 reflective exposure metering, 487–488
 selection guidelines for, 492
 through the lens metering by, 487–490, 492
- Digital photography
 camera systems used in, 477–478
 clinical applications of, 478–481
 diagnostic uses of, 478
 forensic documentation uses of, 479
 insurance verification uses of, 481
 laboratory communication uses of, 480
 legal documentation uses of, 478
 patient education and communication uses of, 479, 481
 professional instruction uses of, 481
 storage considerations, 491–492
 transmission considerations, 491–492
 treatment planning uses of, 478
 viewing considerations, 491–492

- Dimensional stability, of impression materials, 257
- Direct composite resin restorations, 44
- Direct composite resin veneers
case study of, 126–135
total-etching technique, 430–431
- Direct fabrication technique, for provisional restorations, 322–323
- Discoloration of teeth. *See* Tooth discoloration.
- Double-cord gingival displacement technique
anterior, 270–275
posterior, 266–268
- Dual-cured resin cement
composite resin onlay cementation using, 302–303
fiber-reinforced composite resin post, 379, 384, 388–389, 393, 396
indications for, 375
porcelain inlay cementation using, 304–307
- Duo shade placement technique
for Class I composite restoration, 88–89
for Class II composite restoration, 98–103
for Class V composite restoration, 114–117
- E**
- Elastic modulus, 81
- Elastic recovery, of impression materials, 258
- Elastomeric impression materials, 255
- Electrosurgery, 212
- Emergence angle, 221
- Enamel
abraded surface, 452–453
acid etching of, 410–411, 437
adhesion to, 410–411, 414
biomodification of, 410–411
characteristics of, 406–407
hypoplastic, biorestorative modification of, 698–703
“snow capping” dysmineralization, 697
- Enamel bevels, 49
- Enamel glaze, 683
- Enamel microabrasion
case study of, 696–697
composite resin bonding and, 704–709
description of, 680, 683
- Enamel prisms, 406–407
- Envelope technique, 521
- Etching. *See* Acid etching; Total-etching technique.
- Exposure
bracketing, 488–489
compensation, by digital cameras, 488–489
control, 486
metering, 487–488
- “Extension for prevention,” 40–41
- Extracoronary restorations, 45–46
- Extraction sites
defects at, management before implant placement, 628–631
socket preservation, 597, 606–607
- F**
- Fabrication
of diagnostic models, 24–28
of fiber-reinforced composite resin post system, 378
of provisional restorations, 322–323
of provisional veneers, 340–343
of surgical guides for implants, 622–627
- Feldspathic ceramic systems
applications of, 151
description of, 148
- Feldspathic porcelain veneers
platinum foil technique for, 174–179
refractory die technique for, 163–173
- Ferrule effect, 380–381
- Fiber-reinforced composite resin post system
anterior teeth, 382–385
components of, 378–379
description of, 374
dual-curing luting agent for, 375, 379, 384, 388–389, 393, 396
fabrication of, 378
post material, 378
prefabricated
anterior teeth application of, 386–389, 394–400
description of, 378
posterior teeth application of, 390–393
reinforcement material for, 377
root fracture concerns, 376
uninterrupted bonding provided by, 377
- Fillers, 79, 286
- Filmless imaging, 491–492
- Finishing
abraded natural tooth structure, 452–453
anatomical contours, 450–451
anterior ceramic restorations
case study of, 462–463
in gingival/incisal/lingual regions, 466–469
anterior composite restorations
case study of, 456
in gingival region, 458
composite resins, 446–447
fine, 445
illustration of, 415, 426
indirect composite restorations, 460–461
instruments for, 445
polishing versus, 445
porcelain, 447–448
posterior ceramic restorations in occlusal region, 464–465
posterior composite restorations
case study of, 454–455
in occlusal region, 459
purpose of, 445
- Fixed partial denture
abutments for, 48
composite resin, laboratory fabrication of, 326–335
metal-ceramic, 583, 585
zirconia framework, 156–157
- Flap surgery, 605
- Flapless surgery, 605
- Flexural strength, 147
- Fractures
all-ceramic crown, 416–417
composite resin restoration, 422–427
porcelain veneer, 418–421
- f-stop, 486–487
- Full-coverage restorations
considerations for, 68

geometric forms, 70
margin designs for, 69
tooth preparation design for, 68–71

G

Geller technique
for anterior metal-ceramic crowns with a circumferential window, 198–204
for anterior metal-ceramic partial dentures with a circumferential window, 212–217

Gingiva
anatomy of, 263, 515, 663
color analysis of, 664
scalloped, 599–600

Gingival aesthetic line, 527

Gingival displacement techniques
double-cord
anterior, 270–275
posterior, 266–268
single-cord, 269

Gingival floor, 52, 69

Gingival margins
after crown lengthening procedure, 516–517
cavosurface, 67
design of, 46
full-coverage restorations, 69

Gingival recession defects
Class I, 544–547
Class II, 556–561
Class III, 548–555, 562–565
Class IV, 562–565
classification of, 520, 520t
envelope technique for, 521

Gingival retraction
description of, 264
displacement techniques for. *See* Gingival displacement techniques.

Gingivectomy, 527, 536

Glass ceramics
description of, 149–150
properties of, 152

Glass-infiltrated alumina, 152
with partially stabilized zirconia, 152

Glass-infiltrated magnesium alumina, 152

Glass-ionomer cements
description of, 282–283
indications for, 284t
resin-modified. *See* Resin-modified glass-ionomer cements.

Grinding, 160–161

H

Hand polishing, 448

Hard tissue augmentation, 597

Hardness, 445

Hybrid composites, 80, 100, 117

Hydroactive impression materials, 256–257

Hydrofluoric acid etching, 183

Hydrophilicity, of impression materials, 256–257

Hydrophobic impression materials, 256

Hypoplastic enamel, 698–703

I

Immediate placement, of implants
description of, 603–604
single anterior implant, 616–621

Implants
anterior
bilateral maxillary, 612–615
single-tooth, 616–621
anterior ridge augmentation, 608–611
apicocoronal placement of, 603
biotolerant metals, 594
calcium phosphate coatings on, 595
contemporary, 596–597
delayed placement of
bilateral maxillary anterior implants, 612–615
description of, 603–604
single posterior implants, 632–645
diameter of, 602
extraction site defect management before placement of, 628–631
faciolingual placement of, 602–603
flap vs flapless surgery, 605
gingival biotypes, 599–600
hard tissue augmentation, 597
history of, 594–596
immediate placement of
description of, 603–604
single anterior implant, 616–621
interdisciplinary diagnostic evaluation, 597
interdisciplinary presurgical strategy for, 598–602
maxillary anterior, 612–615
mesiodistal placement of, 602
multiple, 648–657
osseointegration of, 595–596
osseous framework for, 598–599
patient education about, 601
peri-implant soft tissue framework for, 599–600
peri-implant zone, anatomical morphologic design of, 646–647
placement of, 602–604, 612–621, 632–645
preservation goals, 597
presurgical considerations
communication, 601–602
examination, 598
prosthesis supported with, 648–657
radiographic imaging, 601
selection of, 602–603
single-tooth
anterior, 616–621
challenges associated with, 612
posterior, 632–645
small-diameter, 596
socket preservation extractions, 597
socket seal surgery, 606–607
soft tissue framework for, 599–600
staged placement of, 603–604
surface modification of, 596
surgical guide for
description of, 601
fabrication of, 622–627
titanium, 595

treatment planning, 600–601
two-stage approach, 595

Impression materials
dimensional stability of, 257
elastic recovery of, 258
elastomeric, 255
hydrophilicity of, 256–257
polyether, 258, 260t
polyvinyl siloxane, 259, 261t, 262
selection of, 256–258
setting time of, 257
tear resistance of, 258
vinyl-polyether hybrid, 262
viscosity of, 256

Impression/impression taking
accurate, 255, 262–263
advances in, 255
clinical suggestions for, 264–265
for composite resin fixed partial denture, 328–329
gingival displacement techniques for. *See* Gingival displacement techniques.
history of, 254
techniques for, 264
tissue management during, 263

Incisal embrasures, 332

Incisolingual interface, 172

Incisors
maxillary central, color management of, 210–211
maxillary or mandibular anterior, photography of
frontal view, 502
left lateral view, 504
right lateral view, 503
preparationless veneer for, 180–183

Indirect composite resins, 84–85

Indirect composite restorations, 460–461

Indirect fabrication technique, for provisional restorations, 322–323

Indirect intracoronal restorations, 45

Indirect resins, 289

Infiltrated ceramic systems
applications of, 152
description of, 150

Inlays, 66–67

Internal line angles, 49, 56

Interpositional graft
description of, 522
indications for, 522–523

Interproximal
contours, 238
finish lines, 61
zone, 102

Intertubular dentin, 408–409

Intracoronal restorations
indirect, 45
tooth preparation for, 44–45

J

Junctional epithelium, 515

L

Labial butt margin, 69

Laboratory-processed acrylic resin provisional restoration, 344–351

Laboratory-processed composite resins, 288–289

Laminate veneers
bonded, 63
development of, 63
preparationless porcelain, 62–65

Laser sintering, selective, 158

Lava software, 158–162

Leucite-reinforced glass ceramics, 152

Lighting
for digital camera, 484–485
in shade selection, 5

Liners, 81–82

Lithium disilicate
applications of, 154
crystals, 151
glass ceramics, 151

Lost wax technique, 149

Low-intensity curing light, 82

Luting cements
adhesion mechanisms for, 285–286
bond strength of, 325
composite resin cements, 283
description of, 280–281
glass-ionomer cements, 282–283
history of, 281–282
ideal characteristics of, 280–281
indications for, 284t
provisional restoration, 323–325, 360–363
removal of, 323

M

Machinable ceramic systems
applications of, 151
description of, 148–149

Magnification ratio, 482

Manual-aided design/manual-aided manufacturing, of zirconia
single-coping and fixed partial denture framework, 156

Marginal tissue recession, 520, 520t

Masticatory stress, 67

Mechanical interlocking, 414

Metal posts, 373

Metal-ceramic crowns
anterior, with a circumferential window, 198–204
existing, replacement of, 205
posterior, 206–209
self-adhesive resin cement for cementation of, 300–301

Metal-ceramic fixed partial dentures, 583, 585

Microabrasion, enamel
case study of, 696–697
composite resin bonding and, 704–709
description of, 680, 683

Microfill composites, 80–81

Microhybrids, 84

Microleakage, 288, 375

Miller's classification of recession-type defects, 231

Modulus of elasticity, 147, 376–377

- Modulus of rupture, 147
Molecular engineering, 85
Mucogingival surgery
 alveolar ridge augmentation, 521–523
 connective tissue grafting. *See* Connective tissue grafting.
 description of, 519
- N**
- Nanoparticle hybrid composite, 86
Nanoscience, 85
Nanotechnology, 85
Noncomposites, 86
Nonvital bleaching
 description of, 682–683
 walking bleach technique for, 682, 692–695
- O**
- Odontoblasts, 408
Onlay(s)
 composite resin, dual-cured resin cement for cementation of, 302–303
 porcelain, total-etching technique with, 432–433
 tooth preparation design for, 66–67
Onlay graft
 description of, 522
 indications for, 523
Oral stratified porcelain buildup technique, for anterior alveolar ridge restoration, 658–667
Osseointegration, 595–596
Osseous crest, 264, 518
Osseous framework for implants, 598–599
Osseous/gingival approach, for crown lengthening, 518, 532–537
Osteotomy, 633
Ovate pontic development, for anterior alveolar ridge augmentation
 delayed, 572–587
 immediate, 566–571
Ovate pontic receptor site, 212
- P**
- Partial dentures
 anterior, 212–217
 fixed. *See* Fixed partial denture.
Pastes, polishing, 447
Periodontal inflammation, 219
Periodontal plastic surgery
 alveolar ridge augmentation. *See* Alveolar ridge augmentation.
 connective tissue grafting. *See* Connective tissue grafting.
 mucogingival surgery. *See* Mucogingival surgery.
 overview of, 514
Periodontal probe, 528
Periodontium, 515
Peritubular dentin, 408–409
Phosphoric acid etching, 187
Photography
 black-and-white, 14
 characterization and surface texture evaluation, 12–17
 communication uses of, 3–4
 digital. *See* Digital photography.
 full face, 508
 full smile
 frontal view, 494
 left lateral view, 496
 right lateral view, 495
 history of, 476–477
 mandibular arch, 505
 maxillary arch, 505
 maxillary or mandibular anterior incisors retracted
 frontal view, 502
 left lateral view, 504
 right lateral view, 503
 maxillary or mandibular quadrant, 507
 maxillary/mandibular retracted
 frontal view, 497
 left lateral view, 499, 501
 reflected technique, 500–501
 right lateral view, 498, 500
 portrait, 508
 profile, 3, 509
 shade analysis, 10–11
 smile analysis, 8–9, 183
Platinum foil technique for feldspathic porcelain veneers, 174–179
Point flash light, 484–485
Polishing
 abraded natural tooth structure, 452–453
 aluminum oxide–based pastes for, 447
 anterior ceramic restorations
 case study of, 462–463
 in gingival/incisal/lingual regions, 466–469
 anterior composite restorations
 case study of, 456
 in gingival region, 458
 composite resins, 446–447
 finishing versus, 445
 hand, 448
 illustration of, 216, 223, 415
 indirect composite restorations, 460–461
 instruments for, 445
 objective of, 445, 452
 pastes for, 447
 porcelain, 447–448
 posterior ceramic restorations in occlusal region, 464–465
 posterior composite restorations
 case study of, 454–455
 in occlusal region, 459
Polycarboxylate cements, 281
Polyether impression materials, 258, 260t
Polyhedral oligomeric silsesquioxanes, 85–86
Polymerization inhibition, 259
Polymerization shrinkage
 ceramic materials, 147
 description of, 44–45, 81
 marginal adaptation of provisional restoration affected by, 322
 methods for managing
 cavity liners and bases, 81–82
 indirect composite resin systems, 84–85
 low-intensity curing light, 82
 low-shrinkage composite resin, 83
 placement techniques, 82–83
 stress, 81

- Polysiloxane impression, 232–233
- Polyvinyl siloxane impression materials, 259, 261t, 262
- Porcelain
- compressive strength of, 146
 - finishing of, 447–448
 - polishing of, 447–448
 - shoulder, 146
 - smoothness of, 447
- Porcelain inlay cementation, using dual-cured resin cement, 304–307
- Porcelain onlay, total-etching technique with, 432–433
- Porcelain restorations
- leucite-reinforced, 146
 - try-in, 241
- Porcelain veneers
- facial reduction, 61
 - feldspathic
 - platinum foil technique for, 174–179
 - refractory die technique for, 163–173
 - fractured, total-etching technique for rebonding of, 418–421
 - history of, 63
 - illustration of, 23
 - intra-enamel preparation, 61
 - preparationless, 62–65
 - retreatment of, 218–225
 - tooth preparation for, 46, 60–61
- Porcelain-fused-to-metal, 146, 148
- Post and core systems
- carbon fiber, 373
 - corrosion issues, 376
 - custom cast, 372–373
 - esthetics of, 375
 - failure of, 372, 374
 - ferrule effect, 380–381
 - fiber-reinforced composite resin. *See* Fiber-reinforced composite resin post system.
 - flexural strength of, 377
 - ideal characteristics of, 374
 - internal adaptation of, 375
 - metal, 373
 - modulus of elasticity, 376–377
 - overview of, 372–373
 - prefabricated, 373
 - retention of, 373, 374
 - root fracture considerations, 373, 375–376
 - rotational forces on, 376
 - tensile strength of, 377
 - tooth structure conservation, 374–375
 - tooth-colored, 373
- Postcuring, 84
- Posterior ceramic restorations, finishing and polishing of, 464–465
- Posterior composite restorations, finishing and polishing of
- case study of, 454–455
 - in occlusal region, 459
- Posterior metal-ceramic crowns, 206–209
- Posterior teeth
- double-cord gingival displacement technique in, 266–268
 - prefabricated fiber-reinforced post system, 390–393
 - single-tooth implants, 632–645
 - tooth preparation requirements for, 47
- Post-retained crowns, 374
- Pouch graft, 522
- Predentin, 409
- Prefabricated fiber-reinforced composite resin post system
- anterior teeth application of, 386–389, 394–400
 - description of, 378
 - posterior teeth application of, 390–393
- Preparationless veneer
- for canines, 194–197
 - for incisors, 180–183
 - porcelain laminate, 62–65
- Pressable ceramic systems
- applications of, 152
 - description of, 149–150
- Prosthesis, implant-supported, 648–657
- Provisional materials
- acrylic resins, 320, 344–351
 - bis-acryl composite resins, 320–321
 - clinical considerations for, 320–321
 - light-cured composites, 321
 - polyethyl methacrylate used as, 320
 - selection of, 321–322
 - self-curing resins, 321
- Provisional restorations
- acrylic resin, 344–351
 - anterior crown, 336–339
 - bond strength, 325
 - cementation of, 323–325, 360–363
 - clinical objectives of, 318–319
 - composite resin
 - case study of, 352–360
 - fixed partial denture, 326–335, 575
 - crown, 336–339
 - description of, 7
 - development of, 319–321
 - direct fabrication technique for, 322–323
 - fabrication of, 322–323
 - indirect fabrication technique for, 322–323
 - luting cement for, 323–325
 - marginal fit of, 322
 - plaque accumulation on, 322
 - polymerization shrinkage effects on, 322
 - semidirect fabrication technique for, 322–323
 - veneer
 - cementation of, using composite resin spot-bonding technique, 360–363
 - fabrication of, 340–343
- Proximal adaptation technique for diastema closure, 118–121
- ## R
- Recession-type defects, 231, 520, 520t
- Reflective exposure metering, 487–488
- Refractory die technique, for feldspathic porcelain veneers, 163–173
- Relationships with team members, 3
- Removable wax-ups, 232
- Resin cements
- composite resin onlay cementation using, 302–303
 - description of, 283
 - indications for, 284t
 - self-adhesive. *See* Self-adhesive resin cements.

- self-curing, 308–311, 321
 - wetting capacity affected by, 375
 - Resin-modified glass-ionomer cements
 - all-ceramic crown restoration cementation using, 290–291
 - bond strength of, 282
 - closed sandwich technique, 122–125
 - excess, removal of, 282–283
 - history of, 281
 - indications for, 284t
 - properties of, 281–282
 - Restorations
 - adhesion to, 413–415
 - all-ceramic. *See* All-ceramic restorations.
 - ceramic. *See* All-ceramic restorations; Ceramic restorations.
 - maintenance of, 448–449
 - provisional. *See* Provisional restorations.
 - surface treatment of, for adhesive resin cementation, 286–289
 - Restorative dentistry
 - clinical objectives of, 42–43
 - tooth structure preservation goals of, 42
 - Retraction cords, for gingival displacement. *See* Gingival displacement techniques.
 - Retreatment, of porcelain veneers, 218–225
 - Ring flash light, 484
 - Root fracture, 373, 375–376
 - Rotational forces, on post-and-core systems, 376
- S**
- Scalloped gingiva, 599–600
 - Scanning methods, 157–158
 - Sealants
 - composite surface, 102
 - total-etching technique, 434–435
 - Second-generation composite resins, 84
 - Selective laser sintering, 158
 - Self-adhesive resin cements
 - all-ceramic crown cementation using
 - description of, 285–286
 - metal-ceramic crown cementation using, 300–301
 - Self-curing resin cements, 308–311, 321
 - Self-etching adhesives, 85, 413
 - Self-etching primer, 206, 215
 - Self-etching technique
 - Class II composite resin restorations, 436–439
 - description of, 412–413
 - Semidirect fabrication technique, for provisional restorations, 322–323
 - Setting time, of impression materials, 257
 - Shade analysis, 10–11, 480
 - Shade determination and color diagramming
 - complex, 20–21
 - description of, 18–19
 - Shade evaluation and complex color diagramming, 22–23
 - Shade guides, 4–5, 22
 - Shade tabs, 17, 118, 705
 - Shade-communication diagram, 18
 - Shade-modification lights, 5
 - Sharp line angles, 47–48
 - Shoulder porcelains, 146
 - Silane coupling agents, 183, 420
 - Silica-based ceramic restorations
 - bonding, 170, 287
 - composite resin bond, 170
 - illustration of, 201
 - surface treatment of, for adhesive resin cementation, 286–287
 - Siloxane bonds, 183
 - Silsesquioxanes, 85
 - Simplified layering technique
 - for Class III composite restoration, 104–105
 - for Class IV composite restoration, 106–107
 - Single central, 205
 - Single-coping, zirconia, 156–157
 - Single-cord gingival displacement technique, 269
 - Single-tooth implants
 - anterior, 616–621
 - challenges associated with, 612
 - posterior, 632–645
 - Sintering, 149, 158
 - Smear layer, 410–411
 - Smile analysis, 8–9
 - Socket preservation extractions, 597, 606–607
 - Socket seal surgery, 606–607
 - Spot metering, 488
 - Spries, 158
 - Stone model, 11
 - Stratified oblique layering technique, 90–93
 - Subepithelial connective tissue grafts/grafting, 521, 564
 - Subgingival finish lines, 264
 - Subgingival margin, 263
 - Surface grinding, 161
 - Surface texture evaluation, 12–17
 - Surface treatment
 - of ceramic materials, 288
 - of high-strength ceramic restorations, 287–288
 - of implants, 596
 - of laboratory-processed composite resin restorations, 288–289
 - of silica-based ceramic restorations, 286–287
 - Surface wetting, 256
 - Surgical guides
 - acrylic, 624
 - for crown lengthening, 538–543
 - for implants
 - description of, 601
 - fabrication of, 622–627
- T**
- Tear resistance, of impression materials, 258
 - Teeth
 - anterior. *See* Anterior teeth.
 - dehydration of, 4
 - posterior. *See* Posterior teeth.
 - shade determination of, 4–6
 - Teleconverter, 483–484
 - Tetracycline-related tooth discoloration, 679
 - Tooth discoloration
 - bleaching techniques for. *See* Bleaching.
 - conservative treatments for, 680
 - enamel microabrasion for
 - case study of, 696–697
 - composite resin bonding and, 704–709
 - description of, 680, 683

extrinsic causes of, 678–679
 hypoplastic enamel, 698–703
 intrinsic causes of, 679
 tetracycline-related, 679

Tooth preparation
 adhesive restorations, 40, 49
 biomaterial selection effects on, 43–46
 for CAD/CAM systems, 46–48
 Class I restorations, 50–51
 Class II restorations, 52–53
 Class III restorations, 54–55
 Class IV restorations, 56–57
 Class V restorations, 58–59
 extracoronary restorations, 45–46
 full-coverage restorations, 68–71
 historical review of, 40–41
 inlays, 66–67
 intracoronary restorations, 44–45
 onlays, 66–67
 porcelain veneers, 46, 60–62
 posterior teeth, 47

Tooth replacement criteria, 43

Tooth stains. *See* Tooth discoloration.

Tooth whitening, 681–682

Total-etching technique
 all-ceramic crown fracture rebonded using, 416–417
 Class II composite resin restoration, 428–429
 composite resin restoration fracture repaired using, 422–427
 description of, 412
 direct composite veneer restoration, 430–431
 porcelain onlay, 432–433
 porcelain veneer fracture rebonded using, 418–421
 sealants, 434–435

Transformation toughening, 150, 155

Transverse strength, 147

Treatment planning, for implants, 600–601

Trough margins, 48

Tunneling technique, for connective tissue grafting, 562–565

Twin flash light, 484–485

Two-stage implant approach, 595

U

Unilateral dry pressing method, for zirconia block fabrication, 155–156

V

Veneers
 direct composite resin
 case study of, 126–135
 total-etching technique, 430–431
 laminate
 bonded, 63
 development of, 63
 preparationless porcelain, 62–65
 porcelain. *See* Porcelain veneers.
 provisional
 cementation of, using composite resin spot-bonding technique, 360–363
 fabrication of, 340–343
 surface preparation of, 342

Vinyl-polyether hybrid impression materials, 262

Viscosity, of impression materials, 256

Vital bleaching
 custom tray technique for, 684–691
 description of, 681–682

W

Walking bleach technique, 682, 692–695

Wax carver, 30

Wax crowns, 348

Whitening of teeth, 681–682

Working time, of impression materials, 257

Y

Yttria-stabilized tetragonal zirconia polycrystals, 151, 155, 161

Z

Zirconia
 characteristics of, 154–155
 description of, 47, 146–147
 fit adjustments, 161
 fixed partial denture framework, 156–157
 grinding effects on, 160
 properties of, 149, 153–155
 pure, 154
 single-coping, 156–157
 stabilization of, 154
 transformation toughening of, 155
 yttria-stabilized tetragonal zirconia polycrystals, 151, 155, 161

Zirconia blocks
 cold isostatic pressing method, 156
 unilateral dry pressing method, 155–156

Zirconia restoration cementation, 287, 296–299

I would like to express my gratitude to my friend Maestro Willi Geller for being my teacher and showing me the way by sharing his vision of esthetics. During this journey, I have realized that true value has come not from words on paper but from all the wonderful experiences I have shared with individuals along the way. I would like to express my gratitude to my dedicated team, Melissa and Lloyd, for their patience, commitment, and midnight hours to complete this endeavor. Also, I would like to recognize a special appreciation to the Quintessence team for their organization and relentless dedication to excellence. And most importantly, I would like to thank my Creator for giving our team the knowledge and wisdom to discover the Truth.

A handwritten signature in cursive script, appearing to read "Lloyd". The signature is fluid and elegant, with a long, sweeping underline that loops back under the main text.