Post & Microleakage

Image Courtesy of NASA

Post and core

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

Wooden dental prostesis of the Tokugawa era (1603-1867)

Do posts reinforce endodontically treated teeth?

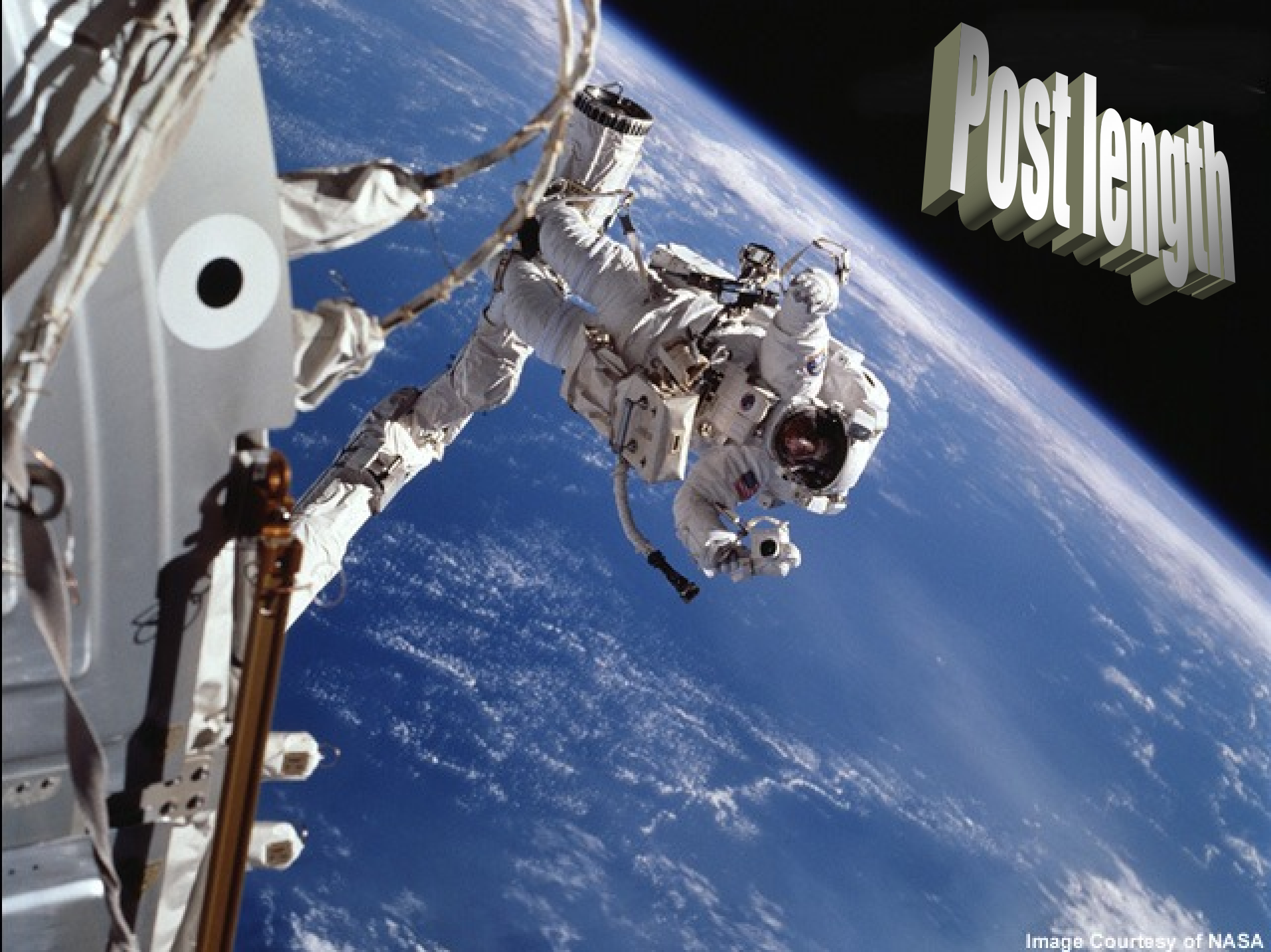
- Lovdahl and Nicholls (1977)
- Guzy and Nicholls (1979)
- Trope et al (1985)

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


Post length
Image Courtesy of NASA

- Various guidelines have been recommended regarding post length
  - The post should be equal of the crown
  - The post should be 1/3 the length of the crown
  - The post should be ½, 2/3, or 4/5
  - The post should end halfway betwen the crestal bone and the root apex
  - The post should be as long as possible without disturbing the apical seal

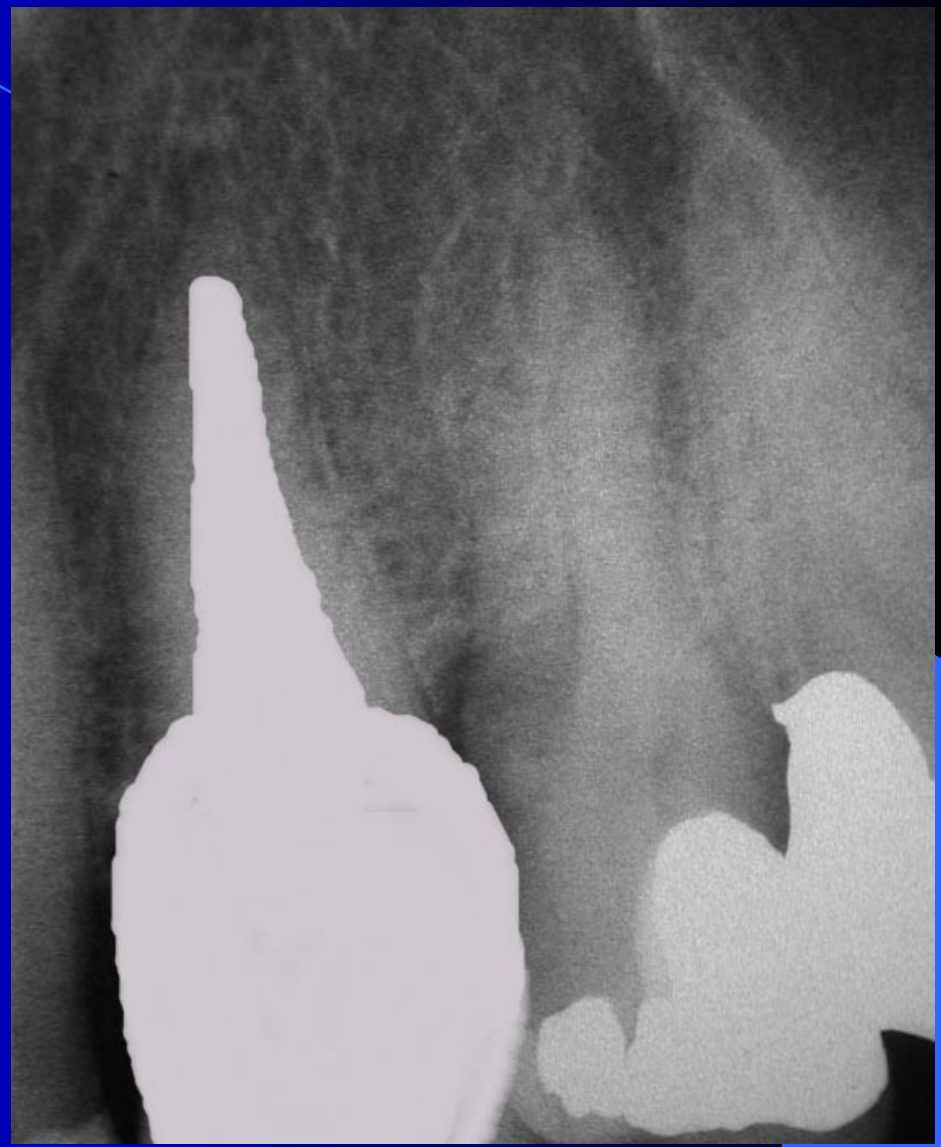
Post length

- 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)

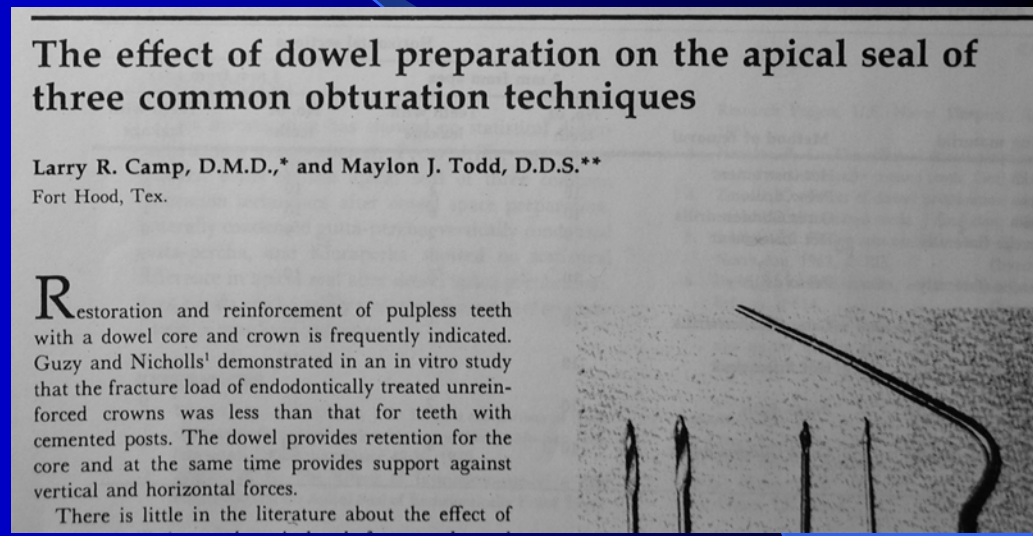
Post diameter

- 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?

Images Courtesy of NASA

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



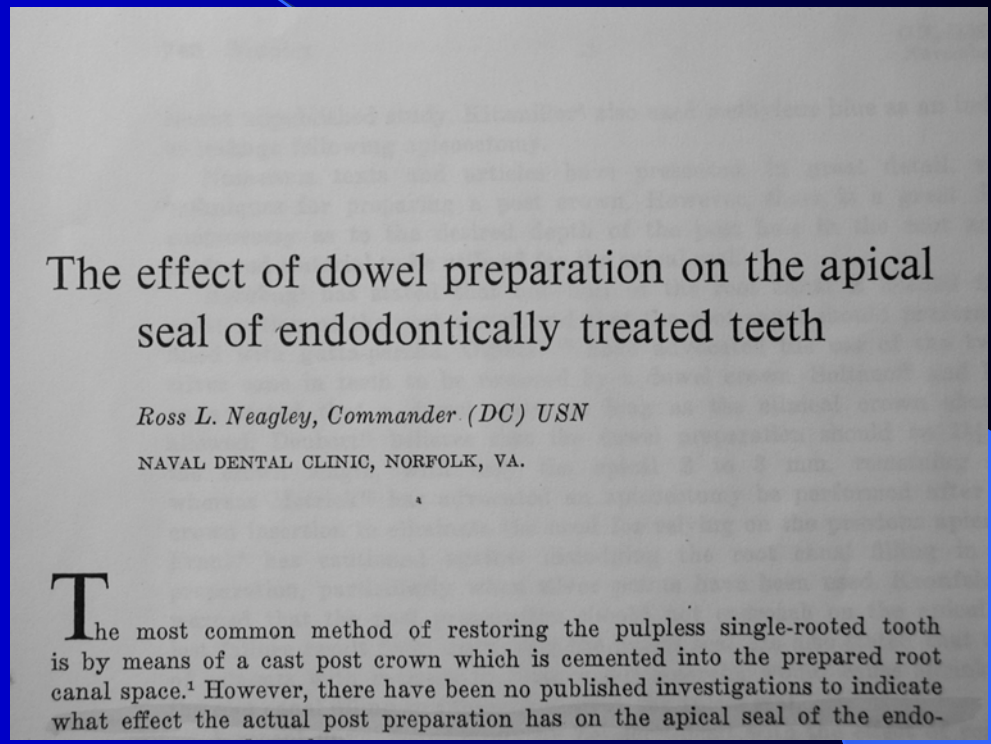
The effect of dowel preparation on the apical seal of three common obturation techniques

Larry R. Camp, D.M.D.,* and Maylon J. Todd, D.D.S.**
Fort Hood, Tex.

Restoration and reinforcement of pulpless teeth with a dowel core and crown is frequently indicated. Guzy and Nicholls[1] demonstrated in an in vitro study that the fracture load of endodontically treated unreinforced crowns was less than that for teeth with cemented posts. The dowel provides retention for the core and at the same time provides support against vertical and horizontal forces.

There is little in the literature about the effect of

Madison, Zakarison (1984) and Neagley (1969) found no leakage at 4 mm



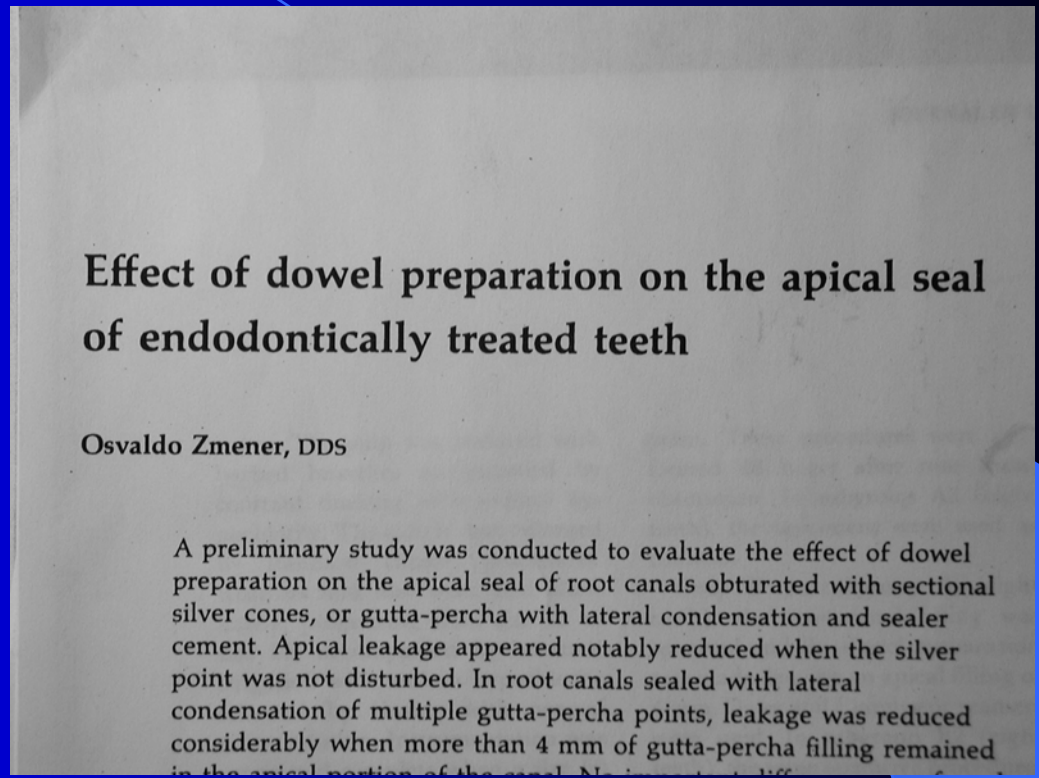
The effect of dowel preparation on the apical seal of endodontically treated teeth

Ross L. Neagley, Commander (DC) USN

NAVAL DENTAL CLINIC, NORFOLK, VA.

The most common method of restoring the pulpless single-rooted tooth is by means of a cast post crown which is cemented into the prepared root canal space.[1] However, there have been no published investigations to indicate what effect the actual post preparation has on the apical seal of the endo-

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



Effect of dowel preparation on the apical seal of endodontically treated teeth

Osvaldo Zmener, DDS

A preliminary study was conducted to evaluate the effect of dowel preparation on the apical seal of root canals obturated with sectional silver cones, or gutta-percha with lateral condensation and sealer cement. Apical leakage appeared notably reduced when the silver point was not disturbed. In root canals sealed with lateral condensation of multiple gutta-percha points, leakage was reduced considerably when more than 4 mm of gutta-percha filling remained

- 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

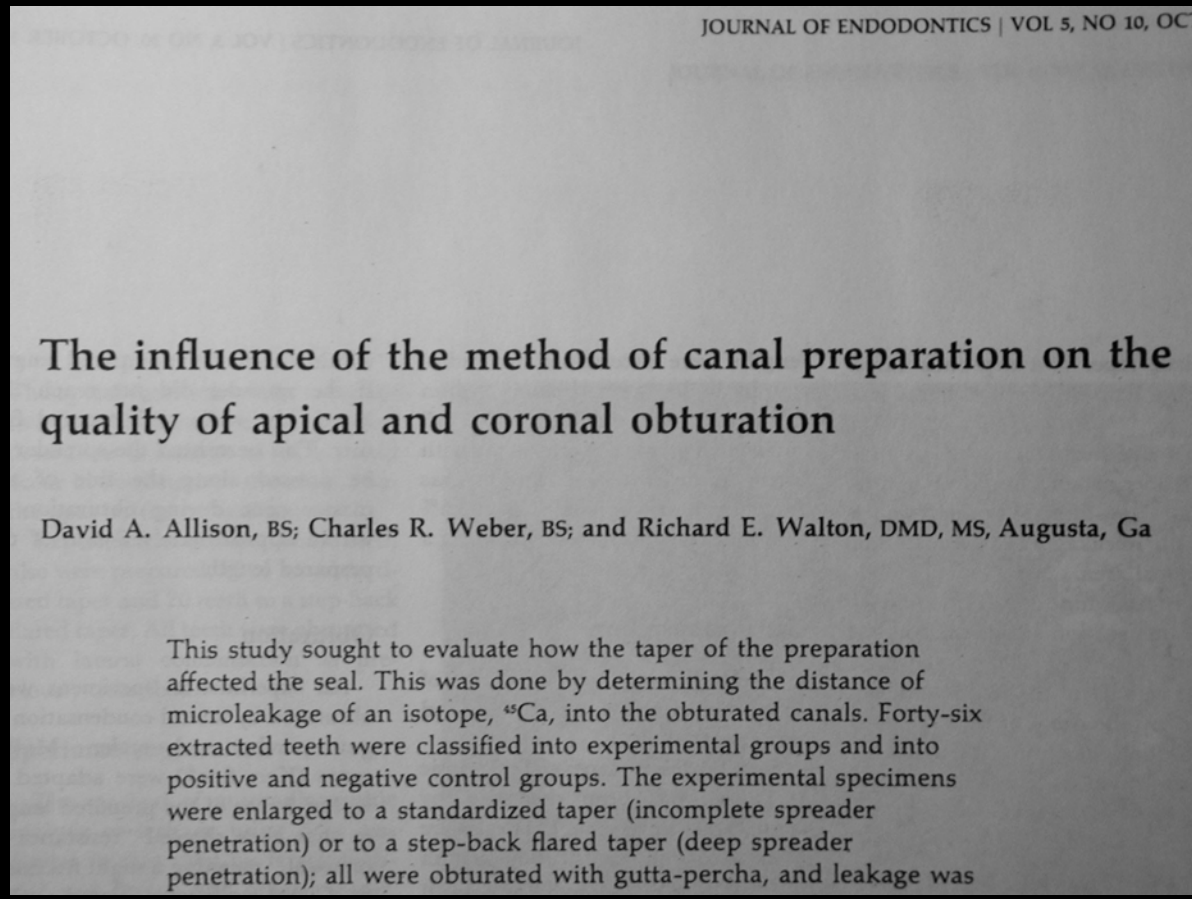
- Fracture of the coronal restoration and /or the tooth
- Preparation of post space when the remaining apical section of the root filling is of inadequate density and / or length

Coronal leakage…

- 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



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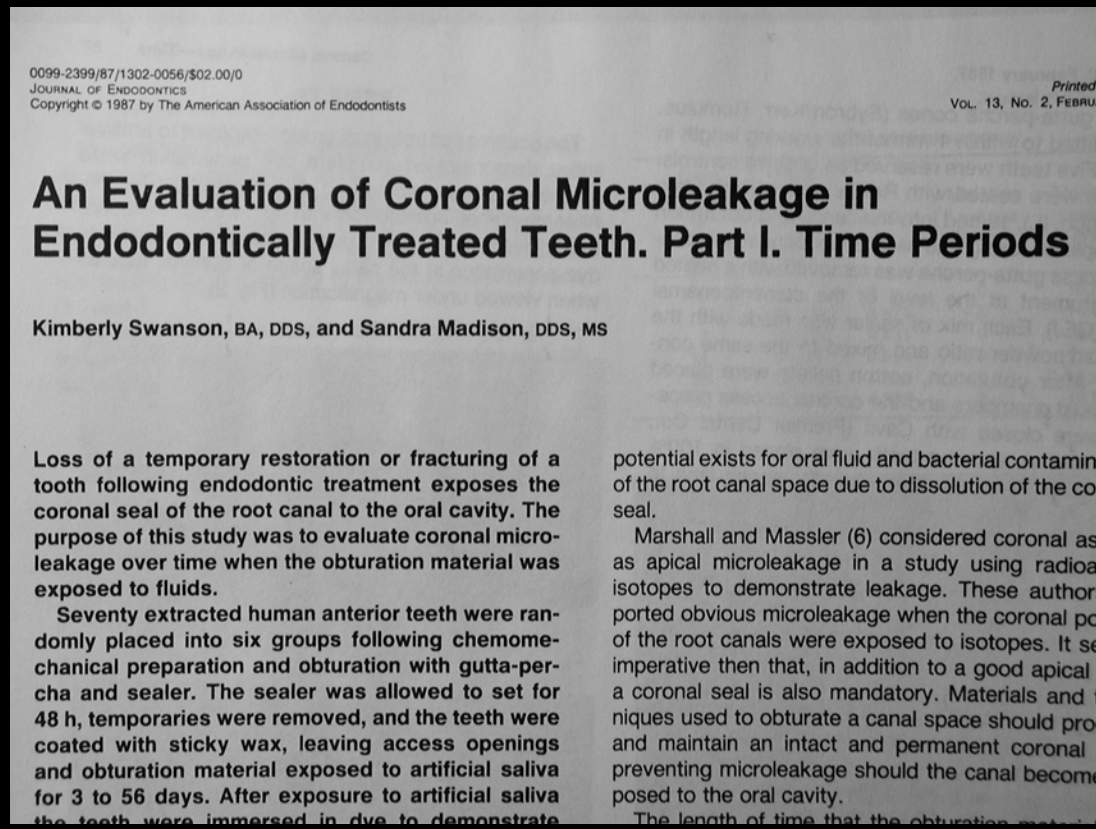
The influence of the method of canal preparation on the quality of apical and coronal obturation

David A. Allison, BS; Charles R. Weber, BS; and Richard E. Walton, DMD, MS, Augusta, Ga

This study sought to evaluate how the taper of the preparation affected the seal. This was done by determining the distance of microleakage of an isotope, ^{45}Ca, into the obturated canals. Forty-six extracted teeth were classified into experimental groups and into positive and negative control groups. The experimental specimens were enlarged to a standardized taper (incomplete spreader penetration) or to a step-back flared taper (deep spreader penetration); all were obturated with gutta-percha, and leakage was

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 aparently sound root filling



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An Evaluation of Coronal Microleakage in Endodontically Treated Teeth. Part I. Time Periods

Kimberly Swanson, BA, DDS, and Sandra Madison, DDS, MS

Loss of a temporary restoration or fracturing of a tooth following endodontic treatment exposes the coronal seal of the root canal to the oral cavity. The purpose of this study was to evaluate coronal microleakage over time when the obturation material was exposed to fluids.

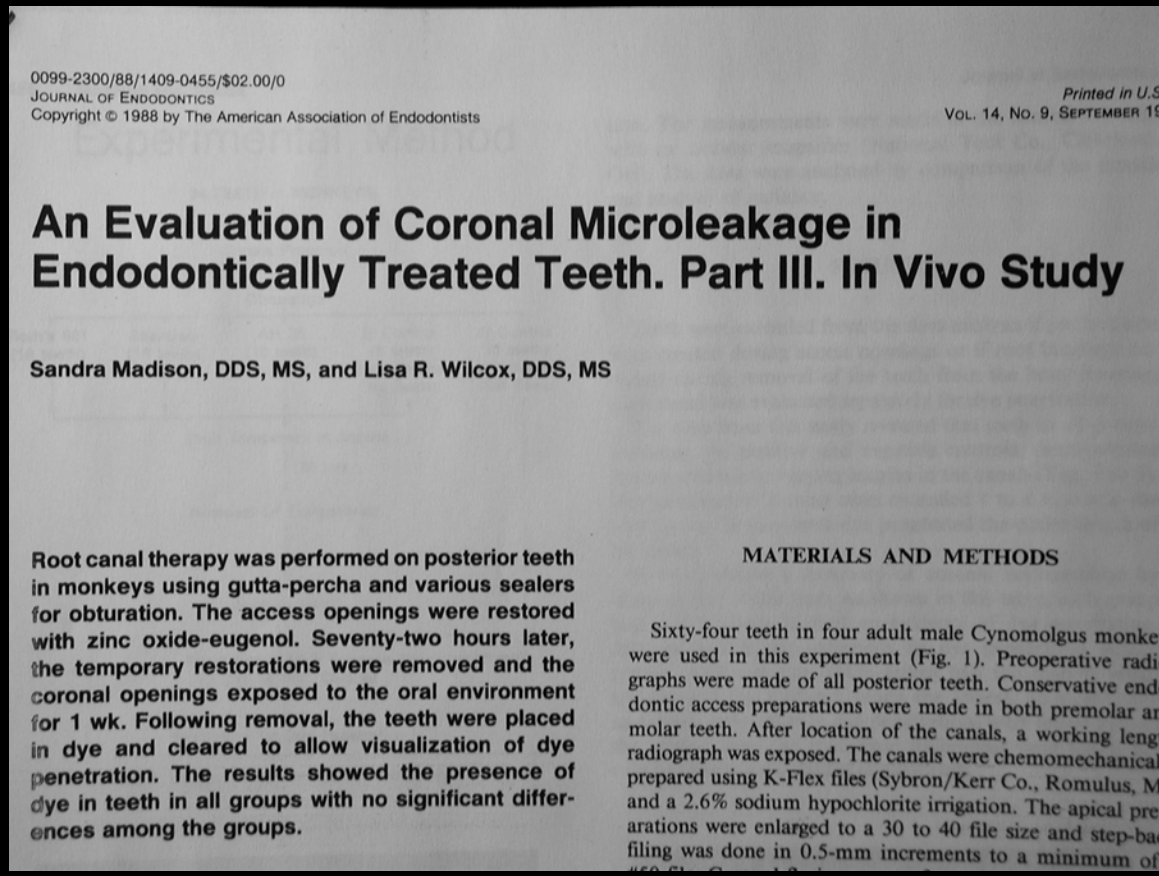
Seventy extracted human anterior teeth were randomly placed into six groups following chemomechanical preparation and obturation with gutta-percha and sealer. The sealer was allowed to set for 48 h, temporaries were removed, and the teeth were coated with sticky wax, leaving access openings and obturation material exposed to artificial saliva for 3 to 56 days. After exposure to artificial saliva the teeth were immersed in dye to demonstrate

potential exists for oral fluid and bacterial contamin
of the root canal space due to dissolution of the co
seal.

Marshall and Massler (6) considered coronal as
as apical microleakage in a study using radioa
isotopes to demonstrate leakage. These author
ported obvious microleakage when the coronal pc
of the root canals were exposed to isotopes. It se
imperative then that, in addition to a good apical
a coronal seal is also mandatory. Materials and
niques used to obturate a canal space should pro
and maintain an intact and permanent coronal
preventing microleakage should the canal becom
posed to the oral cavity.

The length of time that the obturation

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



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JOURNAL OF ENDODONTICS
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An Evaluation of Coronal Microleakage in Endodontically Treated Teeth. Part III. In Vivo Study

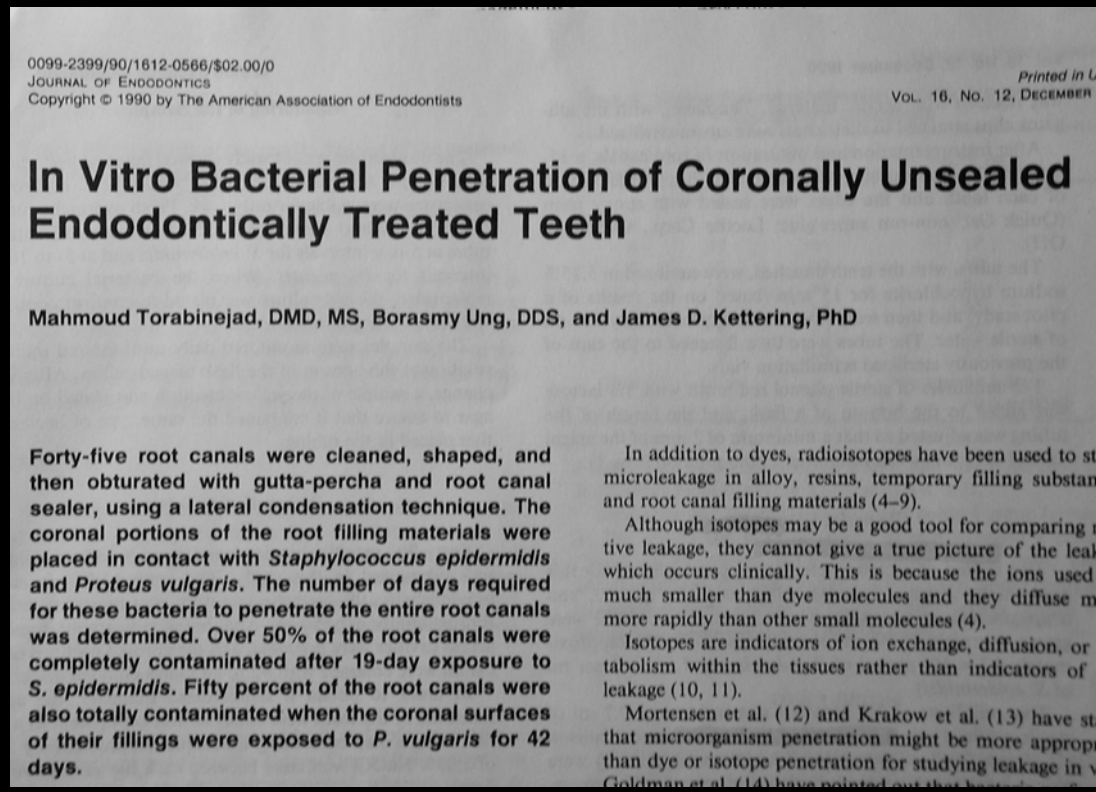
Sandra Madison, DDS, MS, and Lisa R. Wilcox, DDS, MS

Root canal therapy was performed on posterior teeth in monkeys using gutta-percha and various sealers for obturation. The access openings were restored with zinc oxide-eugenol. Seventy-two hours later, the temporary restorations were removed and the coronal openings exposed to the oral environment for 1 wk. Following removal, the teeth were placed in dye and cleared to allow visualization of dye penetration. The results showed the presence of dye in teeth in all groups with no significant differences among the groups.

MATERIALS AND METHODS

Sixty-four teeth in four adult male Cynomolgus monke
were used in this experiment (Fig. 1). Preoperative radi
graphs were made of all posterior teeth. Conservative end
dontic access preparations were made in both premolar ar
molar teeth. After location of the canals, a working leng
radiograph was exposed. The canals were chemomechanical
prepared using K-Flex files (Sybron/Kerr Co., Romulus, M
and a 2.6% sodium hypochlorite irrigation. The apical pre
arations were enlarged to a 30 to 40 file size and step-ba
filing was done in 0.5-mm increments to a minimum of

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



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In Vitro Bacterial Penetration of Coronally Unsealed Endodontically Treated Teeth

Mahmoud Torabinejad, DMD, MS, Borasmy Ung, DDS, and James D. Kettering, PhD

Forty-five root canals were cleaned, shaped, and then obturated with gutta-percha and root canal sealer, using a lateral condensation technique. The coronal portions of the root filling materials were placed in contact with *Staphylococcus epidermidis* and *Proteus vulgaris*. The number of days required for these bacteria to penetrate the entire root canals was determined. Over 50% of the root canals were completely contaminated after 19-day exposure to *S. epidermidis*. Fifty percent of the root canals were also totally contaminated when the coronal surfaces of their fillings were exposed to *P. vulgaris* for 42 days.

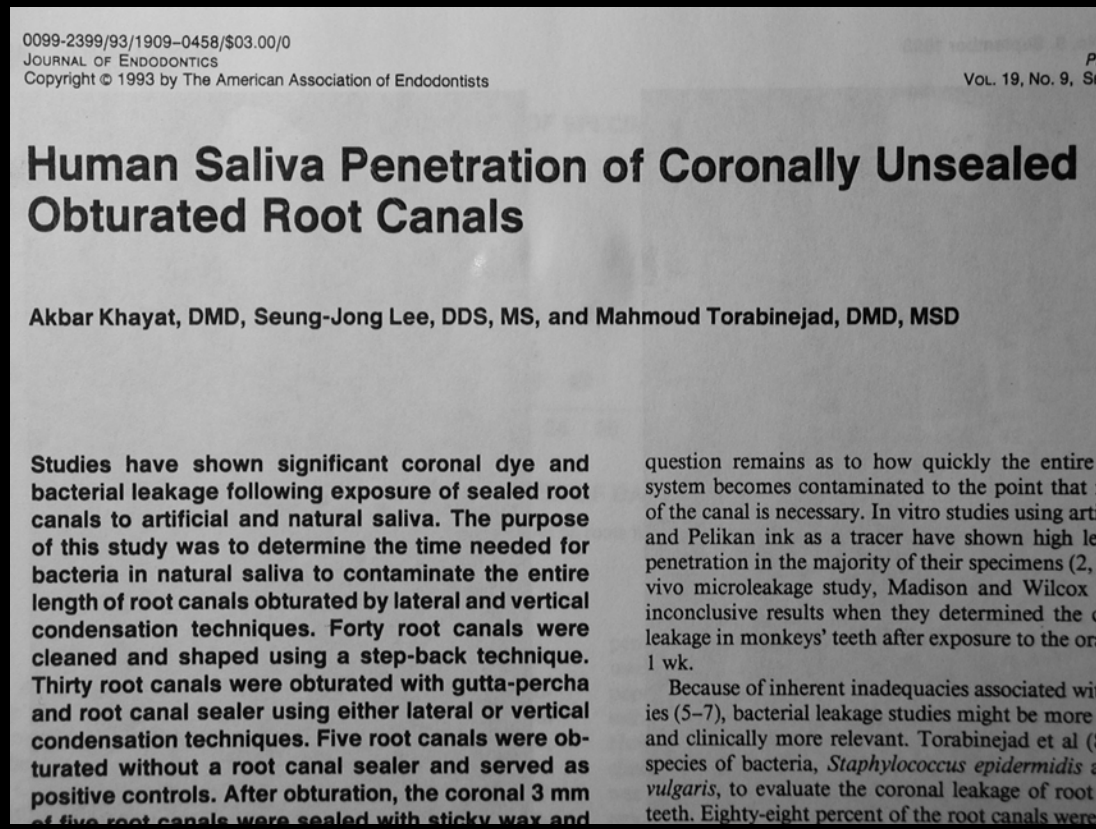
In addition to dyes, radioisotopes have been used to st
microleakage in alloy, resins, temporary filling substan
and root canal filling materials (4–9).

Although isotopes may be a good tool for comparing
tive leakage, they cannot give a true picture of the leal
which occurs clinically. This is because the ions used
much smaller than dye molecules and they diffuse m
more rapidly than other small molecules (4).

Isotopes are indicators of ion exchange, diffusion, or
tabolism within the tissues rather than indicators of
leakage (10, 11).

Mortensen et al. (12) and Krakow et al. (13) have st
that microorganism penetration might be more approp
than dye or isotope penetration for studying leakage in
Goldman et al. (14) have pointed out that bacteria

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



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Human Saliva Penetration of Coronally Unsealed Obturated Root Canals

Akbar Khayat, DMD, Seung-Jong Lee, DDS, MS, and Mahmoud Torabinejad, DMD, MSD

Studies have shown significant coronal dye and bacterial leakage following exposure of sealed root canals to artificial and natural saliva. The purpose of this study was to determine the time needed for bacteria in natural saliva to contaminate the entire length of root canals obturated by lateral and vertical condensation techniques. Forty root canals were cleaned and shaped using a step-back technique. Thirty root canals were obturated with gutta-percha and root canal sealer using either lateral or vertical condensation techniques. Five root canals were obturated without a root canal sealer and served as positive controls. After obturation, the coronal 3 mm

question remains as to how quickly the entire system becomes contaminated to the point that of the canal is necessary. In vitro studies using art and Pelikan ink as a tracer have shown high le penetration in the majority of their specimens (2, vivo microleakage study, Madison and Wilcox inconclusive results when they determined the leakage in monkeys' teeth after exposure to the or 1 wk.

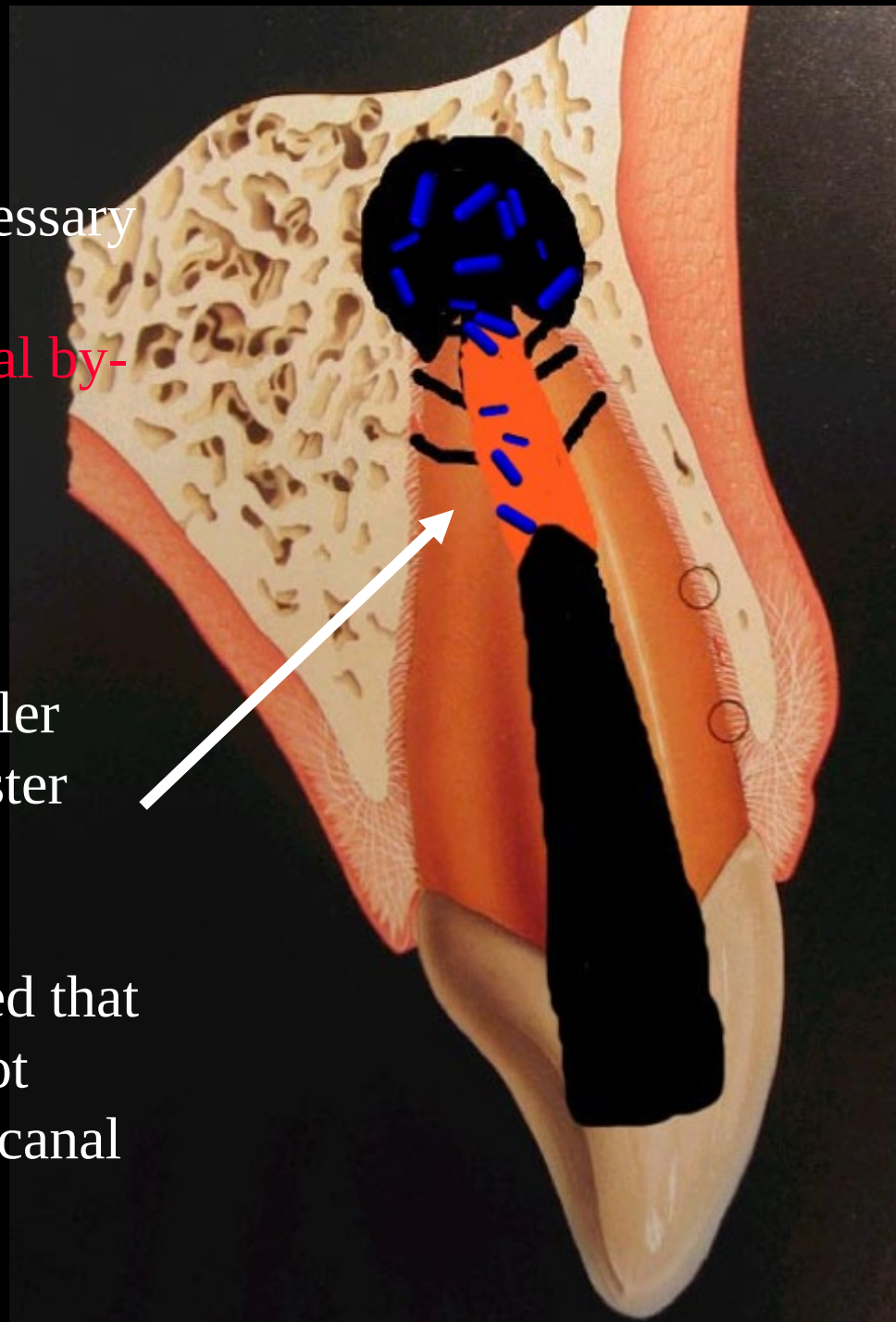
Because of inherent inadequacies associated wi ies (5–7), bacterial leakage studies might be more and clinically more relevant. Torabinejad et al (species of bacteria, *Staphylococcus epidermidis* *vulgaris*, to evaluate the coronal leakage of root teeth. Eighty-eight percent of the root canals were

Microleakage

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

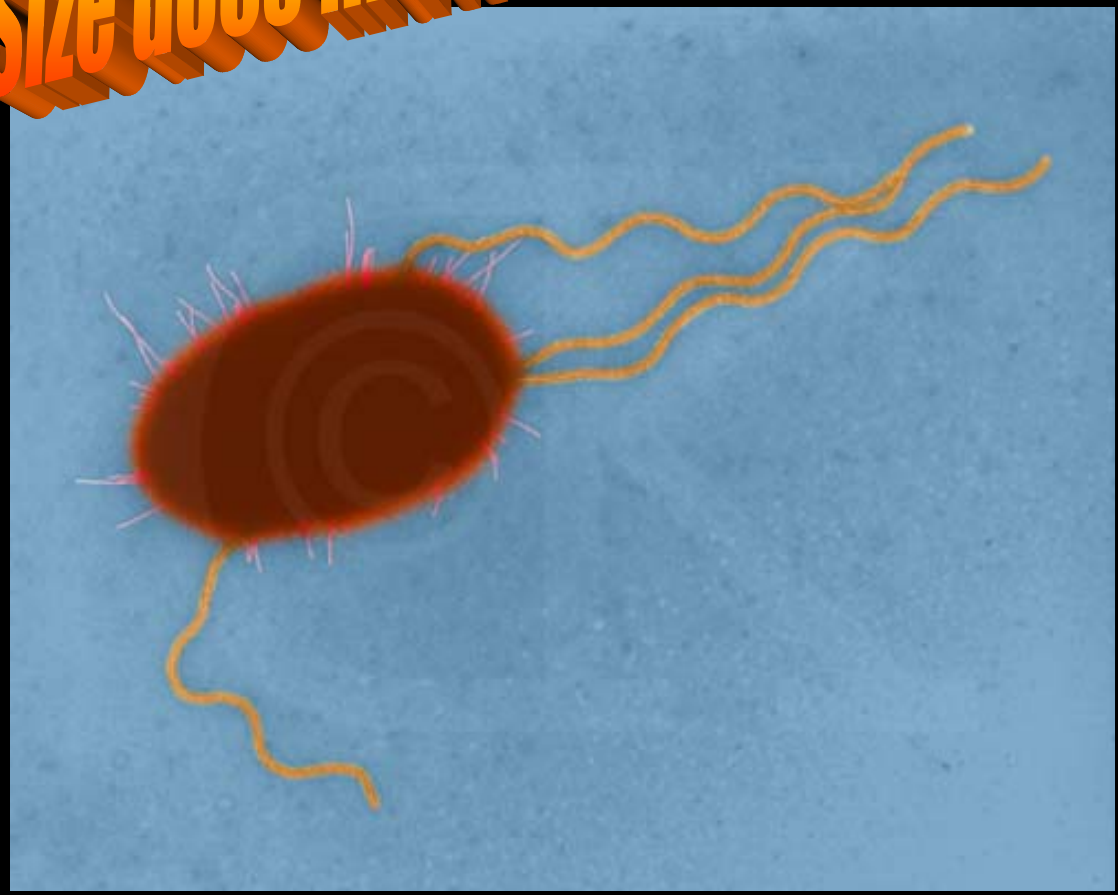
Bacterial metabolites, toxins and degradation products are much smaller than bacteria and could penetrate faster

Hovland & Dumsha, in 1985, showed that most leakage occurs between the root canal sealer and the wall of the root canal



Size does matter !

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



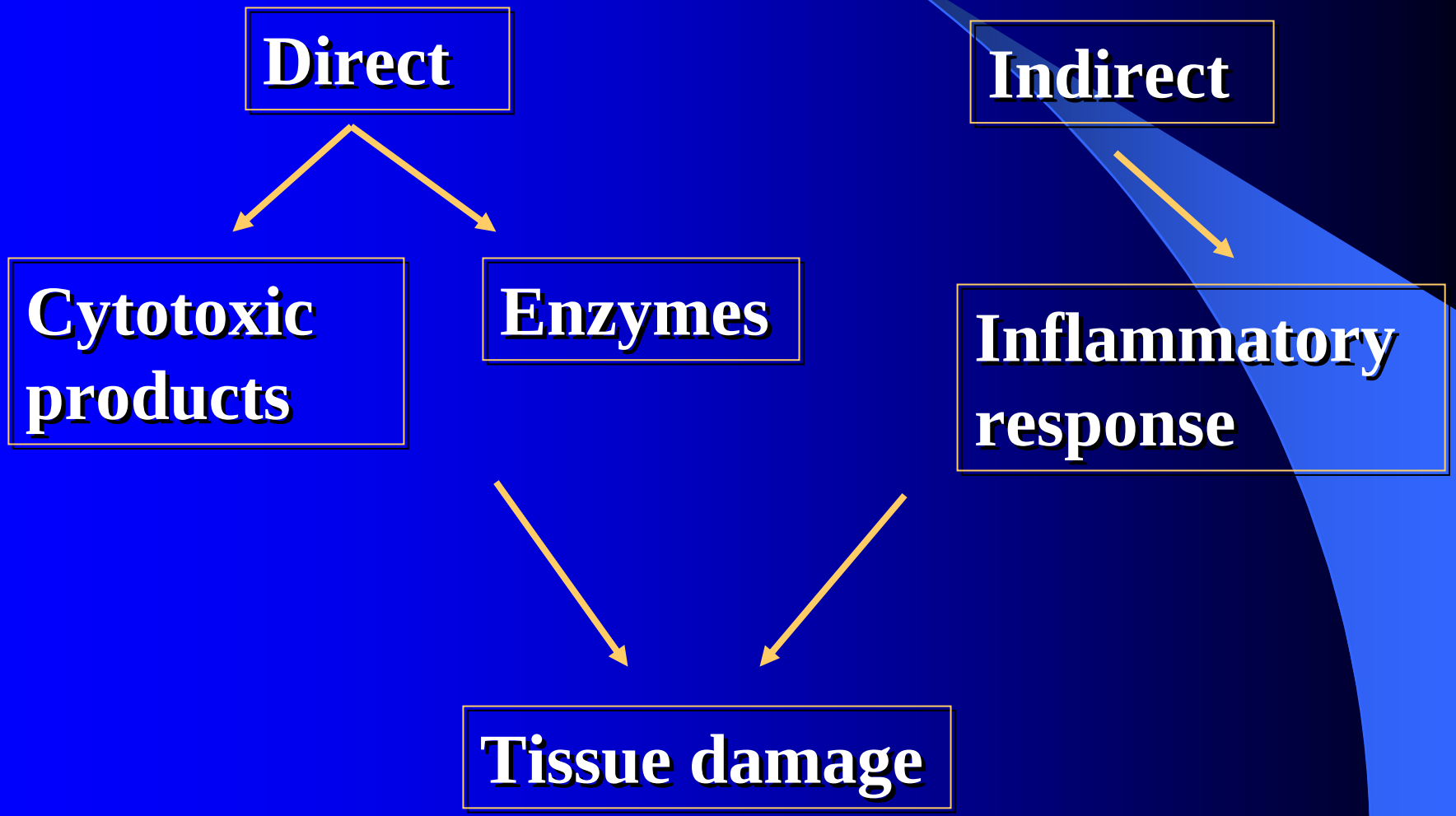
Escherichia coli is approximately 1 µm in diameter

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



Enzymes

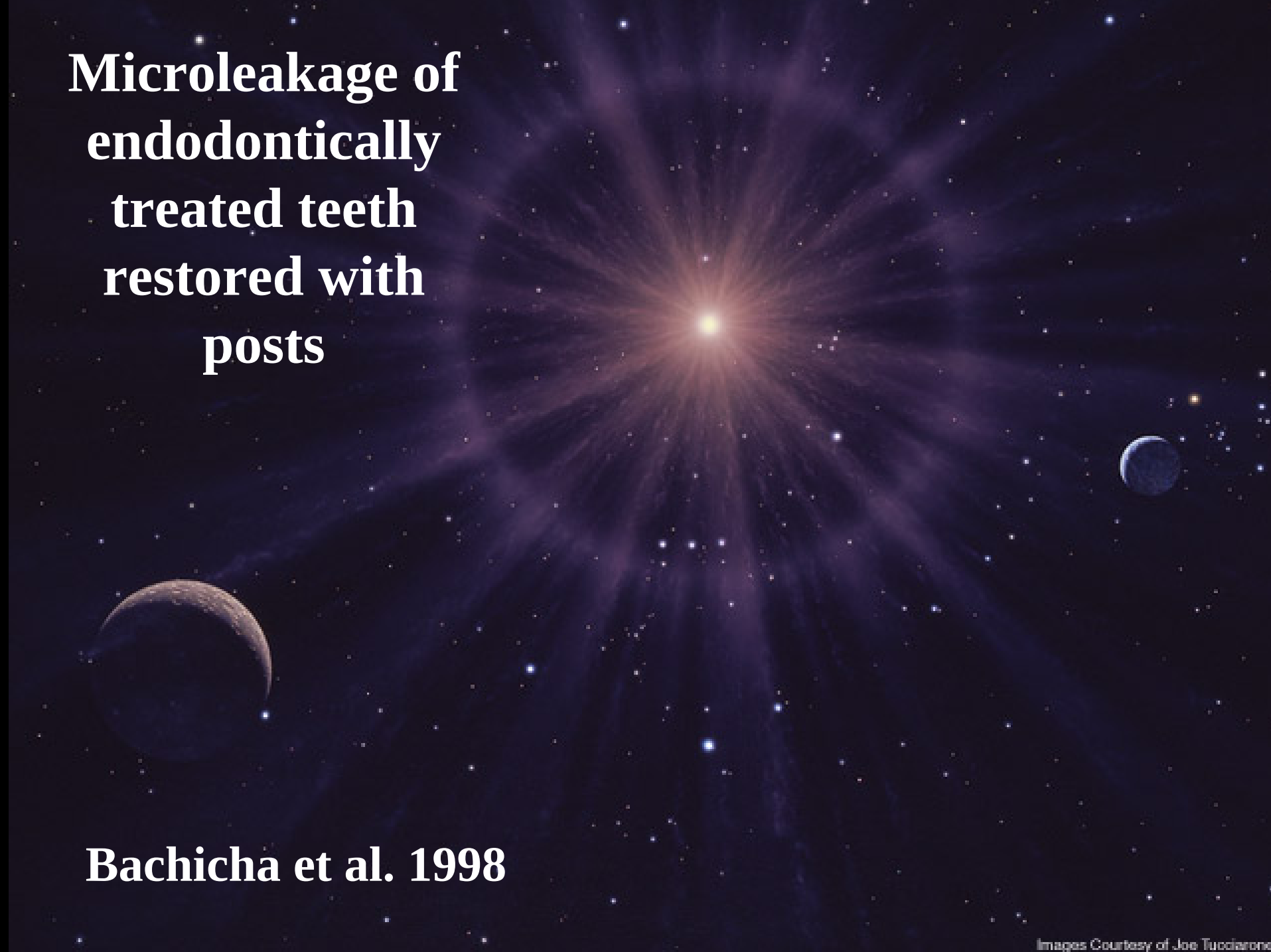
- Collagenase
- Trypsin-like protease
- Gelatinase
- Aminopeptidase
- Phospholipase A
- Alkaline phosphotase
- Acid phosphotase
- hyaluronidase

Toxic factors

- Bone resorbing factors
  - Lipoteichoic acid
  - Lipopolysaccharide
  - Capsule
- Cytotoxins
  - Butyric and propionic acids
  - Indole
  - Amines
  - Ammonia
  - Volitile 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

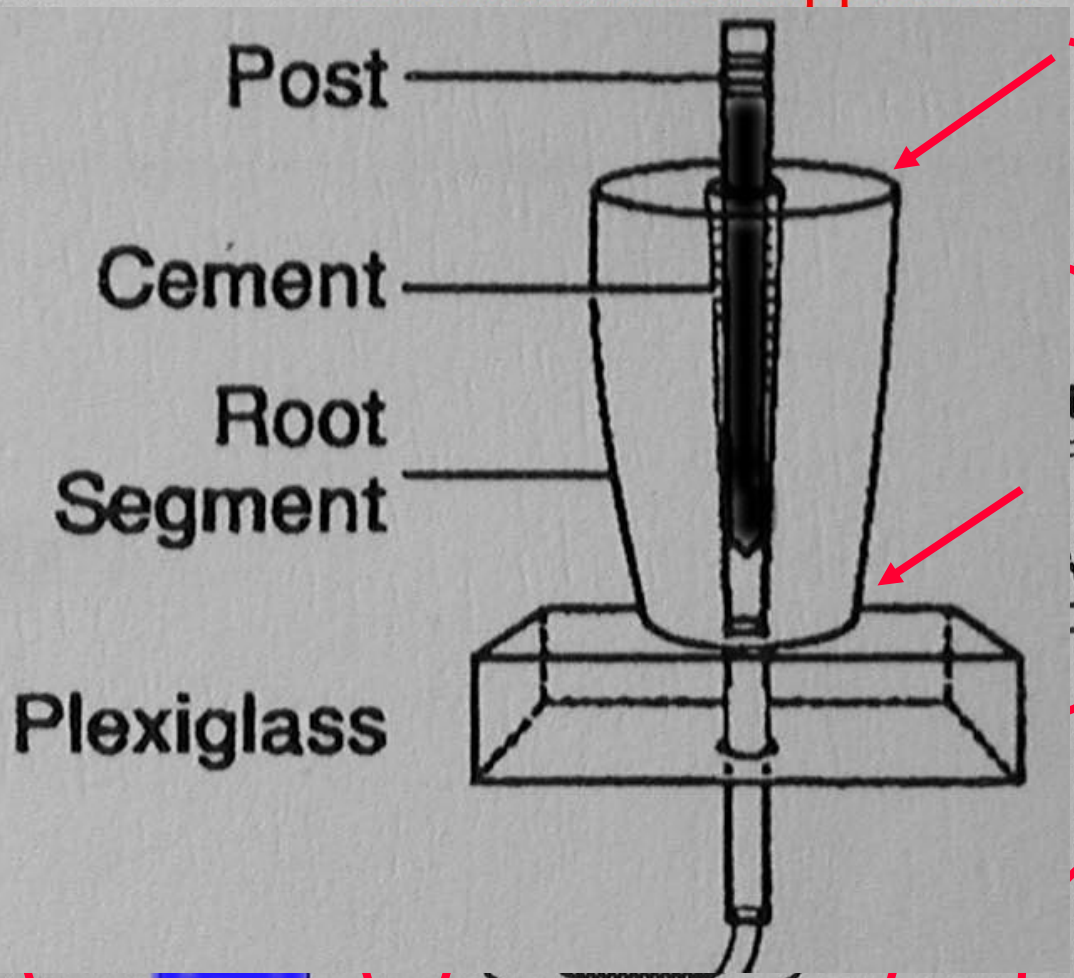
Microleakage ….

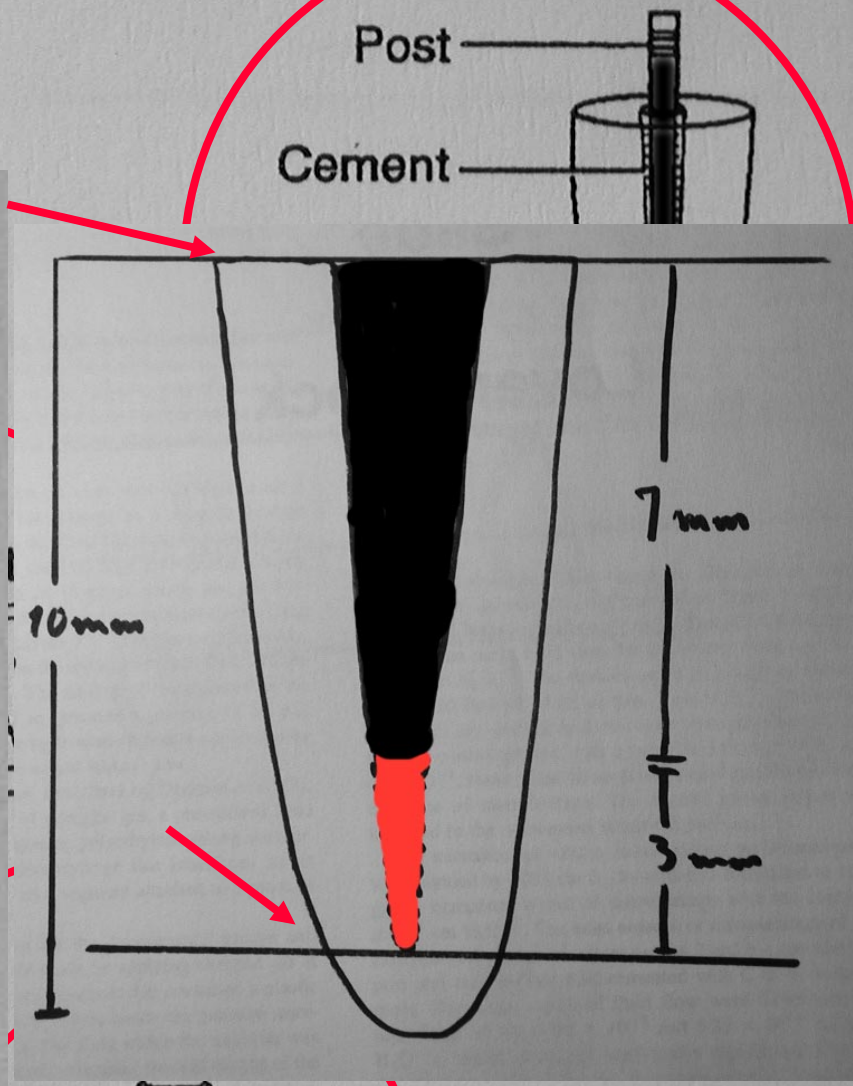
- Leakage of endodontic obturation materials has been measured by:
  - Dyes (Swanson et al, Madison et al)
  - Radioactive isotopes (Marshall et al)
  - Bacteria (Mortensen et al, Goldman et al, Torabinejad et al)

Fluid filtration system

- Was developed by Derksen et al. 1986 to measure quantitatively microleakage around coronal restorations

Fluid filtration apparatus



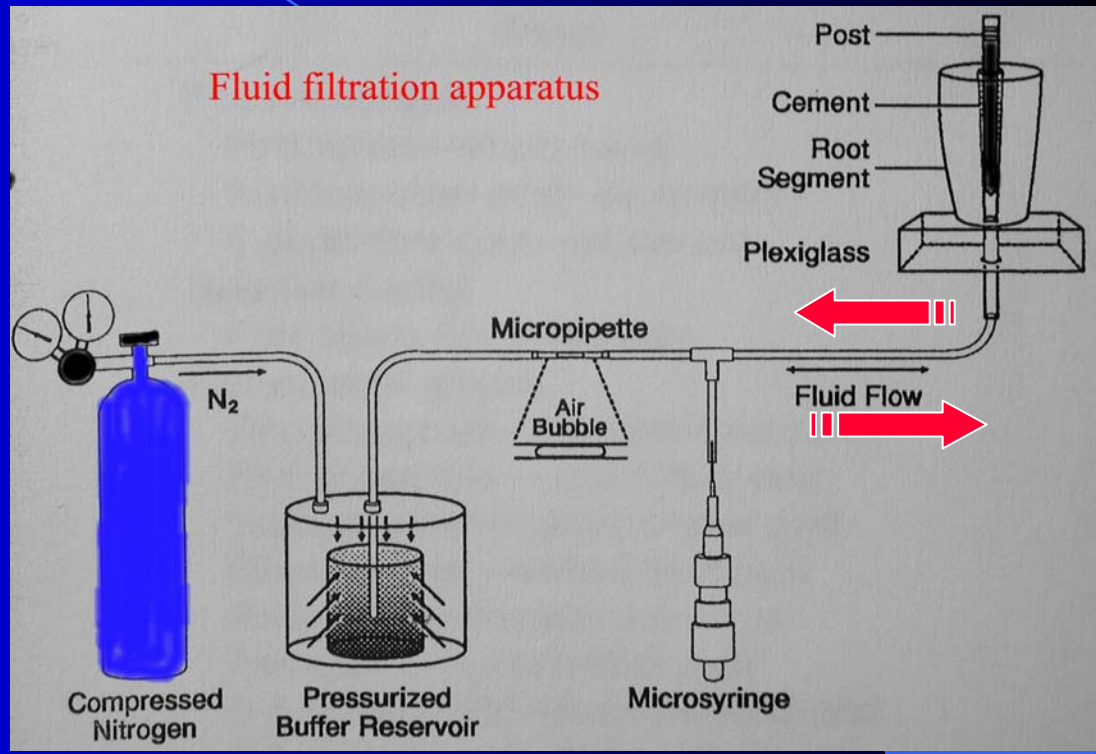


Compressed Nitrogen

Pressurized Buffer Reservoir

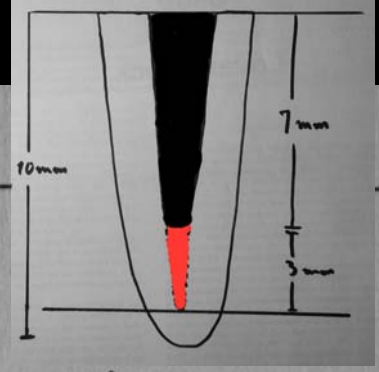
Microsyringe

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

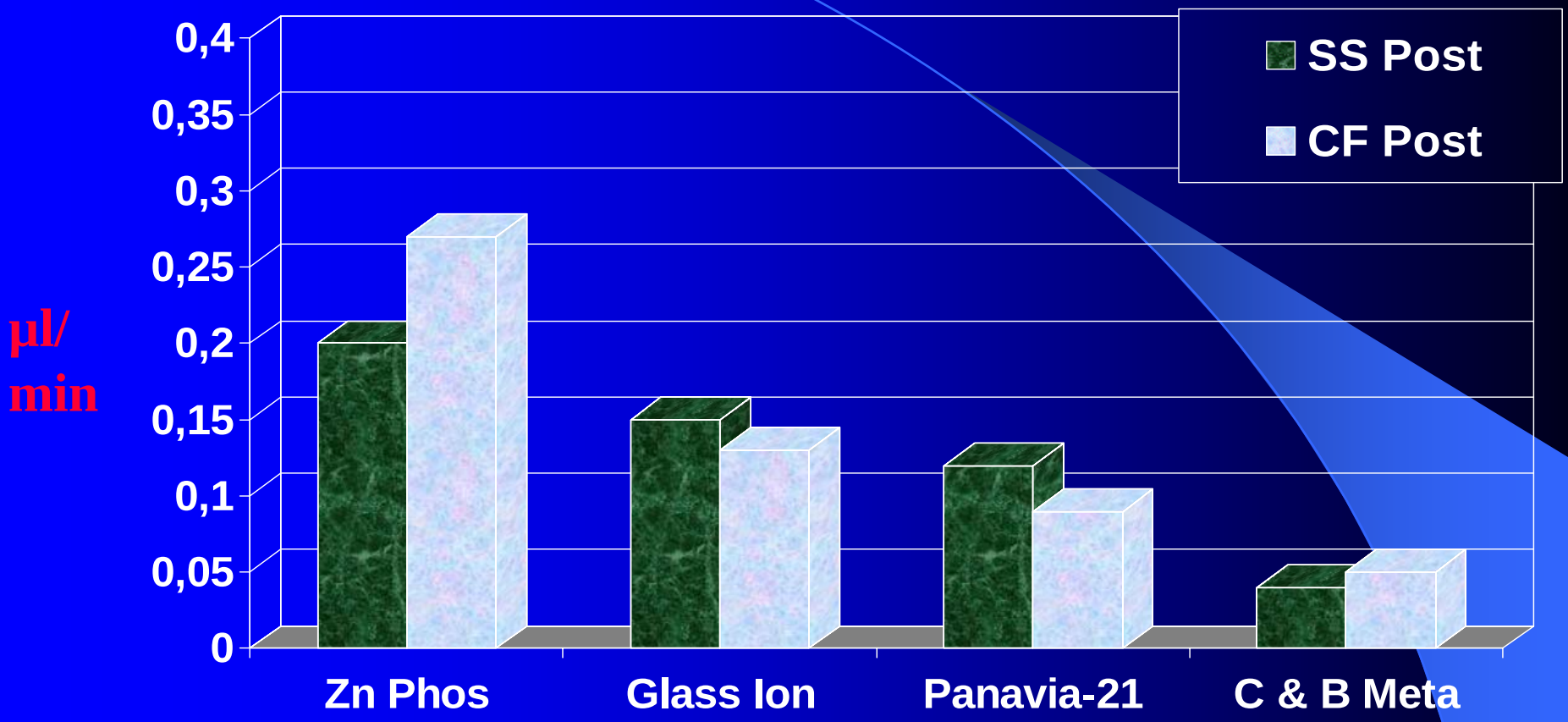
Experimental



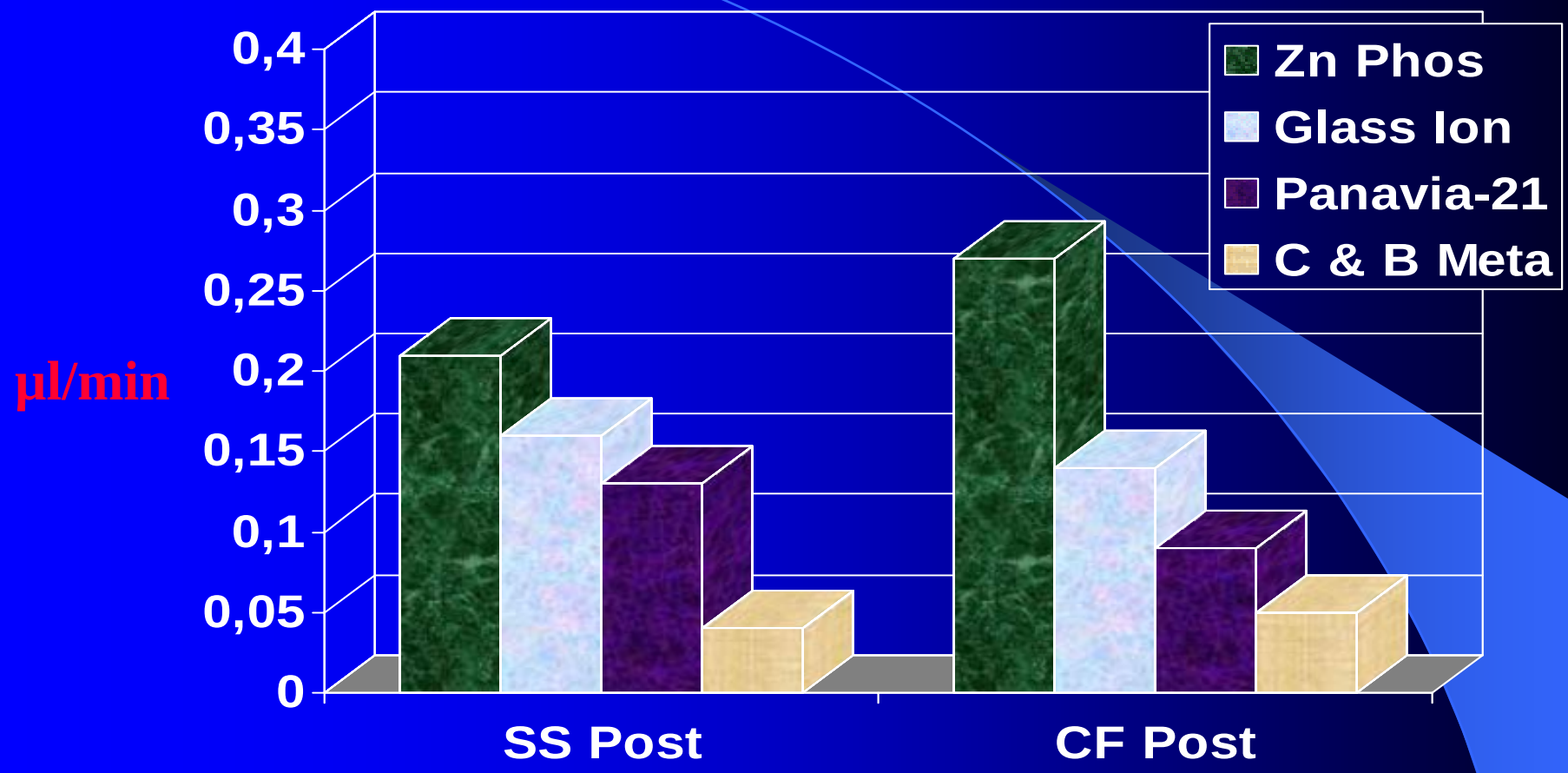
Group

- Positive controls
  - Post space—empty canal
  - Stainless-steel post—no cement
  - Carbon-fiber post—no cement
- Negative control
  - Post space—cyanoacrylate
- 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

Group	*n*	Mean
Positive controls		
Post space—empty canal	40	231.35
Stainless-steel post—no cement	40	35.35
Carbon-fiber post—no cement	40	22.03
Negative control		
Post space—cyanoacrylate	40	0.00
Experimental groups		
Zinc phosphate—stainless-steel post	40	20.80×10^{-5}
Zinc phosphate—carbon-fiber post	40	26.50×10^{-5}
Glass ionomer—stainless-steel post	40	15.90×10^{-5}
Glass ionomer—carbon-fiber post	40	14.60×10^{-5}
Panavia-21—stainless-steel post	40	13.30×10^{-5}
Panavia-21—carbon-fiber post	40	10.20×10^{-5}
C & B Metabond—stainless-steel post	40	4.66×10^{-5}
C & B Metabond—carbon-fiber post	40	5.33×10^{-5}



Microleakage



Microleakage

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