Post & Microleakage

ImageCourtesy of NASA
Post and core

- The primary purpose of a post is to retain a core that can be used to retain the definitive prosthesis.

Wooden dental prosthesis of the Tokugawa era (1603-1867)
Do posts reinforce endodontically treated teeth?
- Lovdahl and Nicholls (1977)
- Guzy and Nicholls (1979)
- Trope et al (1985)
What are the most common types of post and core failures?

- Dislodgement and loosening
- Root fracture
- Caries and apical lesions
Factors affecting the retention

- Post length
- Post diameter
- Post design
- Luting agents
- Luting method
- Canal shape
- Preparation of the canal space and tooth
- Location in the dental arch
Various guidelines have been recommended regarding post length

- The post should be equal of the crown
- The post should be $\frac{1}{3}$ the length of the crown
- The post should be $\frac{1}{2}$, $\frac{2}{3}$, or $\frac{4}{5}$
- The post should end halfway between the crestal bone and the root apex
- The post should be as long as possible without disturbing the apical seal
Post length

Studies have reported that the length of the post has a significant effect on its retention and in most instances, the more deeply the post is placed, the more retentive it becomes (Standlee et al 1978)

Leary et al (1987) found that posts with length of at least 3-quarters of the length of the root offered the greatest rigidity and least root deflection when compared with posts that were half the root length
Post length

From laboratory studies, it is apparent that a length guideline ideally would be three fourths of the root length, but this dimension is not achievable without compromising the apical seal on many teeth.
Post diameter

- Increasing the diameter of the post does not provide a significant increase in the retention of the post (Standlee et al 1978, Sorensen et al 1984, Hunter et al 1989)

- However it can increase the stiffness of the post at the expense of the remaining dentin and the fracture resistance of the root (Trope et al, Mattison et al 1982, Trabert et al 1978)
Goodacre et al suggested that post diameters should not exceed one third of the root diameter at any location.

Studies also indicate that the diameter at the tip should usually be 1 mm or less (Goodacre et al, Abou-Rass et al 1982).
How much gutta percha should be retained apically to preserve the apical seal?
Camp et al (1983) determined that when 4 mm of gutta percha was retained only 1 of 89 specimens showed leakage, whereas 32 of 89 specimens leaked when 2 mm of gutta percha was retained.
Madison, Zakarison (1984) and Neagley (1969) found no leakage at 4 mm.
Zmener (1980) found that in root canals sealed with lateral condensation technique, leakage was reduced when more than 4 mm of gutta-percha remained in the apical portion.
Portell et al (1982) determined that most of the specimens with only 3 mm of apical gutta percha had some leakage.

Mattison et al (1984) found significant differences between 3, 5, and 7 mm of gutta percha, and they concluded that at least 5 mm of gutta percha is necessary for an adequate apical seal.
Post space preparation and leakage

- During the mechanical preparation of the post space it is possible that the root filling may be twisted or vibrated, with disruption of the seal.

- It now seems that the advantages of leaving the apical portion of the root filling undisturbed is outweighed by the fact that much of the canal system is vulnerable to contamination from an inadequate seal coronally.
Provided a minimum of 5 mm of sound apical root filling is left in situ, studies have shown that removal of laterally condensed gutta percha does not affect the apical seal, irrespective of whether the post space is prepared immediately after obturation or is delayed (Zmener 1980, Neagley 1969, Bourgeois et al 1981)
The success of endodontic therapy is commonly thought of in terms of an adequate apical seal.

However, the coronal seal achieved by the restoration may be considered as important for the ultimate success of endodontic treatment (Marshall et al, Swanson et al, Torabinejad et al, Magura et al, Khayat et al, Ray et al, Tronstad et al).
Strinberg, in 1956, considered that the most common cause of failure was leakage of tissue fluids apically around inadequate root fillings.

Ingle in 1965 found that of 104 failed cases, 66 were associated with a poor apical seal.
Importance of coronal leakage in failure of root canal treatment

- Obturated root canals can be recontaminated by micro-organisms in a number of ways:
  
  - Delay in placing a coronal restoration. Temporary materials will dissolve slowly after in time in the presence of saliva and the seal may break down. A temporary restoration of inadequate thickness will eventually leak
Importance of coronal leakage in failure of root canal treatment

- Fracture of the coronal restoration and/or the tooth

- Preparation of post space when the remaining apical section of the root filling is of inadequate density and/or length
The concept that one cause of failure of root canal treatment may be the result of coronal leakage is not a new one.

Marshall & Massler, in 1961, carried out a leakage study using a radioactive tracer and showed that coronal leakage occurred despite the presence of a coronal dressing.
Allison et al, in 1979 made brief reference to the possibility that a poor coronal seal might contribute to clinical failure.
Swanson & Madison, in 1987, did an in vitro study where they showed that after only 3 days exposure to artificial saliva there was extensive coronal leakage of a tracer dye through apparently sound root filling.
Madison & Wilcox, in 1988, confirmed that exposure of root canals to the oral environment allowed coronal leakage to take place, in some cases along the whole length of the root canals.
Torabinejad et al, in 1990, found that 50% of single-rooted teeth, root filled using lateral condensation of gutta percha and a sealer cement, were contaminated with bacteria along the whole length of the root after 19 days or 42 days, depending upon the contaminating organism.
Khayat et al, in 1993, have shown that root canals obturated with gutta percha and Roth’s sealer, using either lateral condensation or vertical condensation were contaminated apically with bacteria from saliva exposed to the coronal part of the root canal only. All canals were contaminated within 30 days of exposure.
Microleakage

Actual bacterial penetration through obturating materials may not be necessary to cause treatment failure. More important may be leakage of bacterial by-products.

Bacterial metabolites, toxins and degradation products are much smaller than bacteria and could penetrate faster.

Hovland & Dumsha, in 1985, showed that most leakage occurs between the root canal sealer and the wall of the root canal.
Prokaryptic cells (bacteria) are the smallest of the unicellular organisms. They are, for the most part, approximately 1 to 1.5 µm wide and 2 to 6 µm long.

Escherichia coli is approximately 1 µm in diameter.
Bacterial mechanism of tissue damage and bacterial products

Bacterial factors for colonization and growth

Bacterial factors for invasion and tissue damage
Bacterial factors for invasion and tissue damage

Direct
- Cytotoxic products
- Enzymes

Indirect
- Inflammatory response

Tissue damage
Enzymes

- Collagenase
- Trypsin-like protease
- Gelatinase
- Aminopeptidase
- Phospholipase A
- Alkaline phosphatase
- Acid phosphatase
- hyaluronidase
Toxic factors

- Bone resorbing factors
  - Lipoteichoic acid
  - Lipopolysaccharide
  - Capsule

- Cytotoxins
  - Butyric and propionic acids
  - Indole
  - Amines
  - Ammonia
  - Volatile sulphur compounds
Microleakage of endodontically treated teeth restored with posts

Bachicha et al. 1998
Purpose

To measure by fluid filtration the microleakage of a stainless-steel post system and a carbon-fiber post system cemented with zinc phosphate and glass ionomer as nondentin-bonding cements, and Panavia-21 and C& B Metabond as dentin-bonding cements.
Microleakage ....

Leakage of endodontic obturation materials has been measured by:

- Dyes (Swanson et al, Madison et al)

- Radioactive isotopes (Marshall et al)

- Bacteria (Mortensen et al, Goldman et al, Torabinejad et al)
Fluid filtration system

Was developed by Derksen et al. 1986 to measure quantitatively microleakage around coronal restorations
Fluid filtration apparatus

- Post
- Cement
- Root Segment
- Plexiglass

Compressed Nitrogen
Pressurized Buffer Reservoir
Microsyringe
The movement of the air bubble in the micropipette toward the apical end of the root per unit time provided a means of measuring microleakage as fluid moved from inside the root toward the external surface.
### Control

- **Positive controls**
  - Post space—empty canal
  - Stainless-steel post—no cement
  - Carbon-fiber post—no cement

- **Negative control**
  - Post space—cyanoacrylate

### Experimental

- **Experimental groups**
  - Zinc phosphate—stainless-steel post
  - Zinc phosphate—carbon-fiber post
  - Glass ionomer—stainless-steel post
  - Glass ionomer—carbon-fiber post
  - Panavia-21—stainless-steel post
  - Panavia-21—carbon-fiber post
  - C & B Metabond—stainless-steel post
  - C & B Metabond—carbon-fiber post
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<th>Mean</th>
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<td>Post space—empty canal</td>
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<td>Stainless-steel post—no cement</td>
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<td>Carbon-fiber post—no cement</td>
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<td>Negative control</td>
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<td>Zinc phosphate—carbon-fiber post</td>
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**Microleakage**

- Zn Phos
- Glass Ion
- Panavia-21
- C & B Meta

μl/min
Microleakage

μl/min

SS Post

CF Post

Zn Phos

Glass Ion

Panavia-21

C & B Meta
Conclusion

Based on the observations of the present study, using the accelerating leakage pressures, it seems that the dentin-bonding cements have less microleakage than the traditional, nondentin-bonding cements.