

Adhesive Technology Solutions

The Art and Science of Modern Techniques for Restoring Badly Broken Down Teeth



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Almost no procedure in dentistry has undergone more evolution both in philosophy and clinical practice than the restoration of badly broken down vital and non-vital teeth. The issues surrounding this topic include post vs. no post, adhesive cements vs. traditional post cements, adhesive technique, core materials, and technique sensitivity in core placement. Within the adhesive technique category, there are a multitude of issues to consider, including mode of cure, compatibility of adhesives and core material, phosphoric acid etch vs. self-etch products, and contamination with sulcular fluids or other agents.

Research and technology have revolutionized dental procedures. This revolution has occurred at such a staggering rate, it has become almost overwhelming to the practicing dentist, who must make decisions based on a combination of experience and current trends. This article will combine the results of current research and clinical experience to provide answers to the many questions that have arisen over the last several years regarding restoration of severely broken down teeth.

The Use of Posts in Non-Vital Teeth

The philosophy of the post and core restoration has changed significantly over the

past 20 years. Research has shown that posts do not strengthen teeth and should only be used to retain the core build-up.^{1,2} Because core build up material can now be adhesively bonded to tooth structure, many clinicians choose not to use posts more frequently than in years past.³ However, in severely broken down teeth, posts are still used to aid in core retention. Modern prefabricated post materials can consist of stainless steel, titanium, ceramic, or fiber-

Therefore, fiber-resin posts may be less likely to cause root fracture than other post materials.⁶

reinforced composite.^{4,5} Some of the newer post designs have been created to more intimately conform to the anatomy of the canal. Many brands are parallel-sided, but tapered at the apical end, or are tapered in shape. Tapered posts have been shown to fit the canal shape more closely, and be safer at the apical end, but have also been shown to create a wedge effect which can result in vertical root fractures.^{2,3}

Stiffness of posts has also become an issue studied recently. The properties of metal, ceramic and resin posts are quite different. It has been shown that the resin-reinforced posts have approximately the same stiffness, or modulus of elasticity, as dentin. The other types of posts are much stiffer than dentin. Therefore, fiber-resin posts may be less likely to cause root fracture than other post materials.⁶

Adhesive versus Traditional Cements

There are different goals practitioners have regarding post cementation. Retrievability is one philosophy in post placement. Some practitioners feel more comfortable being able to re-access the canal

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Practical Restorative Progress

A Rapid Core Buildup Technique

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When a tooth is to be crowned, there must be adequate structure remaining for creating retention and resistance forms for the final restoration.^{1,2,3} If there is insufficient coronal tooth structure remaining, a core buildup must be done. The purpose of the core buildup is to provide the clinician with material which can be shaped properly for the subsequent crown to be placed over.

If a tooth is non-vital and has insufficient coronal tooth structure to retain the core, a post must be used. However, if substantial coronal tooth structure is left on a non-vital tooth, some clinicians say that a post isn't

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at a later time, if necessary. However, studies have shown endodontic success rates to be as high as 90 - 95%.^{7,8} With the quality of endodontic materials and the high success rate of root canal treatments done today, it is very rare that one would need to gain access to an obturated canal. Moreover, most final crown restorations eventually fail because of

strengthen teeth is based on many studies, but most of these studies used traditional cementation methods and materials. Perhaps with adhesive cements, this theory can be disproved. There are adhesive cements available that can bond to all types of post materials as well as to dentin. A recent study reported on the bond strength of adhesive

bond to dentin, such as moisture conditions, dentin depth, curing mode, chemical formulation, and contamination with blood, saliva and astringents.¹¹

The newest generation of adhesives, the self-etching products, contain an acidic monomer that etches and primes dentin simultaneously, thus eliminating the need for phosphoric acid etching.^{12,13} These products are less technique-sensitive because of the fewer steps involved. They also have been shown to produce less post-operative dentin demineralization and resin penetration of dentinal tubules, which prevents a layer of demineralized dentin from forming below the adhesive layer. Also, self-etching adhesives potentially bond better to deep dentin because they precipitate smear layers which keep the large, wet tubules of deep dentin from being exposed.¹⁴ Research has shown some self-etching products provide excellent bond strengths to dentin.¹⁵ Total-etch systems are still excellent adhesives, but the future of dentin bonding will be with the self-etching systems. When bonding with core materials, it is best to follow manufacturers' instructions and read current publications on adhesive dentistry for the best adhesive techniques.

TABLE 1*

Means (standard deviations) of bond strength (MPa) data (N = 5).

Post Material	Esthetic Resin Cement†	Adhesive Resin Cement†	Panavia 21
Stainless Steel	16.4 (9.5)	27.3 (4.6)	29.9 (11.0)
Titanium	11.7 (2.7)	22.0 (2.0)	36.9 (11.7)
Carbon Fiber	13.7 (5.0)	20.0 (3.1)	24.5 (0.9)
Zirconium Ceramic A	8.2 (2.7)	7.4 (3.0)	21.7 (8.0)
Zirconium Ceramic B	7.6 (2.0)	12.8 (5.8)	31.6 (10.2)

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†Brand names available upon request

TABLE 2*

Mean (S.D.) Microtensile Bond Strength (MPa) of Core Materials to Dentin using a Self-Etched, Light-Cured and a Total-Etched, Dual-Cured Adhesive.

	Dual-Cured Core Material†	Self-Cured Core Material†	Clearfil Photo Core
Clearfil SE Bond	41.0 (5.9)	20.4 (8.1)	35.9 (7.4)
Dual-Cured Total Etch Adhesive†	26.7 (7.6)	0.0	23.0 (5.9)

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†Brand names available upon request

post and core failures and/or lack of post retention, not because of failure of the endodontic procedure. However, if the goal of the practitioner is post retrievability, zinc phosphate cement is still an excellent post cement. Adequate working time and low film thickness are also advantages of this type of cement. However, zinc phosphate does not bond to tooth structure.

Glass ionomer (GI) cements can also be used to cement posts. Conventional GI cements release fluoride and have a minimal bond to tooth structure. Resin-modified glass ionomer cements are used most commonly for traditional cementation methods. This cement has a fairly high bond to tooth structure and still releases fluoride, although not to the degree that the conventional GI cements do. However, there has been a problem in the past with delayed expansion, which could be a problem cementing a post in a narrow, enclosed canal space. Most companies state that this problem has been resolved, however.⁹

If the goal in post cementation is strength, adhesive resin cements may be the answer. The theory that posts do not

and conventional resin cements to various post materials.¹⁰ The results of this study are shown in Table 1, which compares a traditional resin cement (Bis-Core) to two adhesive resin cements. In general, bond strengths of 18 MPa or higher represent clinically stable bonds. The adhesive cements display high bond strengths to most (C&B Metabond) or all (Panavia 21) post materials.

Adhesive Technique

At the Houston Biomaterials Research Center of the University of Texas Dental

Branch at Houston, we have tested many adhesive systems in many different bonding conditions. In general, we have learned that many factors affect the successful, long-term

There are adhesive cements available that can bond to all types of post materials as well as to dentin.



Figure 1

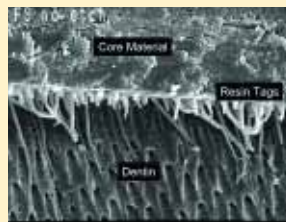


Figure 2

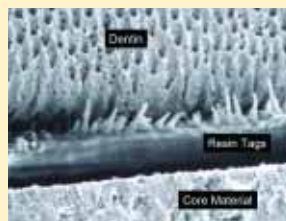


Figure 3

Core Materials

Two of the most critical issues regarding the choice of an ideal core material are retention and strength. The core build-up must be retentive enough short-term to resist dislodgement forces during the preparation and impression-making phase and long-term, after the final restoration is completed. Retention of core material to tooth structure can be obtained by developing undercuts in the preparation, or by bonding to tooth structure, or by a combination of both. It is always best not to depend solely on bond strength, because there are so many factors which affect the bond of composite to dentin, such as moisture tolerance, contamination, and adhesive/core material compatibility.¹⁶ There has been much discussion in the literature relating to

adhesive/core compatibility. Many core materials are dual- or self-cured and may not adhere adequately to a light-cured or a dual-cured adhesive. Recently, an article has been published that supports this contention.¹⁷ In this study, a self-etched, light-cured adhesive and a dual-cured, total-etch adhesive were bonded with light-, dual-, and self-cured core materials to superficial dentin. The results showed that there were some incompatibilities. However, although Clearfil SE Bond is indicated primarily for bonding to light-cured resins, in this study, it was compatible with all types of core materials, as shown in Table 2.

Figures 1, 2 (reprinted with permission from Quintessence Publishing Co.) and 3 show the adhesive interface of several of the groups in this study. Note that in Figure 1, the resin tags are longer and more numerous than those shown in Figure 2. However, the bond strength of the group represented by Figure 1 was lower (26.7 MPa) than the group represented by Figure 2 (41.0 MPa). Resin tag quantity and quality do not necessarily relate to bond strength. Figure 3 is an example of a bonding incompatibility.

Other recent articles have shown that there are less incompatibilities now than there were several years ago between adhesives and core materials, but in general, highest bond strengths were obtained with light-cured core materials.¹⁸

Core material strength is the other critical issue in obtaining a successful, long-term restoration. Many studies have shown that amalgam and composite are the two strongest build-up materials available.^{19,20,21}

Because of the ability to bond to tooth structure and the immediate setting capacity, composite is the material of choice in

..., but in general, highest bond strengths were obtained with light-cured core materials.¹⁸

today's dental offices. There are many composite build-up materials available. Most composite core materials are either dual- or self-cured because often, the restorations

are thick and chemical-curing capability is an advantage. However, in general, dual- and self-cured composites have been shown to have lower bond strengths to dentin than light-cured products.^{22,23,24} Clearfil Photo Core, one of the only light-cured core materials on the market, is very translucent in color and has a very high depth of cure. One study cured 2, 4, 6, and 10 mm of Clearfil Photo Core to dentin with the adhesive Clearfil SE Bond. The results, shown in Table 3, showed that bond strength did not decrease at all with Clearfil Photo Core until the 10 mm thick group, and even at 10 mm, the bond strength was greater than 18 MPa, a clinically acceptable bond. Therefore, these



Figure 4



Figure 5



Figure 6



Figure 7

results suggest that it is possible to use a light-cured core material without compromising strength.

Technique Sensitivity in Core Placement

Often, when restoring badly broken down teeth, it is necessary for the preparation to extend subgingivally, which tends to cause trauma to the soft tissues. One disadvantage of composite core material is the technique sensitivity issue involved in the bonding process. It is always advisable to use rubber dam isolation whenever possible in any bonding situation. Recent studies have reported on the results of various types of contamination on the bond strength of composite to dentin, with varying results. Most studies used one- or two-bottle total-etch systems, rather than self-etching systems. To summarize the results of several studies, saliva did not appear to affect the

bond strength of total-etch adhesives to tooth structure, but blood, handpiece oil, and eugenol lowered bond strengths. However, re-etching with phosphoric acid seemed to raise the bond strengths to nearly control levels.^{25,26} The results of our recent saliva contamination study using Clearfil SE Bond adhesive and Clearfil AP-X composite bonded to human dentin are shown in Table 4.²⁷ The results indicated that saliva did not negatively affect the bonding process, whether contamination occurred before or during adhesive placement

A similar study using the same adhesive and composite showed that contamination with blood also did not affect the bond strength significantly, which differed from previous studies.²⁸ However, in yet another contamination study with astringents, we found that both ferric sulfate and aluminum chloride astringents negatively affected the bond strength of composite to dentin.²⁹ Although it was found that rinsing with water spray restored bond strengths to half or more than half of the original bond, both

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TABLE 3

Mean (S.D.) Tensile Bond Strength (MPa) of Various Thicknesses of Core Materials to Dentin.

	2 mm	4 mm	6 mm	10 mm
Clearfil Photo Core	25.9 (6.8)	24.5 (5.2)	26.3 (6.8)	18.9 (7.6)
Dual-Cured Core Material†	19.3 (3.2)	23.1(7.6)	24.2 (4.0)	15.4 (4.1)
Self-Cured Core Material†	14.3 (2.4)	20.9 (2.2)	16.2 (3.9)	14.9 (3.7)

†Brand names available upon request

TABLE 4

Mean (SD) Bond Strength (MPa) of Composite to Saliva-Contaminated Dentin.

Clearfil SE Bond	Control	SA*	AS*	ASW*	ASWA*
	31.1 (7.6)	30.8 (7.1)	25.1 (9.6)	25.6 (8.2)	31.2 (7.4)

*SA=Saliva, Adhesive

AS=Adhesive, Saliva

ASW=Adhesive, Saliva, Water rinse ASWA=Adhesive, Saliva, Water rinse, Re-apply Adhesive

astringents had a negative affect on the bond to dentin. Therefore, it may be desirable to try to achieve tissue stability without the use of astringents, if possible. Dry retraction cord, or other types of tissue retraction methods may need to be explored when bonding composite core materials.

Clinical Technique

This case describes the technique for creating a bonded core build-up for a vital tooth. In Figure 4, the pre-operative view shows the buccal cusp of tooth #4 fractured off to the level of the gingival tissue. After the rubber dam was placed (Figures 5 and 6), the rest of the old restoration was removed. Figure 7 shows the remaining tooth structure after all caries and old composite were removed. Next, a core former was trimmed and fit to the remaining tooth structure (Figures 8 and 9). Once a correct fit was verified, dry retraction cord was placed and Clearfil SE Bond Primer and Adhesive were applied to the rinsed and gently dried tooth according to manufacturer's instructions, and the adhesive was light-cured for 10 seconds (Figures 10–14). Clearfil Photo Core was placed inside the core former and inserted onto the preparation and light-cured in bulk for 40 seconds (Figure 15, 16). Figure 17 shows the removal of the core former matrix with hemostats. The



Figure 8

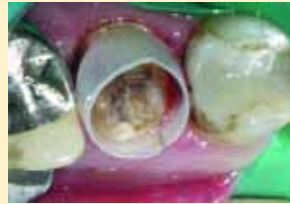


Figure 9



Figure 10



Figure 11

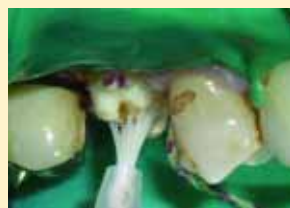


Figure 12



Figure 13

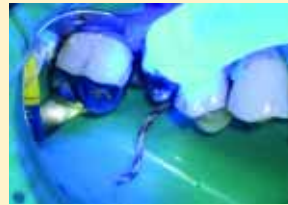


Figure 14



Figure 15



Figure 16



Figure 17

preparation was then refined with diamonds (Figures 18 and 19). Figure 20 shows the core build-up complete and ready for provisionalization or impression-making.

In my clinical practice, I have used these materials for 5 years, and have had no core build-ups de-bond and no post-restorative failures. I highly recommend this technique for building up badly broken-down teeth.

Editorial and research assistance for this article contributed by Lilliam M. Pinzone, DDS.



Figure 18



Figure 19



Figure 20

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Rapid Core Buildup Technique

necessary. While the purpose of a post is to help retain the core, complete elimination of the post is an area that still requires further investigation. In one study, it was shown that core buildups with a post exhibited statistically better strength than similar size core buildups without a post.⁴ If any doubt exists as to whether a post is necessary, placing a post in a non-vital tooth is the prudent alternative.

Prior to the advent of the bonding revolution and adhesive dentistry, amalgam cores with pins were commonly used for core buildups on vital teeth. An alternate technique in some cases was elective devitalization of the tooth and placement of a cast post and core. With adhesive dentistry having advanced to the point where bonding to dentin is predictable and successful, it is possible to secure a composite core to dentin without the use of pins.

In the case of vital teeth, a core buildup may often be done without the need for elective endodontics so long as there is some coronal tooth structure left. With adhesive procedures and composite, it is inappropriate to use pins to help retain the core. Composite has adequate strength for most situations. It can be tooth colored or shaded for contrast to tooth structure, and most composites cut like dentin. Composite materials can also be prepared immediately after curing.

This article will demonstrate a rapid core buildup technique using a self-etching primer/bonding system and a compatible light cured material. The manufacturer suggests a large volume of material may be light cured in bulk. While there is always a concern with regard to possible microleakage from polymerization shrinkage, especially

with a large volume of material cured in one increment, it should not be a factor since the core will be totally covered with a crown. In this case, crowns were to be placed on teeth #12 & 13.

Chairside Technique

All defective restorations and caries were removed from teeth using a KaVo Optilux fiberoptic #649B high speed handpiece (KaVo America).

In the case of vital teeth, a core buildup may often be done without the need for elective endodontics so long as there is some coronal tooth structure left.

Figure 1 shows the completed excavations. A matrix system of the clinician's choice is then placed. In this case, conventional toffemire bands and retainers were used. The matrices are secured at the gingival margin with anatomic

wooden wedges (either Contoured Wood Wedges; Clinician's Choice or Sycamore Wood Wedges; Premier).

(Figure 2) The cavity preparation is washed well and dried.

Using a microbrush (Microbrush Corporation), Clearfil SE Bond self-etching primer (Kuraray) was applied and gently agitated on the tooth surface for 20 seconds.(Figure 4) It was then gently air dried to evaporate any excess solvent. Using another microbrush the bonding agent was applied, air thinned gently, and light cured for 10 seconds.(Figure 5) It is a good idea to always use different color brushes for primer and bond so as not to confuse the two brushes.

After the adhesive was applied, Photo-Core (Kuraray), a light cured core buildup material, was inserted into the

cavities. This material is easily condensed and will have good adaptation to the underlying dentin. According to the manufacturer, a layer of up to 8mm can be cured, thereby obviating the need for incremental buildup unless the amount of core material is going to be greater than 8mm in height.

The matrices were opened and the core cured for another 20 seconds from the facial. Curing can also be done from the palatal or lingual after the bands are completely removed.(Figure 6) After removal of the matrices, the teeth were ready to be prepared for crowns.(Figure 7) Impressions and temporization followed.

There are many ways to accomplish a core buildup on vital teeth. This article offers the clinician an

additional technique to rapidly and predictably accomplish the task.

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Figure 4: applying self etching primer

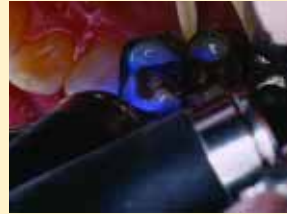


Figure 5: applying adhesive



Figure 6: additional light curing from facial



Figure 7: completed core buildups



Figure 1: completed excavations



Figure 2: matrix bands & wedges placed



Figure 3: Clearfil SE Bond



D2950 core buildup, including any pins

Refers to building up of anatomical crown when restorative crown will be placed, whether or not pins are used.

Limoli Comments:

A core buildup is frequently called a “crown buildup” by the reimbursement industry, even though terminology was changed from “crown buildup” to “core buildup” in the 1991 CDT-1. Its clinical definition is quite clear since it essentially is a constructed foundation upon which a crown is to be seated.

A core buildup is necessary only when the tooth being crowned is so damaged that there is insufficient sound tooth structure remaining to support a restorative crown. According to some reimbursement contracts, liability acceptance for core buildups must clinically involve the remaining compromised clinical crown, which would generally be 3 mm or less in height circumferentially. From the standpoint of the dynamics of occlusion, adequate mechanical retention is required to withstand the displacement of the fabricated crown.

A core crown buildup would be necessary to furnish required retention form or resistance form. Any procedure involving tooth structure replacement for purposes of pulpal insulation, undercut elimination, casting bulk reduction, or for any purpose other than obtaining adequate retention would not qualify as a buildup.

However, it seems prudent to supplement the core retention provided by an endodontic post if more than 50% of the coronal tooth structure has been lost. The core buildup reimbursement criterion is an ongoing controversy. Remaining clinical structures

of 3 mm or less circumferentially do not correspond to less than 50% of remaining, sound, natural tooth structure.

A core buildup may or may not contain pins. If pins are associated with the core buildup, they are all-inclusive in the buildup procedure. The pins that are used should not be identified separately. Your fee for a core buildup should be the same whether or not pins are used.

Many reimbursement contracts consider core buildups on vital teeth to be no more than cement bases. Traditionally, payers do not reimburse providers for cavity liners or cement bases. It is most beneficial to submit code D2950 with a narrative report to avoid reimbursement confusion. The narrative for code D2950 should indicate whether the tooth is vital.

In most cases, core buildups are an allowed benefit if the radiographic and photographic evidences substantiate treatment need and if the procedure is not specifically excluded from coverage. Claims for buildups that are not submitted with the crown's insertion date are either denied, pending submission of the crown, or are reviewed by a dental consultant for liability evaluation.

Claims examiners routinely deny benefits for core buildups because the claims are not submitted with x-rays, photos, or narratives. Most third-party payers agree that the burden of proof for a buildup procedure lies with the submitting dental office. It is a sad fact that most payers find core buildups being billed simply to increase the benefit payable for the crown.

A sample narrative may be:

“Provides needed resistance, retention and geometric form to compromised coronal aspect of tooth. See enclosed photograph.”

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ASK KURARAY

Q I have been using caries disclosing solutions (Caries Detector from Kuraray) for several years and was wondering if the use of such materials has any affect on bond strength to dentin?

A A study published in Operative Dentistry, 27:238-242, 2002, by R.B. Kazeni, et.al, indicated that there was no significant affect on bond strength with the two caries disclosing materials tested with the three bonding agents tested. The project studied the effect of caries disclosing dyes on the bond strength to dentin of Clearfil SE Bond, Prompt L-Pop, and Prime & Bond. Self-etching primer products are rapidly replacing “total-etch” and “acid-etch” systems and the use of caries dye products is also increasing. Clearfil SE Bond, one of the self-etching products studied in this project has become one of the most recognized, tested, and popular of the self-etching primers.

Q What is the best cement to use for post cementation?

A A study published in the Journal of Prosthodontics, 11:168-175, 2002, by M.S. Hagge et. Al., reported that Panavia 21 resin cement had the highest retentive strength of the five cements tested. Parapost posts were cemented with a composite material (Parapost composite), a zinc phosphate (Flecks), a glass ionomer (Ketac-Cem), a 4-META resin (C&B Metabond), and a resin cement (Panavia 21), then tested. The retentive strength reported for Panavia 21 was consistently and significantly higher than any of the other cements in this study.



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