

The Restoration of Endodontically Treated Teeth

Marwan Abou-Rass, DDS, MDS, PhD and Terry E. Donovan, DDS

In the past few decades, the topic of the restoration of endodontically treated teeth has been clouded with controversy. Much of this controversy was simply the result of a lack of scientific evidence to support or refute many of the commonly held beliefs in the field.

Much research has been completed in the past several years. As a result, it is quite possible that many of the most fiercely contested controversies may, in fact, be basically resolved. In order to determine the current state-of-the-art thinking about the restoration of endodontically treated teeth, a series of questions covering the major areas of controversy were sent to many of the leading authorities in the field. These questions were grouped into four major areas:

- Endodontic Treatment Planning
- Post Placement in Endodontically Treated Teeth
- Coronal Restoration of Endodontically Treated Teeth
- Materials Related Topics

The following narrative is a compilation of the responses of these experi-

enced clinicians and researchers. In many cases, the statements represent a consensus. Where widely divergent views were presented, statements have been attributed to a specific contributor.

I. Endodontic Treatment Planning

A tooth that is clinically asymptomatic, but has a radiographically substandard root canal filling, requires a cast restoration. Is endodontic re-treatment always required prior to restoration?

The authorities unanimously agreed that retreatment is required, for the sake of both the patient and the treating dentist. While it is possible that such asymptomatic teeth may not present a problem in the future, the odds are that poor quality root canal therapies will generally fail given enough time. Bollinger passionately makes the case for re-treatment:

"Lack of symptoms is not a measure of current, or future, endodontic success. Lesions may not be radiographically detectable until the pathology becomes severe. A radiographically substandard root canal treatment associated with a lesion,

even apparently incipient, **must** be retreated as these lesions are much larger in reality than their radiographic appearance indicates, and will **not** improve without treatment. Leaving the cause of the lesion untreated when one has the opportunity to correct it prior to restoration placement is an invitation to problems at a later date — usually at a less convenient time when much more is at stake."

The disadvantages of failing to treat the defective root canal filling are numerous. They include:

1. Mutilation of the restoration when re-treatment is required in the future.
2. Loss of retention and support for the restoration due to access preparation and subsequent instrumentation of the canal(s).
3. Loss of structural integrity of all-ceramic restorations and further weakening by the introduction of microcracks in the body of the ceramic, which generally propagate over time and lead to restoration failure.
4. If a post is placed over the defective endodontics, either the restoration

FORUM

will have to be destroyed in the event of eventual endodontic failure, or a surgical solution will be required. This approach, in itself, has limitations. Due to medical or financial limitations, not every patient is a candidate for surgery. Success rates for surgery are substantially lower when the existing intracanal deficiencies are not corrected prior to the surgery. Also, periapical lesions can eventually create or connect to periodontal lesions that mitigate against long-term survival of certain teeth.

Bollinger summed up this question-forcefully:

"Retreatment of defective endodontics becomes an absolute necessity when extensive, interdependent restorations are to be placed above. It is imperative that endodontic foundations are the most sound possible in cases where the teeth serve as abutments for extensive bridgework, splints, precision attachments and removable partial dentures."

Teeth with existing restorations often require endodontic treatment. Should such

therapy be performed through existing restorations such as MOD amalgams, cast gold inlays and clinically acceptable complete crowns?

The decision as to whether endodontic treatment should be accomplished **through** an existing restoration or whether the restoration should be removed prior to therapy depends upon a benefits vs. risks assessment in each individual case. There was general agreement that intracoronar restorations such as MOD amalgams or gold inlays should be removed prior to endodontic therapy and followed with full-coverage restorations.

Dick Burns indicated that attempting treatment through a clinically acceptable crown is reasonable if access is not severely compromised. Bollinger pointed out the many hazards of attempting to complete endodontic therapy with the restoration in place. These include restriction of access, increased iatrogenic errors and greater difficulty in detecting potential causes of failure such as caries, cracks and perforations. Full crown restorations often disguise the original morphology of

the tooth, making locating canals and furca positions more difficult and increasing the risk of perforation.

"In the case of full coverage restorations, endodontics may be performed through sound existing restorations. If, upon accessing through the crown, all canals cannot be located and completely instrumented because of the presence of the restoration, then the restoration should be sacrificed to save the tooth and optimize the chances for predictable long-term success." (Bollinger)

Another factor mitigating against performing endodontic therapy through an existing restoration is that the treating dentist must now accept responsibility for any errors in treatment or judgment that may have been made by the preceding dentist. Errors in resistance/retention form, or failure to completely remove caries or observe the presence of cracks, cannot be diagnosed and will subsequently become the ultimate responsibility of the treating dentist.

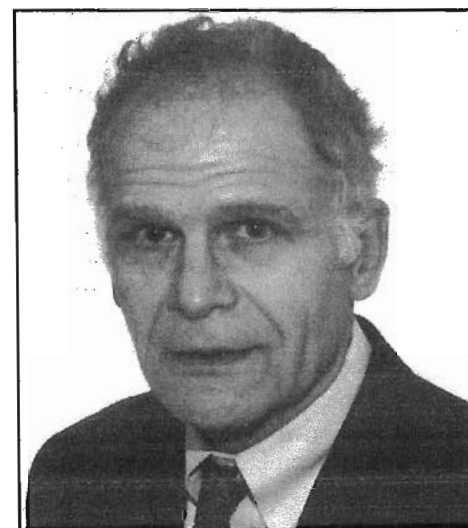
There was also general agreement that treatment should be attempted only through sound restorations.



Dr. James E. Bollinger, Private Practice, Agoura, California



Dr. Richard Burns, Clinical Professor, Department of Endodontics, University of the Pacific School of Dentistry



Dr. Philip Millstein, Clinical Professor, Department of Biomaterials, Boston University

FORUM

Leakage resulting from faulty crown margins can break the seal of the root canal filling and precipitate failure. It was recognized that some compromise must be made when dealing with large fixed restorations, and that the benefit/risk ratio is altered if a multi-unit restoration must be remade.

What risks are inherent in performing endodontic therapy through full-coverage restorations? Differentiate between anterior teeth, bicuspid and molars.

The multitude of risks inherent in performing endodontic therapy through existing restorations were well delineated by the respondents. For all teeth, these include:

- Unnecessary loss of coronal dentin.
- Potential loss of retention and loosened restorations.
- Overlooked caries and fractures.
- The chance of missing canals.
- Increased probability of iatrogenic errors (stripping, perforation, ledging, inadvertent obturation of the canal, etc.) due to restricted access.

Crowns on anterior teeth often have altered angulation for esthetic reasons.

This can make canal location extremely difficult and can result in a higher incidence of labial root wall perforation. (Burns)

Bollinger indicated that the greatest hazard involved with maxillary bicuspid teeth is the potential for perforation through the furcal wall or through the mesial concavity. The buccal wall often is difficult to locate because of coronal calcification resulting from Class V caries or cervical erosion and the restoration of such lesions.

With molar teeth, all of the above risks increase because of the restricted access coupled with the inherently more complex anatomy associated with molars.

Dick Burns suggested that when a complication is suspected during an attempt to complete endodontic therapy through a crown, the treatment plan should be immediately altered, and the restorations, caries, cement and debris removed. The remaining tooth structure should be examined carefully under magnification.

What criteria should be used to establish the endodontic standard of care prior

to post placement?

It is imperative that the endodontic therapy completed prior to post placement be of the highest quality possible: once a post is properly placed, it effectively blocks the canal and prevents straightforward retreatment. Posts often are difficult to remove, and cannot be removed without extensive access that effectively destroys the restoration. Resorting to surgery alone without proper retreatment severely compromises the long-term prognosis.

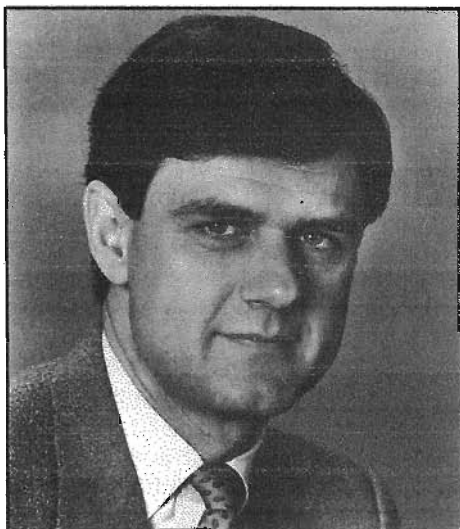
With these factors in mind, the fol-

PHOTOS NOT AVAILABLE FOR

Dr. Donna A. Burns, Private Practice, Midlothian, Virginia

Dr. Robert Staffanou, Professor and Chairman, Section of Fixed Prosthodontics, Baylor University

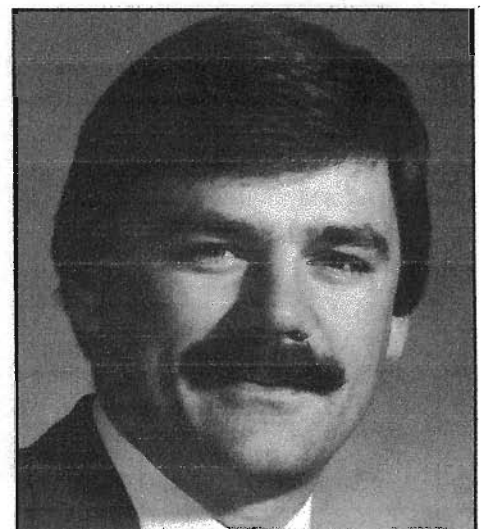
Dr. Anthony H.L. Tjan, Research Professor, Loma Linda University School of Dentistry



Dr. Dan Nathanson, Professor and Chairman, Department of Biomaterials, Boston University



Dr. Herbert Shillingburg, Professor and Chairman, Department of Restorative Dentistry, University of Oklahoma College of Dentistry



Dr. John Sorensen, Associate Professor and Director, Advanced Prosthodontics, UCLA School of Dentistry

FORUM

lowing criteria should be met prior to post placement:

1. All canals should be located and well-obtured to within 1 mm. of the radiographic apex.

2. The tooth should be examined carefully and the presence of fractures and perforations ruled out.

3. When the tooth to be posted has been treated endodontically by someone else, extra care must be exercised. (Bollinger) Even though the radiographic appearance of the root filling may appear adequate, details concerning the quality of the seal, canal conditions during obturation, etc., are lacking. The tooth must be evaluated carefully for missed canals, perforations, strips, etc. In many cases, it may be advisable to retreat the tooth prior to posting.

If endodontic treatment is performed through an existing full coverage restoration, is it necessary to place a post in the canal to reinforce the tooth?

The decision as to whether a post is required after performing endodontics through a full crown restoration must necessarily be made on a tooth by tooth basis. There was universal agreement that posts do not reinforce teeth in these situations, and that they do not increase the tooth's resistance to fracture. Thus, the function of a post in this situation would be to retain the core.

With the full crown remaining in place, it is very difficult to ascertain the retentive potential and structural integrity and strength of the remaining tooth structure. Given that the exercise is, at best, an estimation, the following guidelines suggested by Bollinger seem appropriate:

1. If adequate undercuts are provided by the pulp chamber itself, there is no reason to place a post. Placement of an intracoronal amalgam or composite resin buildup should suffice. (Donovan suggested that use of a spherical amalgam material with specific dentinal bonding agents is clinically superior to the use of composite resin.)

2. If additional retention is

required, the coronal 2-3 mm. of divergent canals may be used for additional undercuts and retention.

3. In cases where the quality and quantity of remaining dentin is deemed insufficient, posting may be indicated. Because this is obviously an inexact science, Bollinger suggested that it is probably wise to err on the side of safety and use a post whenever in doubt.

II. Post Placement in Endodontically Treated Teeth

What are the functions of a post in endodontically treated teeth?

The primary function of a post in an endodontically treated tooth is retention of the core material to provide adequate retention for the crown. Shillingburg mentioned that a secondary function of a post is to reinforce the preparation near the preparation finish line, but emphasized that the post does **not** reinforce the root, and actually weakens it. Others stated clearly that use of a post does not reinforce the endodontically treated tooth against fracture.

Tjan speculated that some reinforcement may be possible when reliable luting agents that can chemically bond to dentin and to the metallic post are available. This may well be a reality today, with both metal and reinforced graphite posts and several of the contemporary dentin-bonding agents.

Shillingburg also noted, quite correctly, that the term "dowel" is preferred over the term "post."

What criteria should be used to determine if a tooth has insufficient tooth structure remaining and hence requires post placement? Differentiate between anterior, bicuspid and molar teeth.

There was general agreement that there are two main criteria for determining whether the amount of tooth structure remaining is sufficient or insufficient to retain a crown. A minimum of two walls of tooth structure are required, and at least 2.0 mm. of coronal tooth structure should extend occlusally above the crown margin. These factors are then modified, depending upon the position of the

tooth in the arch.

Anterior Teeth:

Assuming that a crown is required for the final restoration, cast dowels and cores are recommended in the following situations for anterior teeth:

■ Lateral incisors with proximal lesions or restorations.

■ Incisors or canines with less than 50 percent of coronal tooth structure remaining.

■ When the crown preparation is approximately 1 mm. shorter occlusal-lingivally than an ideal tooth preparation. (Sorensen)

It was generally agreed that use of prefabricated cemented posts with some type of coronal buildup is contraindicated in anterior teeth. Because buildup materials (amalgam, composite resin, glass ionomer, etc.) lack adequate strength in the dimensions required for anterior crown preparations, clinical failure is a common occurrence.

Premolar Teeth:

These are treated similarly to anterior teeth in most respects, and should receive cast dowel and core restorations when they have no cusps or there is minimal support from one cusp.

Molar Teeth:

1. If two or more walls are present, use of a coronal-radicular core of amalgam is indicated, keeping the margin of the preparation a minimum of 1 mm. past the core/tooth junction.

2. With less than 2.0 mm. of coronal tooth structure remaining, and fewer than 2 cusps, dowel(s) should be used to augment retention of an amalgam core. As with #1, crown margins should be placed at least 1 mm. past the tooth/core junction.

What criteria are used to determine whether a custom cast post and core or a prefabricated post is used?

Dick Burns listed a number of factors that must be considered, mentioning that the choice of post must be made by the restoring dentist. The factors include:

- Diameter of the root.
- Length of the root.
- Quality of supporting bone.
- Angulation of the root.

- Quantity and quality of remaining dentin.

- Shape of the canal (ovoid or triangular).

Cast dowels and cores are generally indicated on anterior teeth, while prefabricated dowels are used with amalgam cores on molars. (Shillingburg indicated that use of pins to aid in retention of the amalgam core is acceptable.) Cast dowels and cores would be preferred in small premolar teeth, while prefabricated dowels and amalgam buildups are preferred on larger premolars.

Because a reliable manufacturer can readily control the fabrication process, the material itself and the overall quality of the product, Tjan generally favors prefabricated posts. He does however, agree that custom dowel cores are indicated when there is extensive damage to the tooth, especially when the margin of the subsequent restoration cannot be placed on sound dentin. In this circumstance, use of a custom dowel core would permit placement of the crown margin on the gold core.

What are the optimum design parameters of a prefabricated post system?

A prefabricated dowel should be:

- Parallel-sided. For roots that morphologically are very tapered, a post that is tapered in the apical 1/3 is preferred. (Tjan)

- Serrated (or at least roughened).

- Passive.

- As long as possible, leaving a minimum of 4 mm. gutta percha for apical seal.

- Less than 1.2 mm. in/diameter. Another suggested criteria for diameter would be 1/3 of the mesial-distal and buccolingual diameter of the root. Gains in retention due to increases in diameter are minimal, and come at the expense of critical tooth structure.

What are the indications for active threaded screw posts?

Answers varied from "none" to use with "short roots and no coronal tooth structure." These teeth would not be suitable for use as a fixed partial denture abutment.

Do you consider posts such as the "Flexi-Post System" to be active or passive screw posts?

Most authorities considered the Flexi-Post System to be an active screw post. One expert described the Flexi-Post as "an active post with some stress release or reduction at best." Sorensen indicated that although it is definitely an active post in that it is tapped and threaded into tooth structure, when properly handled, it exerts less force on the lateral walls of the canal than some of the more traditional active systems. He suggested the use of the term "semi-active screw post."

"Based on the work of Ross, Nicholls and Harrington, it would appear that stress is developed within the root as the Flexi-Post is placed, and it would be misleading to classify it as anything but an active post." (Donovan)

Donna Burns commented: "All posts will cause internal stresses in remaining dentin. Some post designs are better able to distribute these stresses over a larger surface area and minimize focal stresses which can lead to vertical fracture of the remaining tooth structure and tooth loss. In our study of stresses produced during post cementation, we compared two passively cemented, parallel-sided, serrated, vented posts and one parallel-sided threaded post with a tapered apical end and split shaft. We found that the threaded post design produced asymmetric stress patterns with concentrations of stress associated with each thread. The parallel-sided non-threaded posts produced more evenly distributed patterns of stress within dentin. Additionally, the threaded post displayed significantly higher shoulder stresses and substantially greater stresses along the coronal surface of the post's length than the nonthreaded variety."

III. Coronal Restoration of Endodontically Treated Teeth

Do endodontically treated anterior teeth generally require coronal coverage?

Endodontically treated anterior teeth do **not** necessarily require coronal coverage. That will depend on esthetics, degree of breakdown of the tooth and patient desires. Routine coronal

coverage of anterior teeth for protective reasons is contraindicated.

Do endodontically treated posterior teeth generally require coronal coverage? If so, is complete coverage essential, or will a partial veneer restoration, such as a 3/4 crown or MOD onlay, suffice?

Endodontically treated posterior teeth definitely require coronal coverage. Both complete coverage and partial coverage are acceptable, depending upon the amount and location of tooth structure remaining and expected occlusal forces, among other factors.

Are posts required on anterior and posterior endodontically treated teeth with intact coronal surfaces?

Answers varied from "yes" (Staffanou) to "maybe," depending upon the situation. If credence is given to the answers to the first question in Part II, regarding the function(s) of a dowel (retention of the core), then the answer would likely be "no" in most situations.

What occlusal factors might be important to consider in the restoration of endodontically treated teeth?

Consideration must be given to the potential amount of force that will be delivered to an endodontically treated tooth. In this regard, posterior teeth generally receive more force than anterior teeth, and thus require coronal protection. With anterior teeth, consideration must be given to the direction of applied force and the strength of the remaining tooth structure. The existence of parafunctional habits also might necessitate coronal coverage in some situations.

Is the optimum restoration of an endodontically treated tooth different when the tooth will be used as an abutment for a fixed partial denture or a removable partial denture as opposed to a single unit?

Answers ranged from "no" to "yes." Most felt that an endodontically treated tooth used as an abutment for a fixed partial denture would require maximum reinforcement for resistance to torsional forces and protection

FORUM

against breakage. The main feature in this regard is achieving a maximum ferrule effect.

IV. Materials Related Questions

When coronal coverage is not required, what is the optimum material when restoring the access opening of an anterior tooth? Of a posterior tooth?

Respondents were unanimous in the opinion that the best material for restoring an access opening of an anterior tooth is composite resin bonded to the tooth by means of acid-etching the enamel walls. Use of one of the contemporary dentin-bonding agents on the dentin walls also would be indicated.

The experts also were unanimous in indicating that because endodontically treated posterior teeth generally

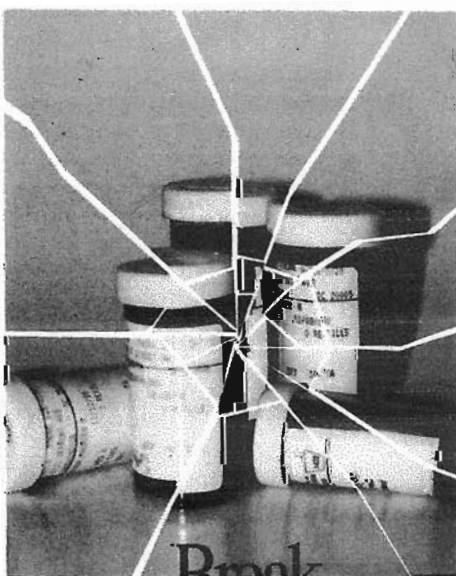
require coronal coverage, the question as to what to use to restore the access opening is unimportant. Donovan felt that, even though the restoration of the access opening was important only for a short time, the use of bonded amalgam is indicated for optimum seal and some potential for cuspal reinforcement.

What is the alloy of choice for cast post and cores?

Donovan reported that this is a question that has not really been addressed in the literature. Desirable properties for such an alloy include high yield strength, biocompatibility, castability, minimal casting shrinkage and relative economy. Most alloys are adequate in terms of strength and castability, making the important fac-

tors biocompatibility, casting shrinkage and economy.

Casting shrinkage is an important consideration, especially when a well-defined ferrule is achieved with a core. In this situation, an extremely accurate casting is required because the dowel must not expand in order to remain passive, yet the core itself cannot shrink, or it will fail to seat completely. With base metals that display high casting shrinkage (2.4 percent), it is a common practice to slightly overexpand the casting with high expansion phosphate-bonded investments. This allows complete seating with a totally extracoronary casting, but is contraindicated with a complicated casting such as a dowel and core. Alloys with minimal casting shrinkage, such as Type III golds, can be compensated with



Break the Rx Silence Barrier

Write for a free "Talk About Prescriptions" Month Guide containing "how-to" ideas and reproducible patient handouts to:



The National Council on Patient Information and Education
666 11th Street, NW, Suite 810
Washington, D.C. 20001

¹ FDA survey, "Patient Receipt of Rx Drug Information", 1983

² A Study of Attitudes, Concerns, and Information Needs for Rx Drugs and Related Illnesses, CBS Television Network Consumer Model Survey, 1983



dMax™

#1 Rated Dental Management Software For Macintosh® Computers

Find out why two independent
surveys rated dMax #1!

Get The Facts!

Call Today For Free 40 Page Brochure
1-800-MAC-7796

dMax™ - Beal Systems Inc.

23 Altarinda Road, Suite 103
Orinda CA 94563

Since 1985

Macintosh is a Registered Trademark of Apple Computer, Inc.

impressive accuracy with gypsum-bonded investments.

The issue of economy often is of some importance with a cast dowel and core because of the size of the casting in some situations. This is especially true with those fabricated for posterior teeth.

In terms of biocompatibility, nickel-containing alloys are undesirable due to the high incidence of nickel allergy in the population, especially among women (9 percent). Alloys with a high concentration of silver, such as the silver/palladium alloys, have the potential to corrode within the canal, and should not be used. Type IV golds containing 60-70 percent gold and 20-28 percent silver seem to be ideal for this use. They are quite strong, with yield strengths in the 45,000-55,000 psi range; are biocompatible; do not tend to corrode; and display casting shrinkage similar to Type III golds (1.2-1.3 percent). Also, because the gold content is somewhat less than that of Type III golds, these alloys are reasonably economical.

Are prefabricated posts best fabricated from titanium or stainless steel?

There is no good evidence on this issue one way or the other. Titanium posts have adequate physical properties and are obviously biocompatible, and thus have captured a large share of the market. Whether or not the improved biocompatibility is a real advantage is open for debate. However, since there are no major disadvantages to the use of titanium posts, it seems reasonable to use them.

What luting agent is preferred for the cementation of posts?

The vast majority of dowels should be cemented with zinc-phosphate cement. (Donovan) The primary function of a dowel is retention of the core. In order to attain retention, the dowel should be as long as possible, without disturbing the apical seal of the gutta percha root canal filling. If adequate dowel length is achieved, the dowel will be readily retained with a proper

mix of zinc-phosphate cement. If indicated some time in the future, it is probable that such a cemented dowel could be removed to allow retreatment.

Glass ionomer should not be used for dowel cementation because it takes considerable time to reach maximum strength. The core usually is shaped and adjusted with high-speed rotary instruments shortly after cementation, and the forces generated at that time can dislodge the dowel.

Resin cements can provide increased dowel retention when it is required, but are more technique-sensitive to use, and also will prevent dowel removal when it is desirable. Thus, resin cements should only be used in situations where exceptional retention is required. This might occur when the anatomic limitations are such that only a short dowel can be fabricated, and when using attachments with overdentures.

When a direct restorative material is used to build up a tooth prior to crown fabrication, is the optimum material silver amalgam, conventional glass ionomer or glass cermet, a light-cured glass ionomer or a composite resin? If composite resin, should it be chemical-cured or light-cured?

Assuming that the buildup will play an important role in the resistance/retention form of the preparation, the optimum material is clearly silver amalgam. Adequate mechanical retention form must be achieved for the amalgam within the tooth and pulp chamber, augmented with the placement of a prefabricated post where necessary. Retention also can be augmented using the bonded amalgam approach with dentin-bonding agents.

Conventional glass ionomers and glass cermets do not possess adequate tensile strength to serve as large buildup materials. Some of the newer light-cure glass ionomers (Vitremmer, 3M Dental, St. Paul, MN) have vastly improved physical properties over conventional glass ionomers, and may be used in intermediate buildups, but more clinical experience is essential before recommending their use in large buildups.

Chemical-cure composite resin, while convenient to use, is problematic, because the material will shrink toward the center of the mass when placed in bulk, and no dentin-bonding agent on the planet has the ability to resist the resulting shrinkage stress. The result is that the resin core will not adhere to the remaining tooth structure and a gap will be created. This gap results in delayed stress transfer when forces are applied to the coronal restoration. Over time, this can lead to the crown coming loose.

Light-cure composite resin materials cannot be cured in bulk, and thus must be cured in small increments. These materials, used in conjunction with contemporary dentin-bonding agents, can be used successfully for large buildups. By curing the composite material in small increments, the deleterious effects of polymerization shrinkage can be negated, and integrity with the remaining tooth structure maintained. The disadvantage to this approach is that it is quite time-consuming.

SUMMARY

A number of well-known authorities on the topic of the restoration of endodontically treated teeth were posed a number of questions related to the topic. It was apparent to the authors that consensus was achieved on almost all of the issues addressed. It is apparent that published research and clinical experience have resolved many of the questions that once were considered controversial regarding the restoration of endodontically treated teeth.

The authors wish to express their appreciation for the efforts and timely contributions of the authorities consulted. CDA

Authors

Dr. Abou-Rass is a professor, chairman of the Department of Endodontics and director of Advanced Education in Endodontics at the USC School of Dentistry. Dr. Donovan is an associate professor, chairman of the Section of Biomaterials Science and director of Advanced Education in Prosthodontics at the USC School of Dentistry.

Copyrights Dr. Marwan Abou-Rass.
mar@abourass.com
PAADI.org