ROOTS

SPECIAL POINTS OF INTEREST

- Coronal microleakage
- Dentin bonding
- Bonding systems
- Bonding RCT teeth
- Orifice barriers
- Access openings
- Posts—overview
- Restoring RCT teeth
- Fibre posts
- Post length
- Restoration trivia

Prevention of Coronal Leakage

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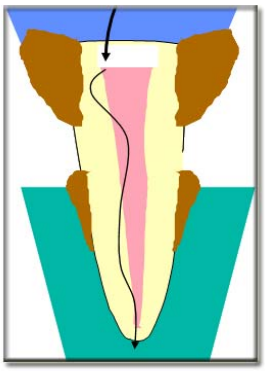
In vitro/In vivo

The use of orifice barriers as a precursor to or a concomitant component of restoring an access opening separately or doing a core buildup in conjunction with obturation has long been understood to be an integral component of endodontic success.

Coronal microleakage is a potential cause of endodontic failure *(Saunders and Saunders 1994)*. The quality of the coronal restoration has a significant impact on the health of the periradicular health of root filled teeth *(Tronstad et al, 2000, Hommez et al 2002, Siquiera et al 2005)*. A study of 775 endodontically treated teeth in 508 patients showed higher survival rate if restored within 2 weeks *(Willershausen et al 2005)*.



Once root canal treatment is completed, immediate restoration of the tooth is recommended whenever possible *(Heling et al 2002)*.

Swanson& Madison 1987—dye leakage to apex—3 days
Torabinejad et al 1990/Khayat et al. 1993—bacteria to apex—30days
Trope et al. 1985– Endotoxins to apex—20days

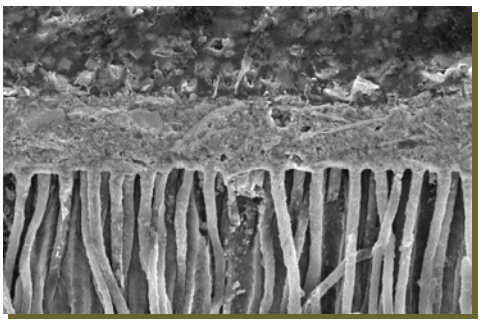
Bonded permanent restorations (regardless of the restorative material) should be used whenever possible to minimize microleakage *(Urange et al 1999, Howdle et al 2002)*.

Dentin bonding

Acid-etching demineralizes dentin and exposes the superficial collagen matrix - a hydrophilic primer penetrates the collagen matrix - the volatile liquid in the primer evaporates - an adhesive resin co-polymerizes with the resin in the collagen matrix. The layer between the restorative material and the dentin consists of collagen fibres surrounded by resin and is referred to as the HYBRID LAYER. Dentinal tubules are not major contributors to retention. The collagen matrix in the intertubular dentin is more important to retention than the tubules and dentinal tubules account for only about 15% of retention.

Dentin and Enamel Bonding Systems

Etch and Rinse—4th generation—etch, rinse, primer, air dry, adhesive, polymerize.
3 steps



5th generation—etch, rinse, combined primer and adhesive, polymerize, 2 steps.

Self Etching—6th generation—acidic primer, air dry, adhesive, polymerize. 2 steps

7th—generation—acidic primer and adhesive combined, polymerize. 1 step

In general—3 step adhesives work the best and area most durable *(Inoue et al. 2001, van Meerbeek et al 2003, Tay et al. 2003, Fabianelli et al. 2003, de Munck et al. 2003, Armsrtong et al. 2003, Chersoni et al. 2005, Breaschi et al. 2008.* **Dental bonding agents lose bond strength over time** *(Takahashi et al. 2000, de Munck et al. 2005, Shirai et al. 2005).* **The three step etch and rinse adhesives remain the gold standard in terms of durability. Any kind of simplification in the clinical application procedure results in loss of bonding effectiveness.**

Bonding Systems

(exceptional track record)

- Optibond FL (Kerr): 3–step etch and rinse adhesive *(van Dijken & Pallesen Dent Mater 2008)*

4th generation

High bond strength

Stable bond over time—annual failure rate 3.1%

13 years of clinical data

20 years of clinical results

Works in wet, moist and dry preparation

Compatible with self or dual cure composites

Least technique sensitive of any adhesive

- Photobond (Kuraray): 3—step etch and rinse adhesive

4th generation

High bond strength

Fairly stable bond over time, annual failure rate 2%

13 years of clinical data

20 years of clinical results

Will work with wet, moist or dry preparation

Compatible with self or dual cure composites

Probably one of the least technique-sensitive of any adhesive

- Clearfill SE Bond (Kuraray): 2—step self etch adhesive

Composites *(Feltzer et al. 87, 88, Carvalho et al. 96, Braga et al 02, de Munck et al 05)*

The biggest disadvantage of composite resins is they shrink during polymerization (2-6%) and the contraction forces from polymerization shrinkage often exceed the bond strengths of dentinal adhesives. This may lead to stress, fractures, debonding and microleakage.

Solution

Incremental filling. Self or dual cure core materials: slow setting composites place less stress on the bond. The obvious answer is development of composites that shrink less—3M's new Filtek-Silorane composite, <1%)

Bonding in Endodontically Treated Teeth

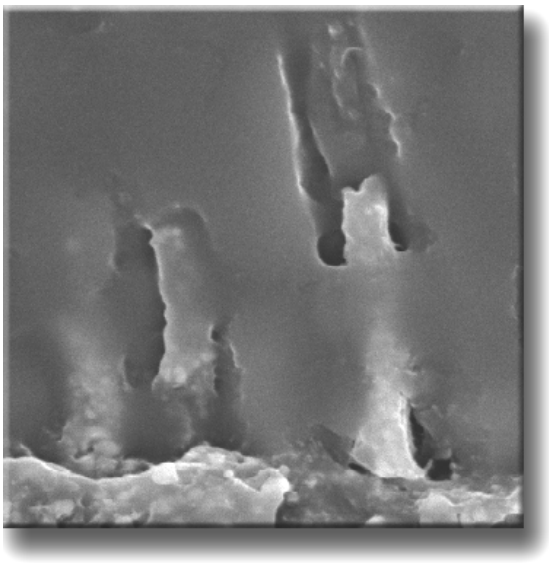
Eugenol—ZOE sealers and most temporary cements leave behind an oily debris which interferes with polymerization and bonding of resin *(Woody et al. 1992, Watanabe et al. 1997, Peutzfeldt et a. 1999).* NaOCl breaks down to oxygen a and sodium chloride and hydrogen peroxide (RC Prep, Glyde) form an oxygen rich surface which interferes with polymerization and bonding of resin *(Morris et al. 2001, Lai et al 2001, Ari et al. 2003, Ozturk et al. 2004, Santos et al. 2006).* The oxygen rich layer left behind by NaOCl can be reversed by a reducing agent like sodium ascorbate or ascorbic acid *(Morris et al. 2001, Lai et al. 2001, Yui et al. 2002).*

10% sodium ascorbate for one minute restores the original bond strengths *(Weston et al. 2007).* A final rinse of EDTA reversed the effects of NaOCl on bonding *(Doyle et al. 2006).* ***Chlorhexidine*** has no effect on bond strength *(Perdigao et al. 1994, Erdemir et al. 2004, Santos et al. 2006).*

Orifice Barriers

- Tetric Chroma (Vivadent)
- Permaflow Purple (Ultradent)
- Flow-it clear (Pentron)
- Effective bonding needs a clean surface

Danville Microetcher



Orifice Barriers, **clinical procedures**

- Countersink the orifices
- Clean the chamber
- Acid-etch for 15 seconds and rinse
- Apply a 4th generation primer and adhesive
- Apply a clear or colored flowable composite over the pulp floor
- Or use 6th generation system if non-eugenol sealer has been used (self etching systems incorporate the eugenol in the hybrid layer)
- Or use a resin modified glass ionomer material (Most materials have little or no effect on GIC)

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Restoration of an access opening

Considerations; Bond to dentin, metal or porcelain.

The access cavity has been abraded, and is clean and ready to restore.

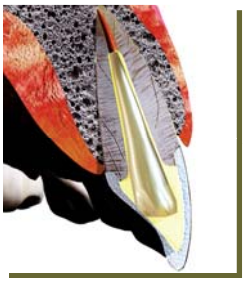
- Porcelain: Apply 10% hydrofluoric acid to the porcelain for 1minute resulting in a frosty appearance.
- Acid etch the dentin for 15 seconds.
- Apply silane to the porcelain.
- Apply primer and bonding.
- Apply clear flowable composite.
- Apply dual or self cure core.
- Apply an opaquer, colour modifier ie. A3 Kerr
- Apply top layer ie. Tetric Ceram A3 or LuxaCore, or Ceramage OD A 3.5 (Shofu), or Filtek Supreme XT A2E (3M)

Article to review—Schwartz and Fransman. J Endod. 2005 Mar; 31(3):151-65.

Posts—Overview

Important post principles

- Retention and resistance form
- Preservation of tooth structure
- Ferrule (collet)
- Failure mode
- Retrievability



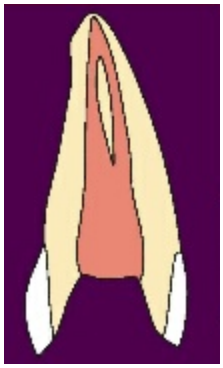
Ferrule *(latin: viriola— small bracelet) is a ring or cap usually of metal put around a slender shaft to strengthen it or prevent splitting. When the supra-marginal dentin of a root-filled tooth is engaged by a crown, it may create a stronger tooth/restoration complex: the ferrule effect. (Stankiewicz & Wilson, Dent Update. 2008 May;35(4):222-8.*

It provides primarily resistance form and enhances longevity. A ferrule with 1 mm vertical height doubles the resistance to fracture *(Sorenson et al. 1990).* Maximum beneficial effect from a ferrule occurs with 1.5—2 mm of vertical tooth structure *(Stankiewicz et al. 2002, Zhi-Yue et al. 2003).*

The lingual surface is the most important in upper anterior teeth (Ng et al. 2006).

Restoration of endodontically treat teeth

Cuspal coverage is the most important restorative factor in the survival of endodontically treated teeth *(Sorensen & Martinoff 1984, Cheung & Chan 2003, Salehrabi & Rotstein 2004).* Endodontically treated teeth with cuspal coverage had six times greater rate of survival *(Aquilino & Caplan 2002).* The five year survival rate of teeth w/o cuspal coverage was 36% *(Nagasiri & Chitmongkolsuk 2005).*



In vitro failure modes of fibre, metal and ceramic post/core systems. (Fokkinga et al. Int J Prosthodont. 2004 Jul-Aug;17(4):476-82.

298 papers were selected from literature between 1984 and 2003. Metal posts had the highest failure loads, ceramic the lowest. Significantly more favourable failures occurred with prefabricated Fibre-Reinforced Composite (FRC) post systems than with prefabricated and custom-cast metal post systems.

Clinical Studies of Fibre Posts; a lit review

Since 1990, 5 randomized controlled trials on fibre posts have been published in peer reviewed journals, but a meta-analysis is not applicable. Two trials indicate that FRC posts outperform metal posts, but this evidence is not considered conclusive. The placement of an FRC post protects against failure, especially under conditions of extensive coronal destruction. The most common type of failure with fibre-reinforced composite posts is debonding.

Tobjorner & Fransson, Int J Prosthdodont, 2004 May-Jun; 17(3):369-76. Fibre posts may be at risk for early failure, however, there is less risk of catastrophic failure. Metal posts demonstrate longer service with fewer problems with post fracture and or loss of retention, however, there are more non-restorable failures.

Post placement and root canal treatment are the major etiologic factors for root fractures *(Fuss et al. 2001).* ***Most fractured teeth: second maxillary premolars and mesial roots of mandibular molars (Tamse et al. 1999)***

Advantages of Fibre Posts

Can be used in aesthetically demanding areas. Their elastic modulus more closely approaches that of dentin—better distribution of forces of occlusion. More favorable failures occur than with custom cast metal post systems and there is growing evidence that they improve fracture resistance of pulpless teeth *(Rosentritt et al. 2004, Cavalho et al. 2005, Goncalves et al. 2006, Schmitter et al. 2006, Salameh et al. 2007, D'Arcangelo et al. 2008, Salameh et al. 2008).*

Most fractured teeth: second maxillary premolars and mesial roots of mandibular molars

Cast versus Fibre Posts

Cast Post	Fiber Post
Non-salvageable root fractures	More benign fracture type
Can compromise aesthetic result	Can be used in aesthetically demanding situation
Extra session required for insertion	Can be placed after finishing RCT
Strong	Lower strength value
Long record of clinical performance	More followup studies needed

No monoblock with current materials

There is evidence that fibre posts rely on mechanical (frictional) retention rather than bonding, just like metal posts *(Manocci et al. 2003, Goracci et al. 2004, 2005, Perdigao et al. 2004, Pirani et al. 2005, Sadek et al. 2006)*. Gaps can be demonstrated between the resin and dentin *(Manocci et al. 2003, Goracci et al. 2005, Pirani et al. 2005)* and low bond strengths are demonstrated between fibre posts and root canal walls *(Goracci et al. 2004, Perdigao et al. 2004)*.

Fibre posts will undergo a process of cement failure during cyclic loading, as do metal posts *(Baldissara et al.2006)*. Configuration factor—C factor—ratio of bonded to unbonded free surfaces—C factor in root canal system is unfavourable *(Feltzer et al. 1987, 1988, Carvalho et al. 1996)*. Higher ratio results in greater stress of the dentin bond. Class V highest—incisal edges lowest 5:1 vs. 1:5. Bouillaget noted that bond strengths in intact canals were lower than bonding onto flat dentin surfaces *(Dent Mater 2003 May; 19(3):199-205)*.

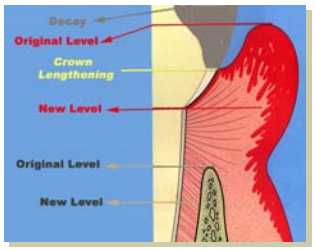
And yet

Long-term retrospective study of the clinical performance of fibre posts

Retrospective study of 3 types of fibre posts (n=985) after a service period of 7-11 years.

Results: A total of 79 failures were recorded (7-11% failure rate).

- 39 endodontic failures
- 1 root fracture
- 1 fibre post fracture
- 21 due to post debonding
- 17 crown dislodgements



The mechanical failures were always related to the lack of coronal tooth structure.

(Ferrari et al. Am J Dent. 2007 Oct;20(5):287-91.

The choice of the total etch technique using dual curing adhesive systems and cements represents the most predictable method for luting fibre posts.

Technique

- Removal of gutta-percha—heat and then passive refinement of space with drill
- Acid etching with phosphoric acid—15 seconds
- Rinse and air dry
- Primer (dentin)
- Bonding (dentin and post)
- Composite in post space (needle tube)
- Post placement
- Build-up of composite (light cure if necessary)

Post Length

2/3 length of the canal—or at least equal to the length of the crown (97% success)

Post should extend apically beyond crest of bone –least risk to remaining tooth structure by occlusal forces *(Goodacre & Spolnik 1995, Sorensen & Martinoff 1984, Hunter et al. 1989)*.

Restoration Trivia

Placement of fibre posts can improve fracture resistance in pulpless maxillary premolars, even under full coverage crowns *(Salameh et al. 2007)*. The use of fibre posts in endodontically treated maxillary incisors with different types of full-coverage crowns increased their resistance to fracture *(Salameh et al. 2008)*. ***Fibre post restorations seemed to significantly increase mean maximum load values for maxillary central incisors prepared for veneers (D'Arcangelo et al. 2008).***

Placing a post through an existing crown

- Crown retention will be increased
- Resistance to fracture may be increased, provided no additional radicular dentin is removed
- Choose a post that fits the canal preparation
- Extend it several mm apical to the crest of bone
  Use them routinely in front teeth and bicuspids

GIC or RMGIC

- Weak tensile strength and lowered resistance to fracture—brittle
- Low retention to metal posts
- Not strong enough to be used as a bulk material
- Suitable to block out undercuts after removing restoration
- Hygroscopic expansion can cause fracture of ceramic crowns

Post surface treatment for improving adhesiveness

> Silanization and/or adhesive application—improvement in bond strength between silanized fibre posts and composite cores *(Goracci et al, 2005, Aksommuang et al. 2006)*

> Acid etching, sandblasting and silica coating—air abrasion improved retention of glass fibre posts (*Balbosh & Kerr 2006)*.

> Alternate etching techniques—pretreatment of fibre posts with hydrogen peroxide and silane improves the bond to composite *(Monticelli et al. 2006)*

Post treatment with 24% H_20_2 for 10 minutes followed by silane application, appears to be an effective and inexpensive method that can improve the clinical performance of both the methacrylate based and epoxy resin based fibre posts. (Vano et al. 2006).

ROOTS