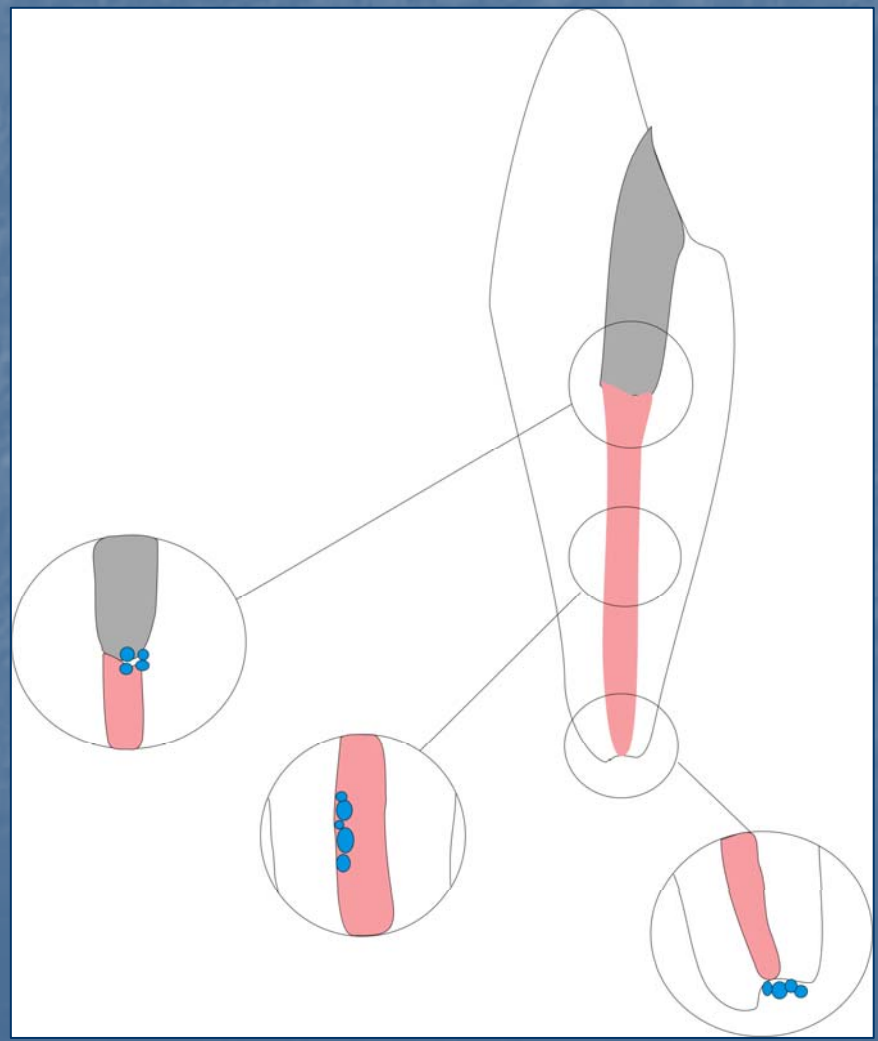
Purpose, rationale, and importance of obturation: standard of care

Homan Zandi 2004

The ultimate biological aim of root canal treatment is either to prevent or cure apical periodontitis

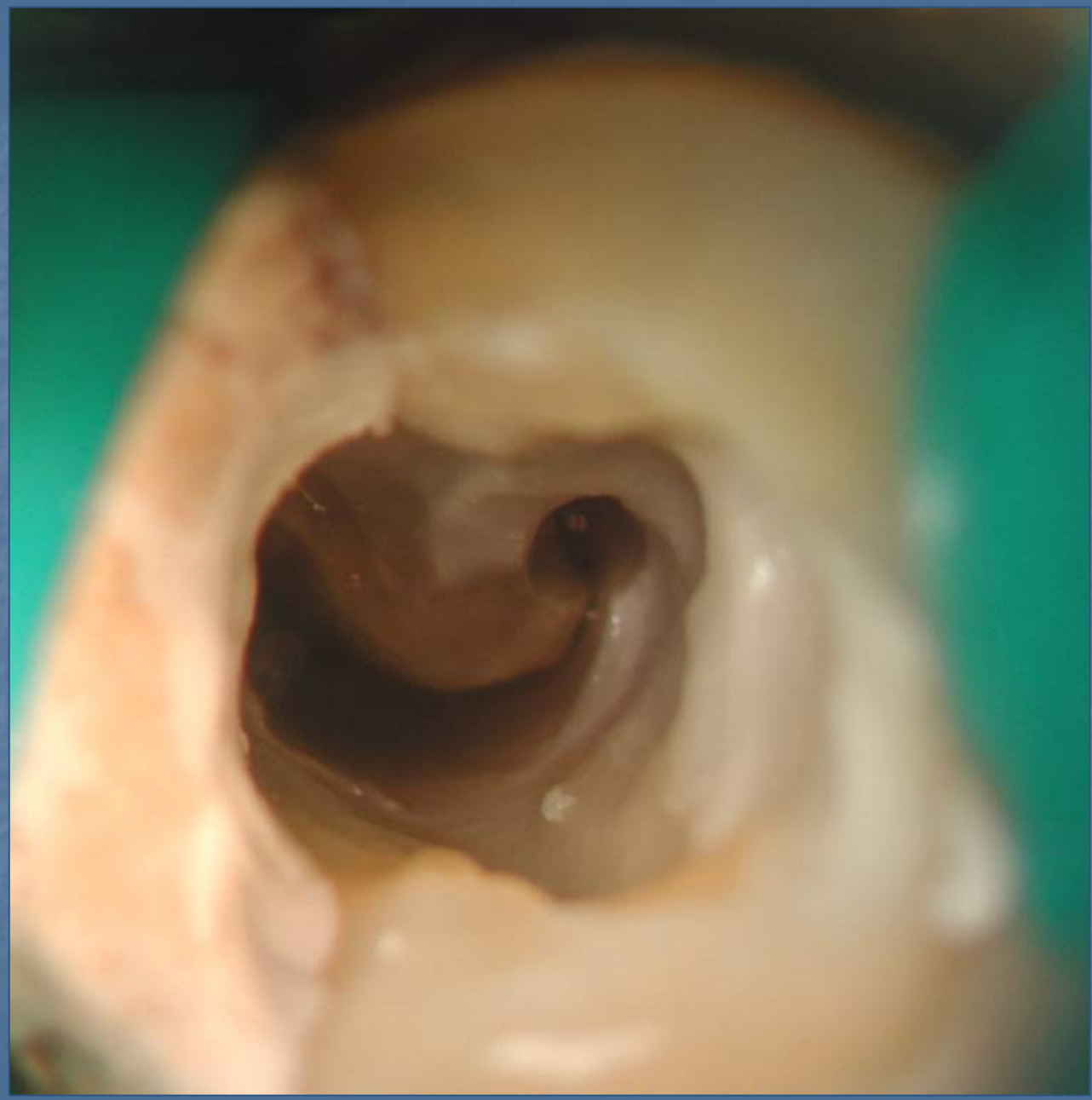
Functions of the root filling

- Preventing the reinfection by acting as a barrier
- Sealing any surviving bacterial cells and their irritants
- Stopping influx of periapical tissue fluids



Failure to eliminate these etiological factors and to prevent further irritation via continued contamination of the root canal system are the prime causes of failure of nonsurgical and surgical root canal treatment

- Three-dimensional (3-D) obturation
- Radiographic evaluation
  - Poor correlation between the quality of the root canal obturation and what is viewed on a buccal radiograph
  - When the root filling is radiograpically acceptable, the likelihood of leakage is still rather high

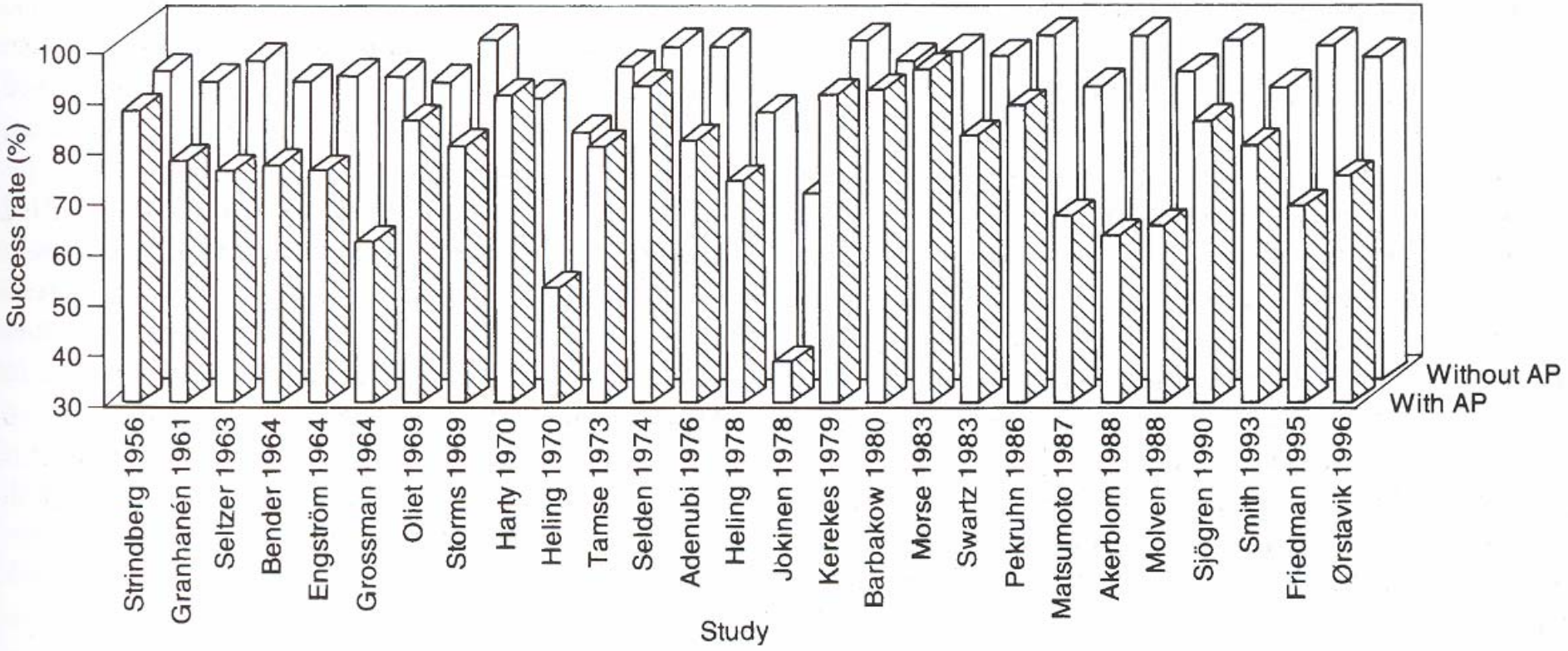


Prognostic factors in root canal therapy

- Preoperative factors
- Intraoperative factors
- Postoperative factors

Preoperative factors

- Apical periodontitis



S Friedman 1998

Preoperative factors

- Apical periodontitis
- Lesion size

Preoperative factors

- Apical periodontitis
- Lesion size
- Pulpal status

Preoperative factors

- Apical periodontitis
- Lesion size
- Pulpal status
- Symptoms

Preoperative factors

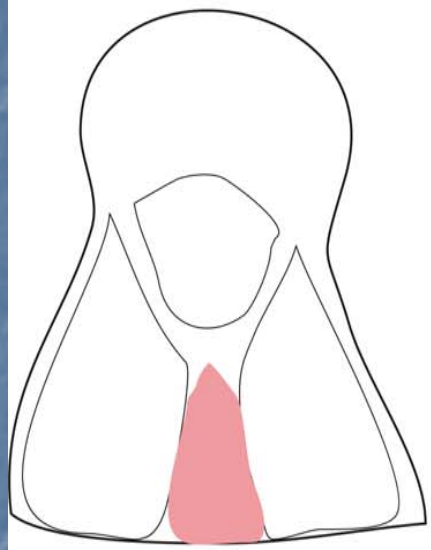
- Apical periodontitis
- Lesion size
- Pulpal status
- Symptoms
- Age, gender, tooth location, health

Preoperative factors

- Apical periodontitis
- Lesion size
- Pulpal status
- Symptoms
- Age, gender, tooth location, health
- Periodontal condition

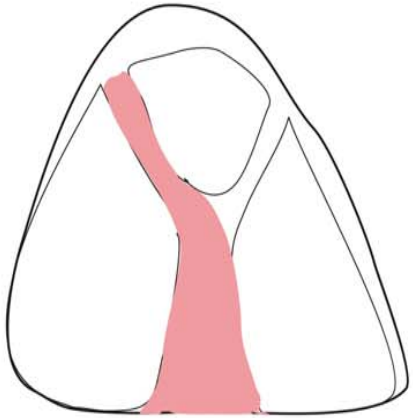
Intraoperative factors

- Apical extent of canal instrumentation and filling



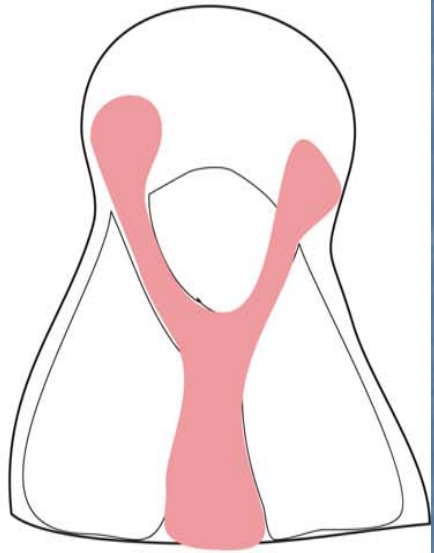
Underfilled (>2 mm)

68% success



0-2 mm from apex

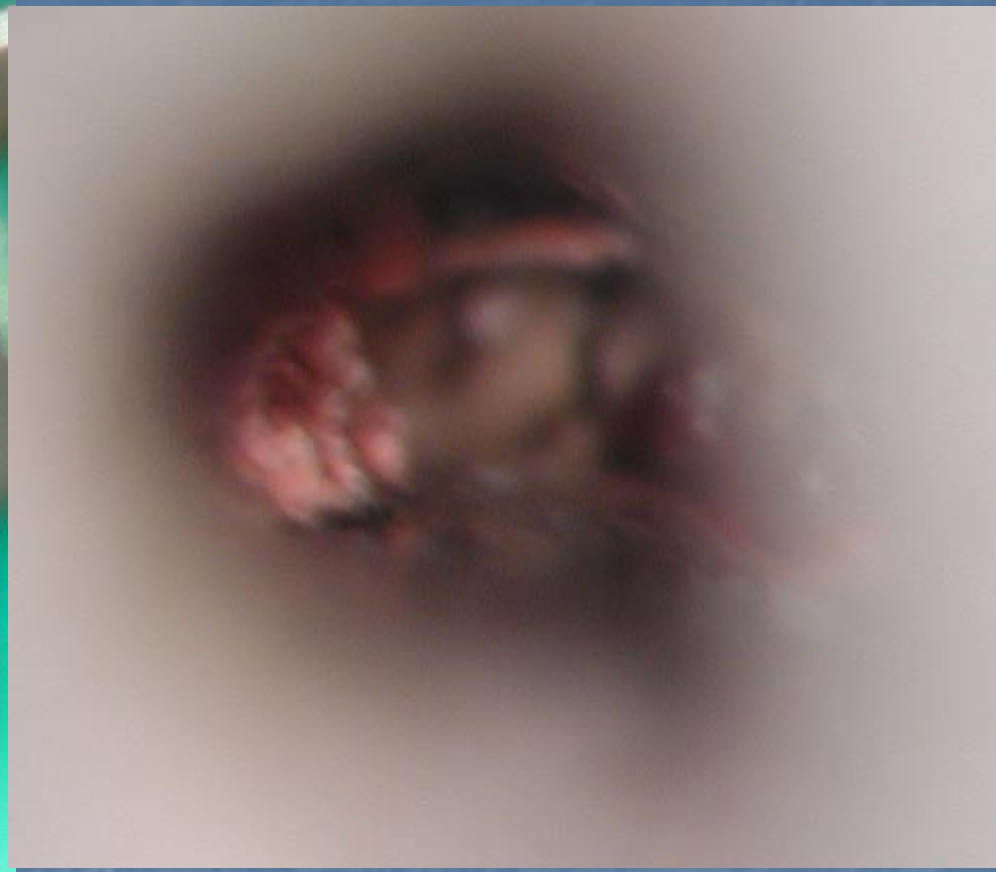
94% success

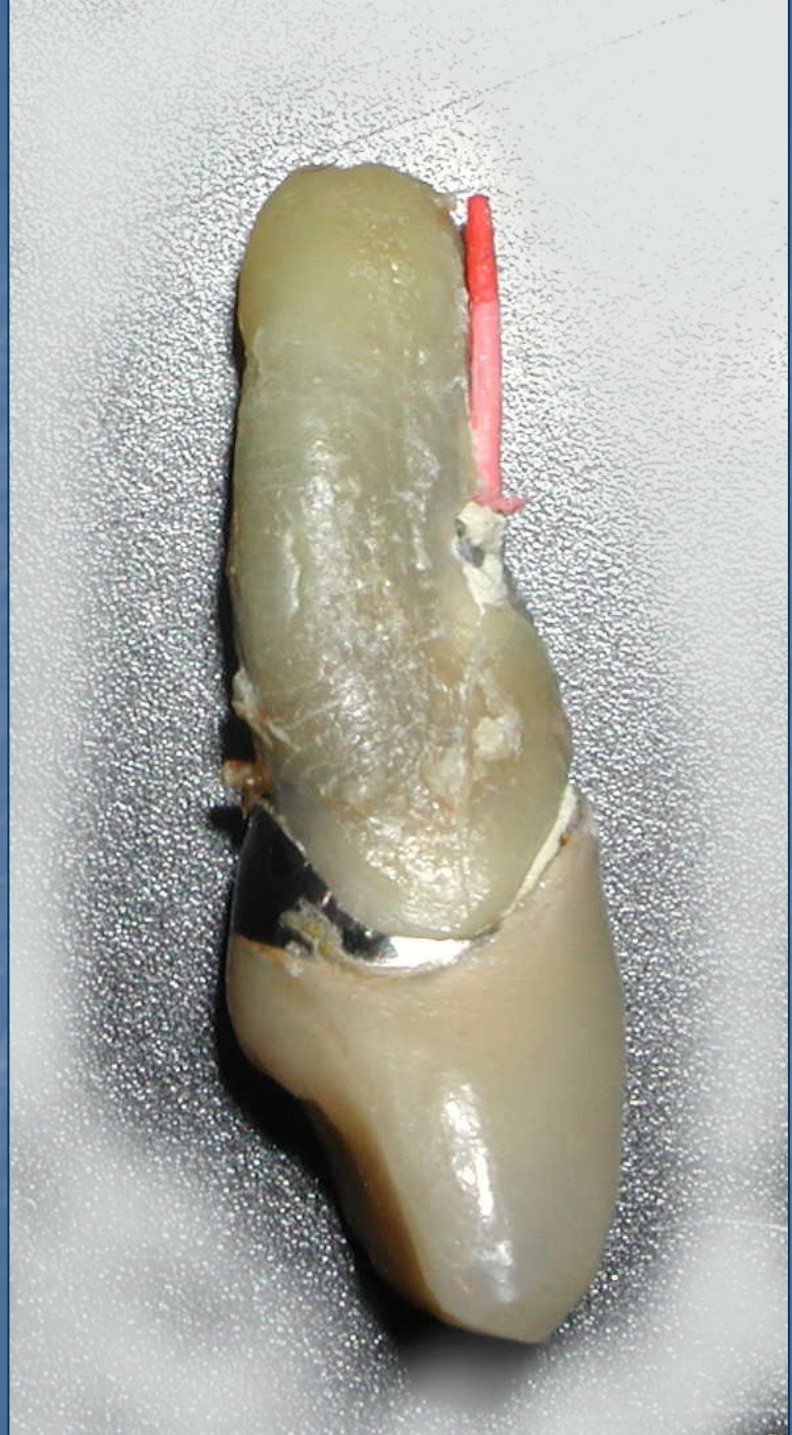


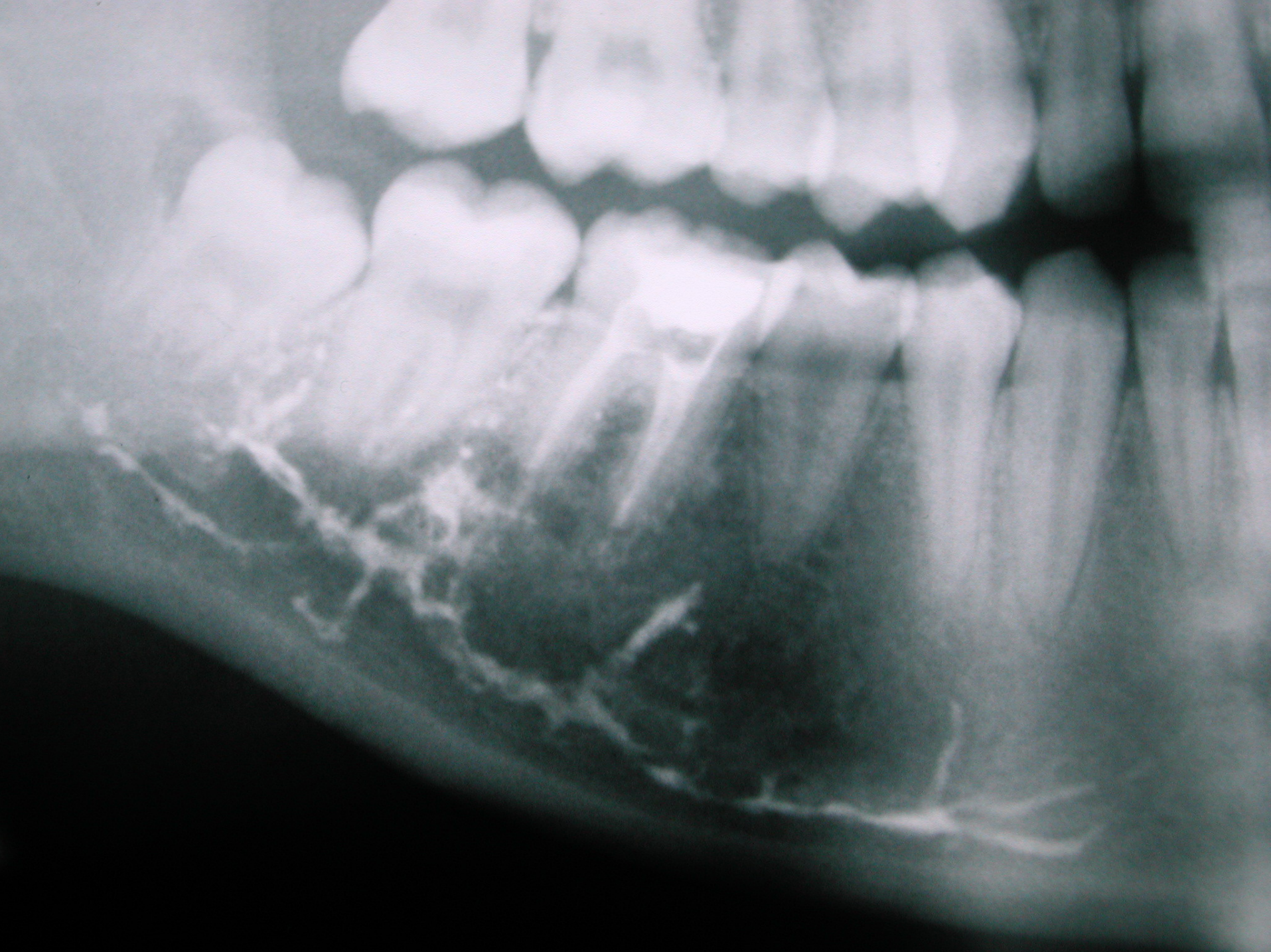
Overfilled

76% success

Sjögren et al., 1991







Intraoperative factors

- Apical extent of canal instrumentation and filling
- Apical enlargement
- Treatment sessions
- Material and techniques
- Complications

Postoperative factors

- Restoration

- The success of endodontic therapy is commonly thought of in terms of an adequate apical seal

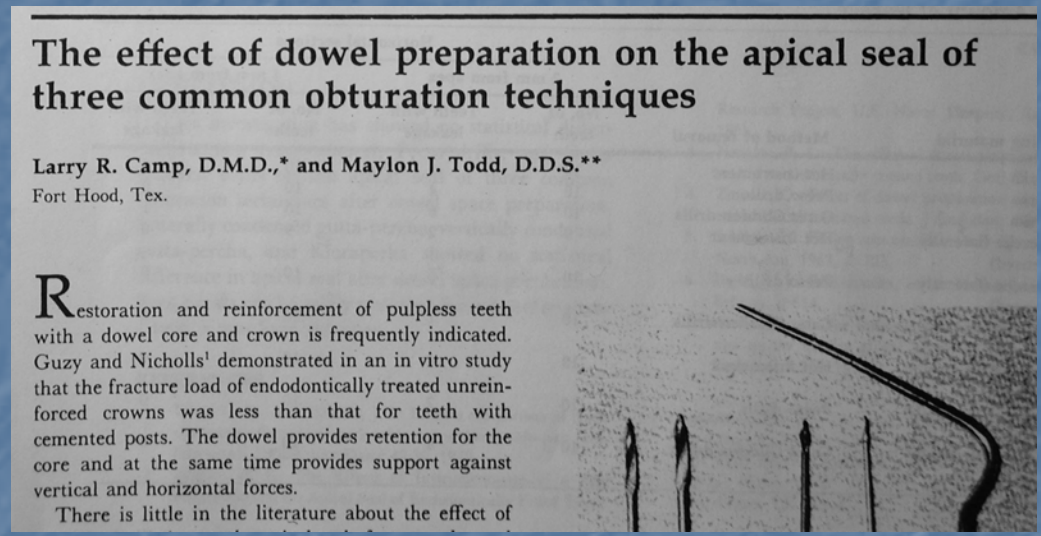
- However, the coronal seal achieved by the restoration may be considered as important for the ultimate success of endodontic treatment (Marshall et al, Swanson et al, Torabinejad et al, Magura et al. Khayat et al, Ray et al, Tronstad et al)

Strindberg, 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

How much gutta-percha should be retained to maintain 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



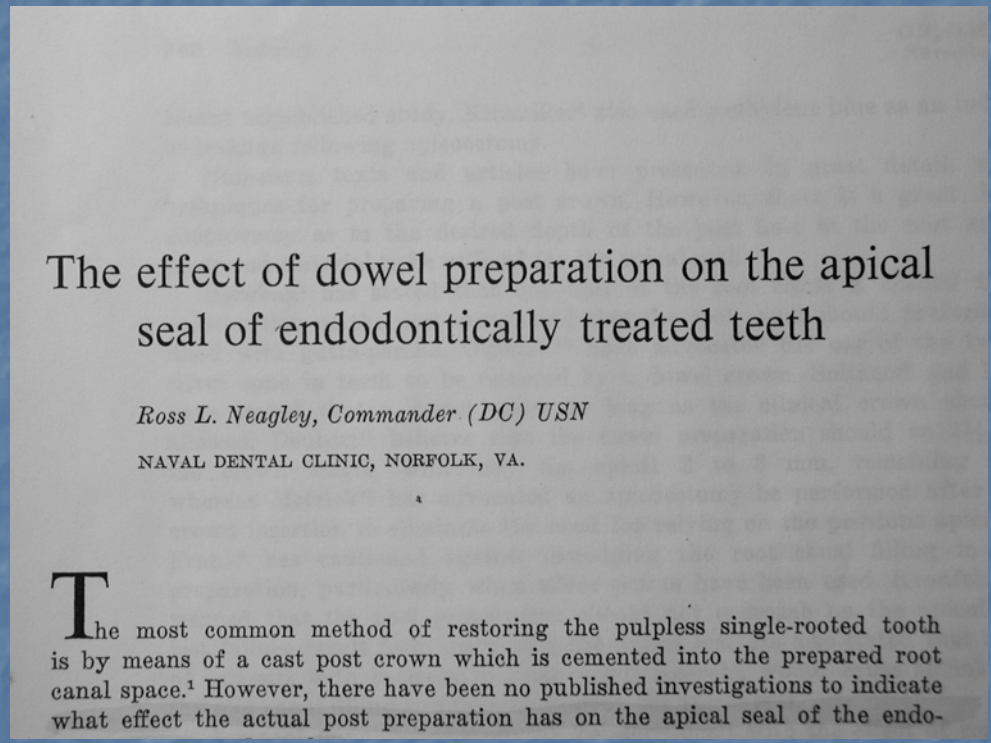
The effect of dowel preparation on the apical seal of three common obturation techniques

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



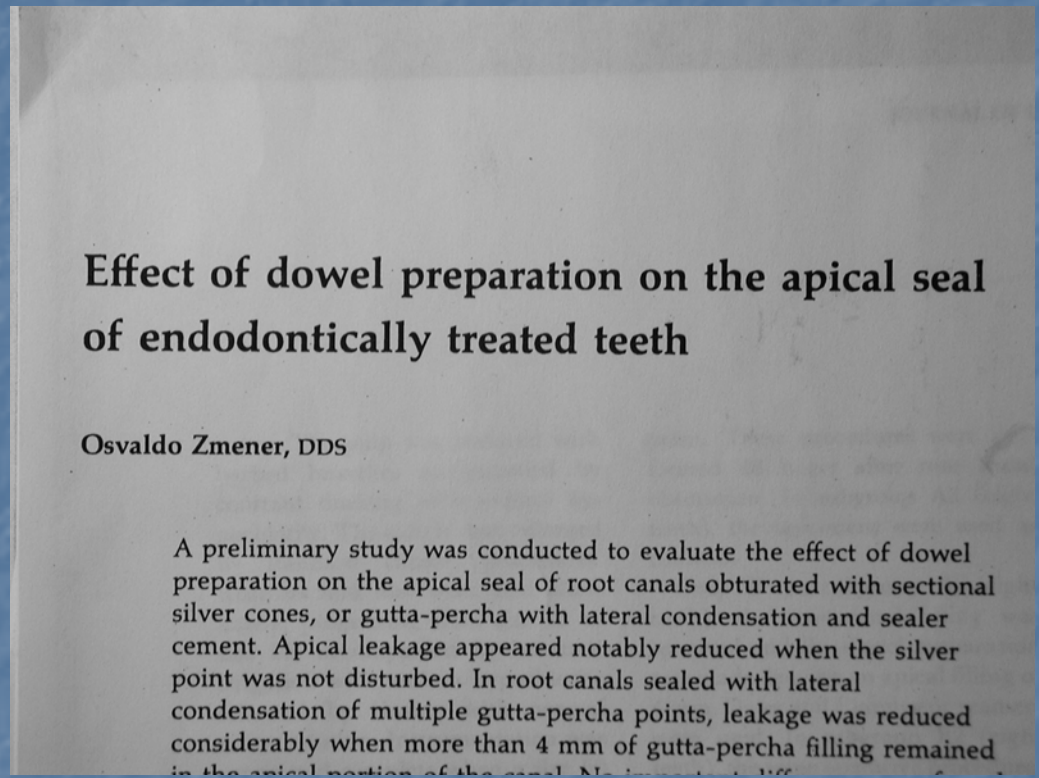
The effect of dowel preparation on the apical seal of endodontically treated teeth

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

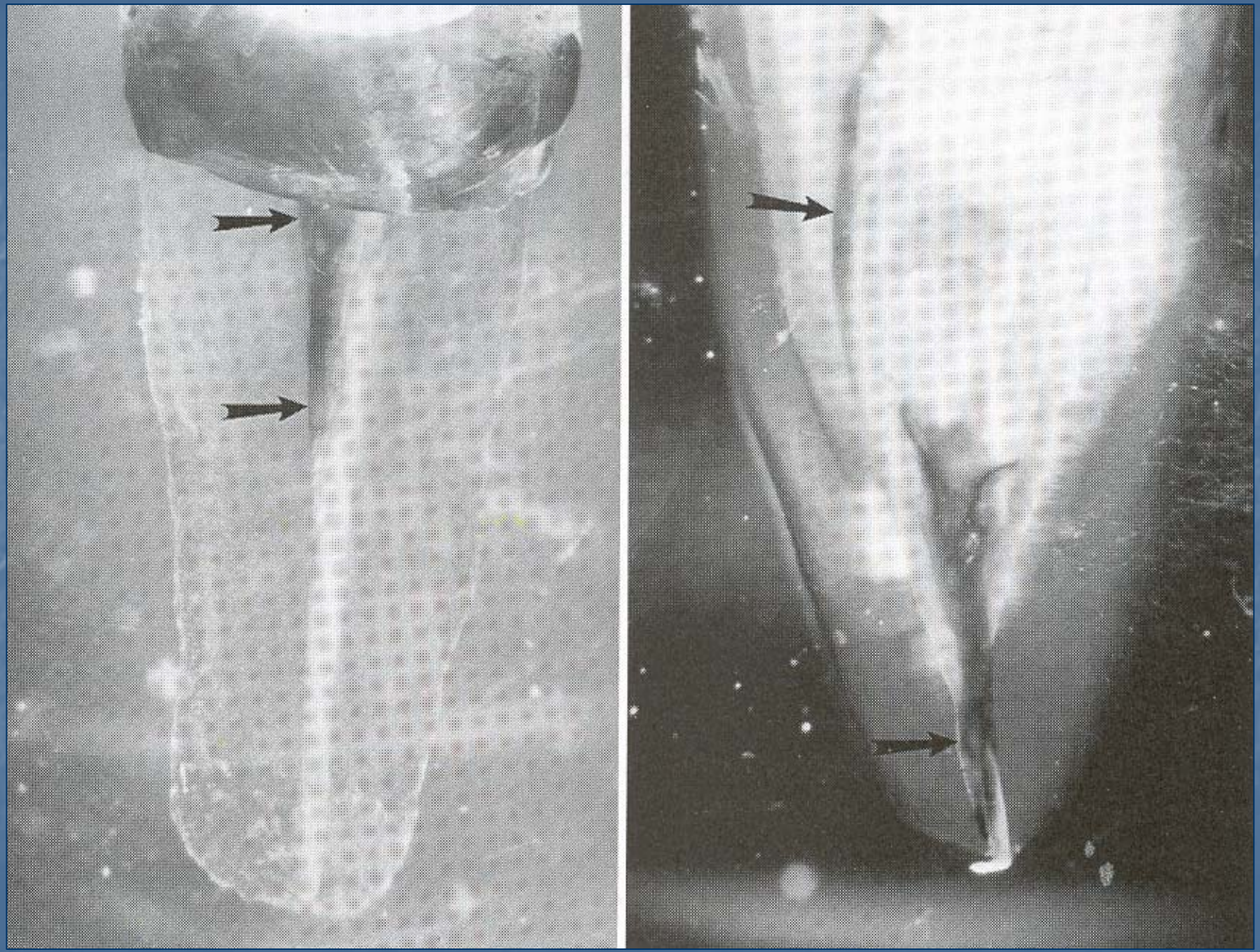
- During the mechanical preparation of the post space it is possible that the root filling may be twisted or vibrated, with disruption of the seal

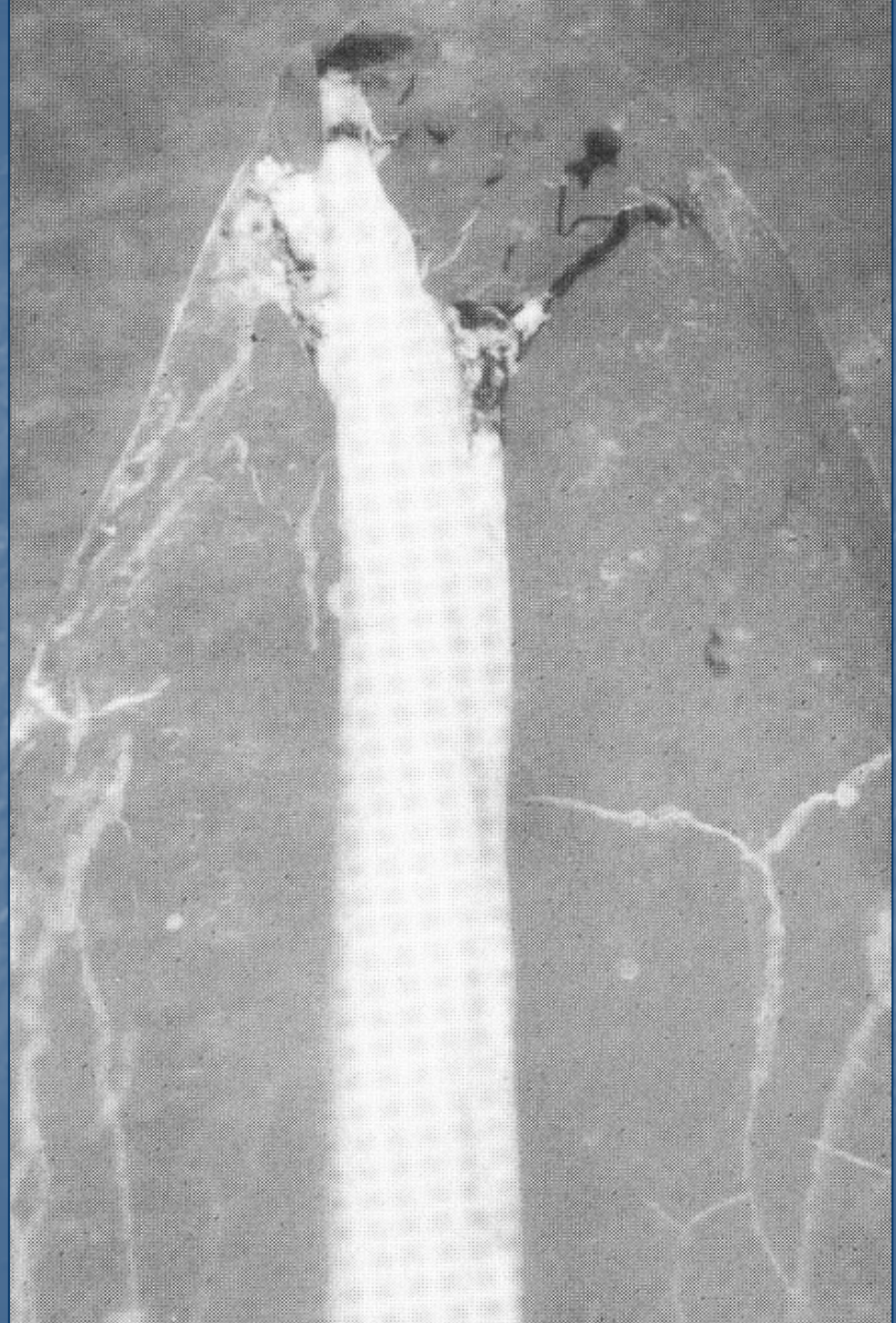
- Provided a minimum of 5 mm of sound apical root filling is left *in situ,* studies have shown that removal of laterally condensed gutta percha does not affect the apical seal, irrespective of whether the post space is prepared immediately after obturation or is delayed (Zmener 1980, Neagley 1969, Bourgeois et al 1981)

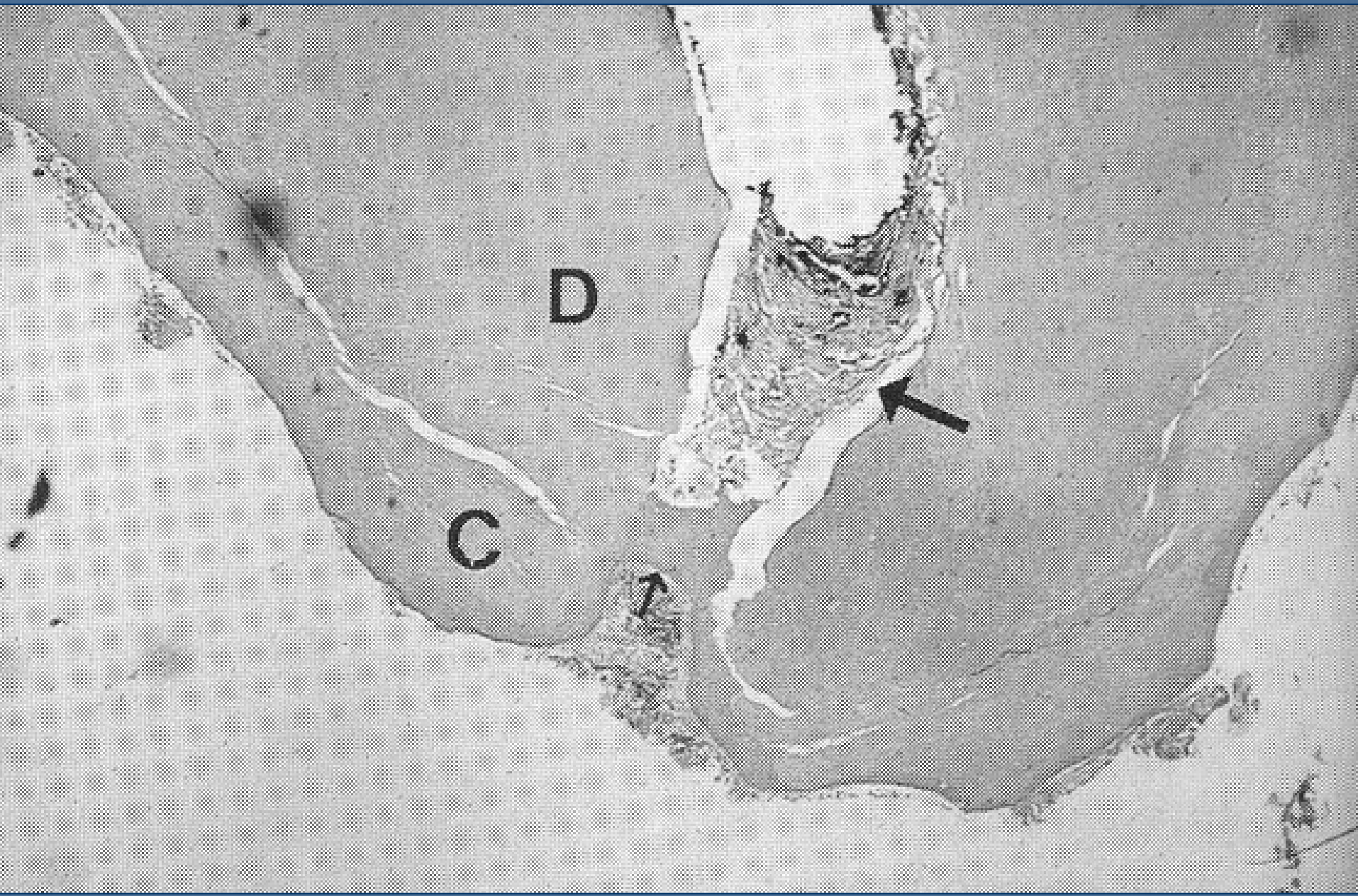
Endodontic success

- It is generally accepted that the success rate of the treatment is positively correlated with the criteria for good technical quality of the root filling

- Even in a good root filling performed under optimal condition, the coronal leakage will be consistent and extensive if the access cavity is left unfilled and thus exposed to fluids



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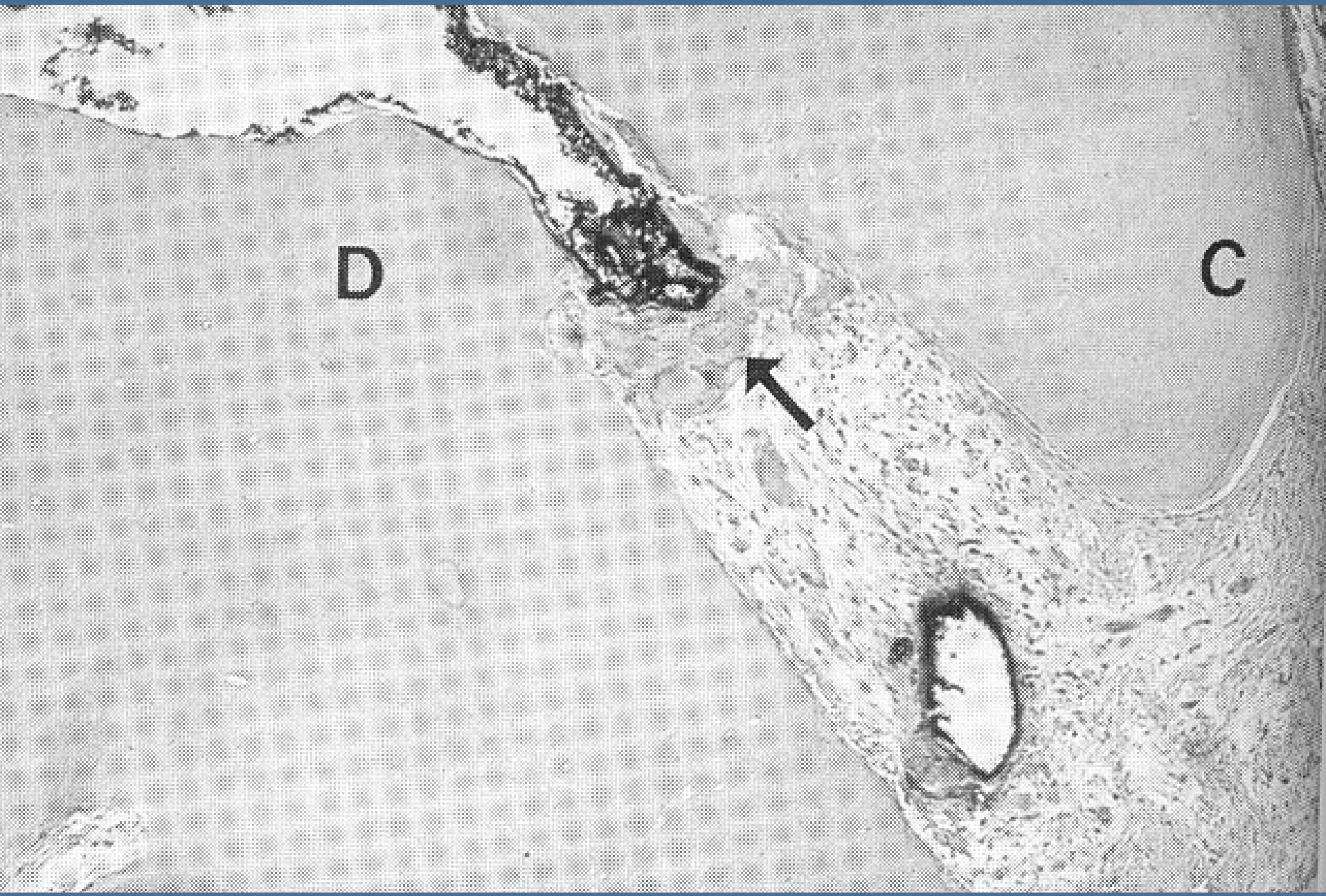
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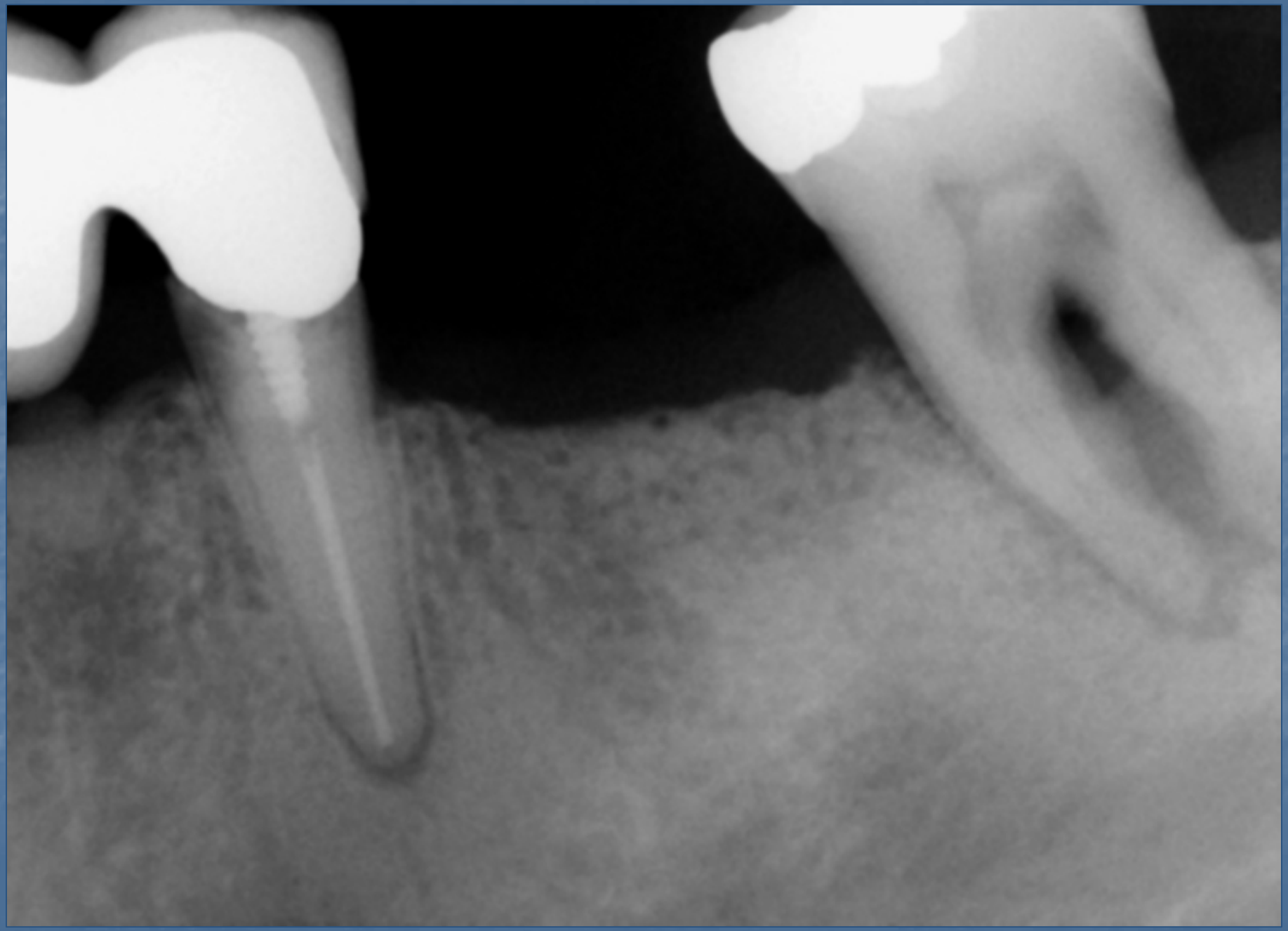


Obturated root canals can be recontaminated by micro-organisms in a number of ways:

- 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

- 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

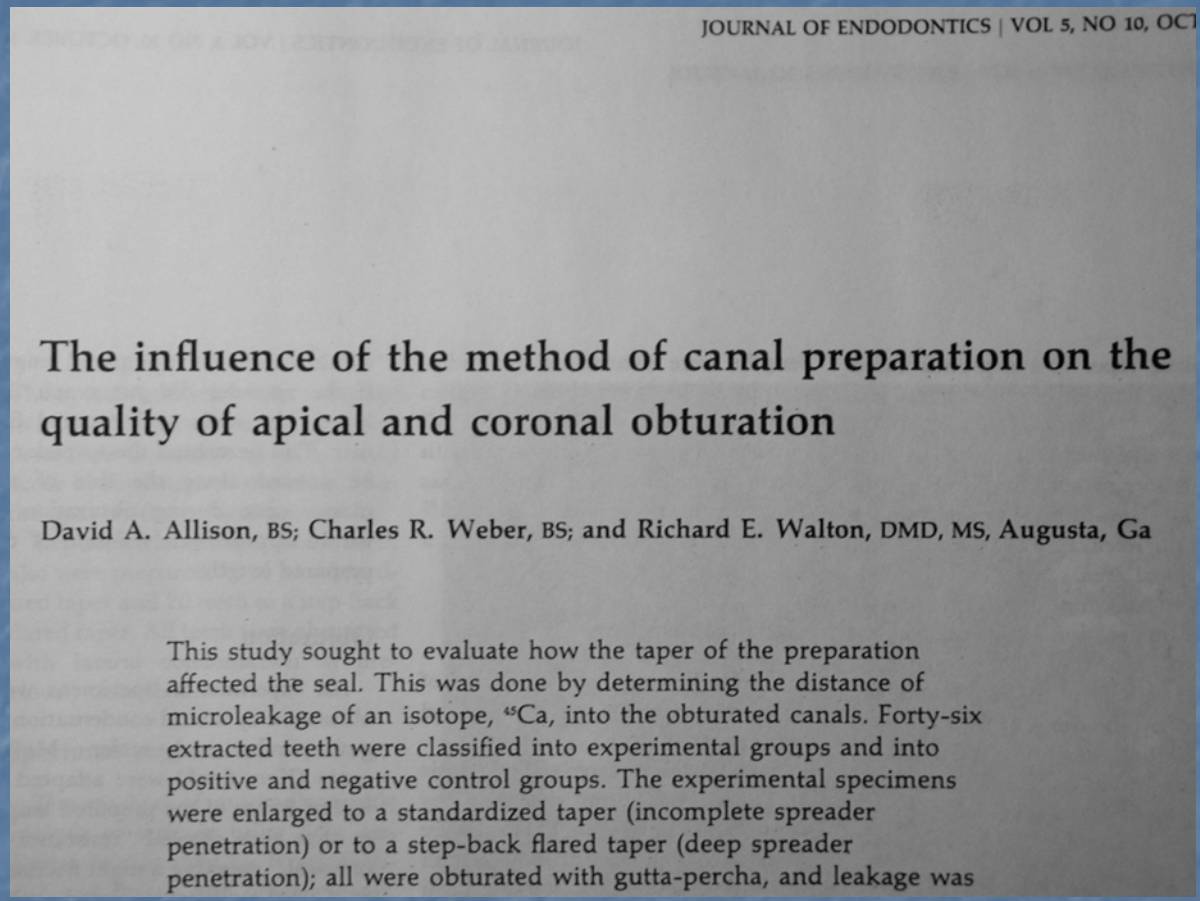
Coronal leakage...

- 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

Leakage of endodontic obturation materials are 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 method (Derksen et al)

Allison et al, in 1979 made brief reference to the possibility that a poor coronal seal might contribute to clinical failure



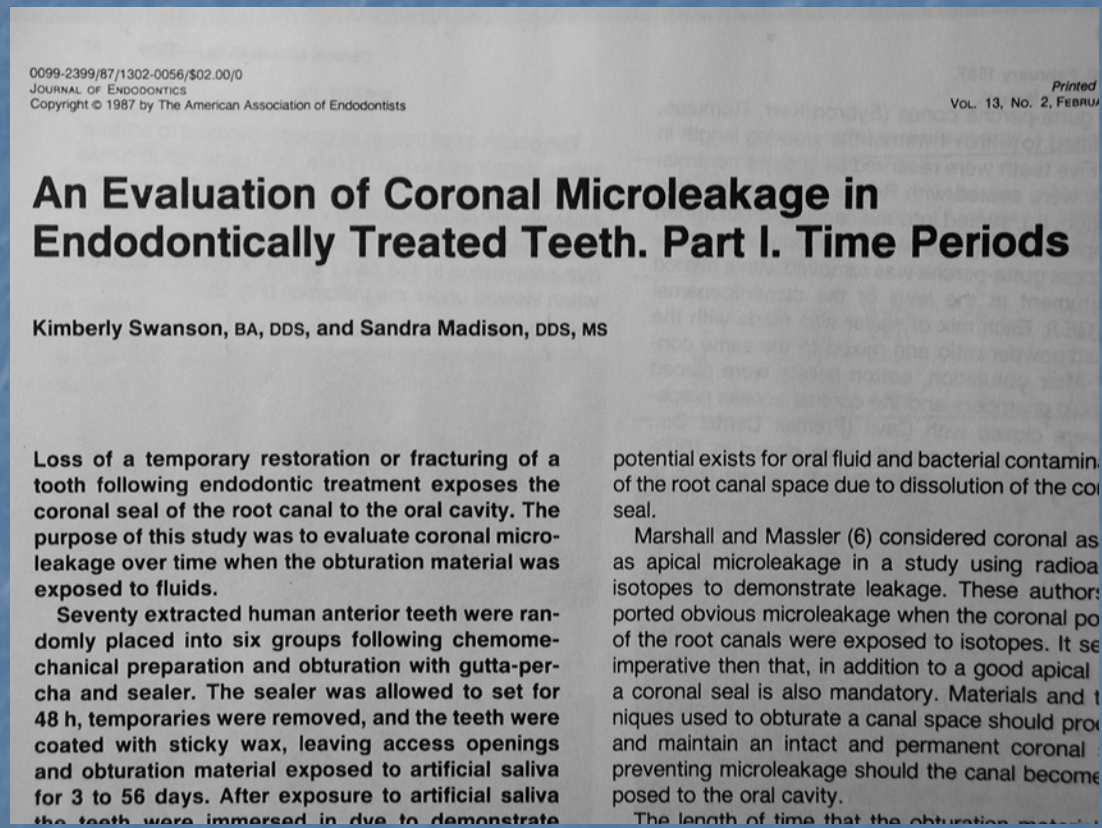
JOURNAL OF ENDODONTICS | VOL 5, NO 10, OCT

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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JOURNAL OF ENDODONTICS

Printed
VOL. 13, NO. 2, FEBRU

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.

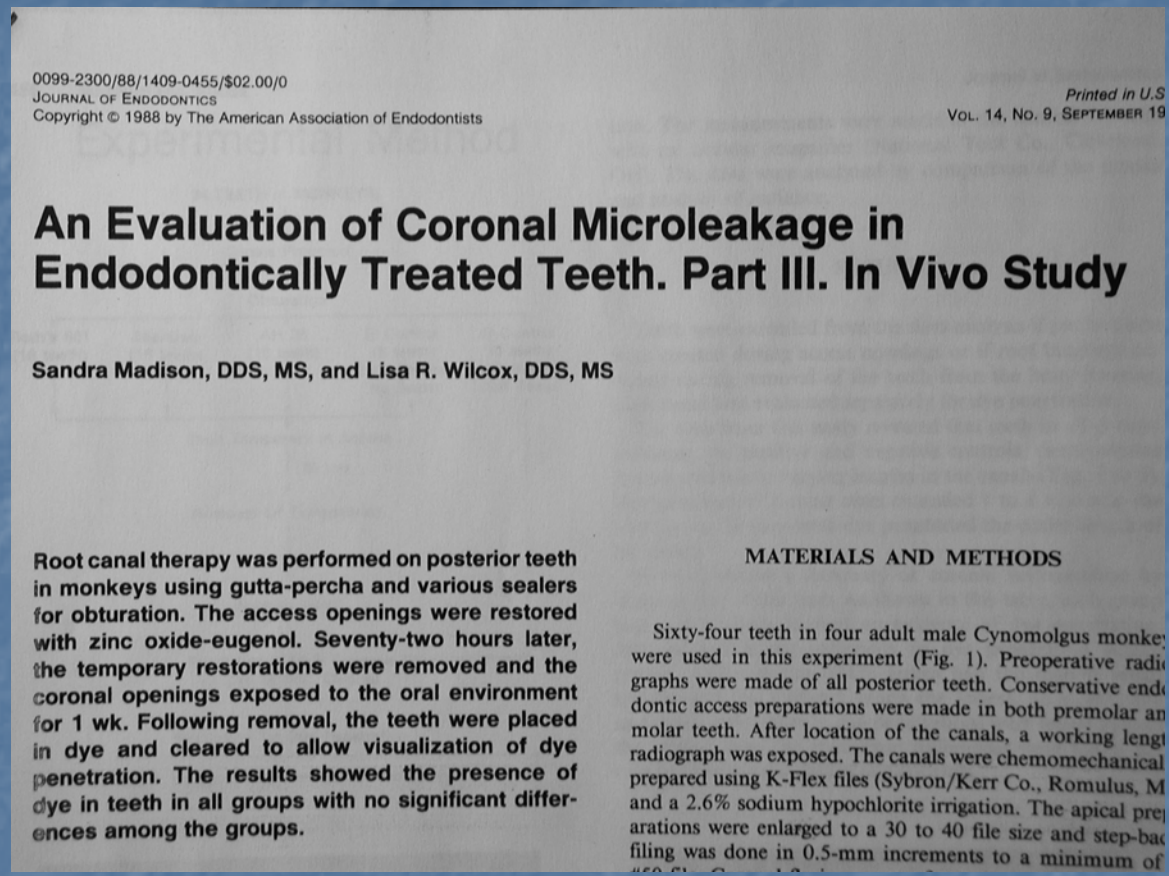
Seventy extracted human anterior teeth were randomly placed into six groups following chemomechanical preparation and obturation with gutta-percha and sealer. The sealer was allowed to set for 48 h, temporaries were removed, and the teeth were coated with sticky wax, leaving access openings and obturation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

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 po
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 t
niques used to obturate a canal space should pro
and maintain an intact and permanent coronal
preventing microleakage should the canal become
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
Printed in U.S
VOL. 14, NO. 9, SEPTEMBER 19

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

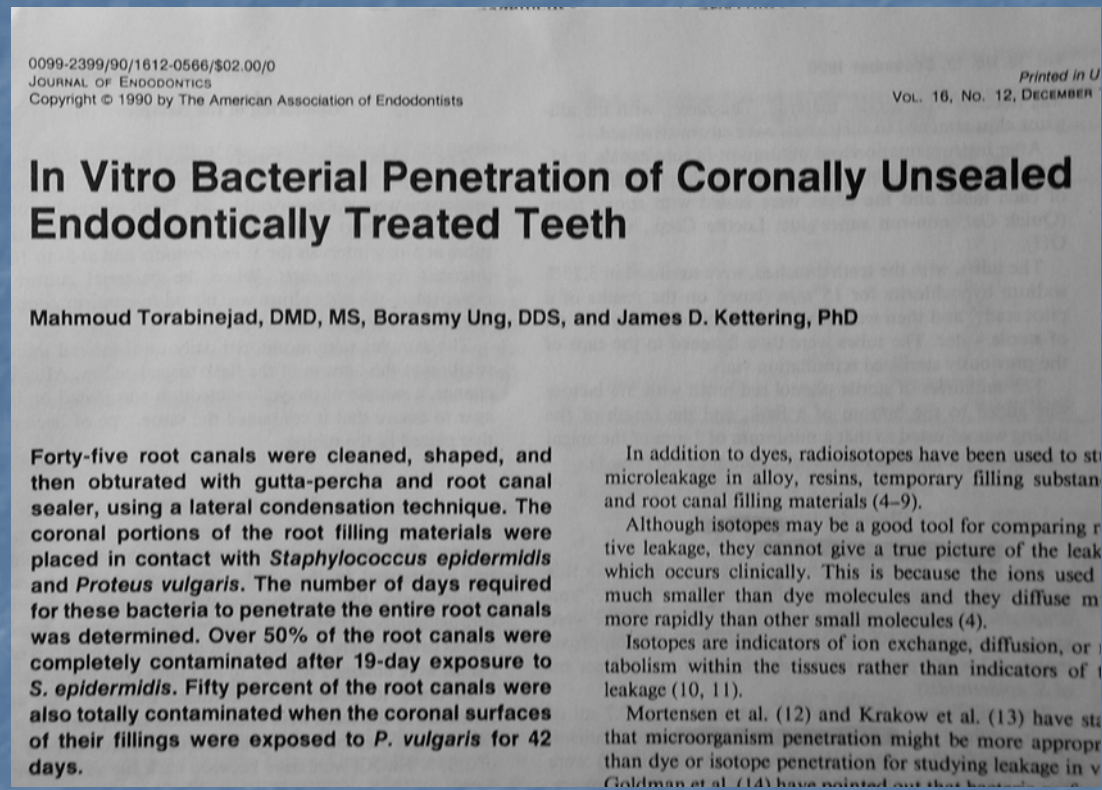
Sandra Madison, DDS, MS, and Lisa R. Wilcox, DDS, MS

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 an
molar teeth. After location of the canals, a working lengt
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-bac
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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JOURNAL OF ENDODONTICS

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VOL. 16, NO. 12, DECEMBER

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.

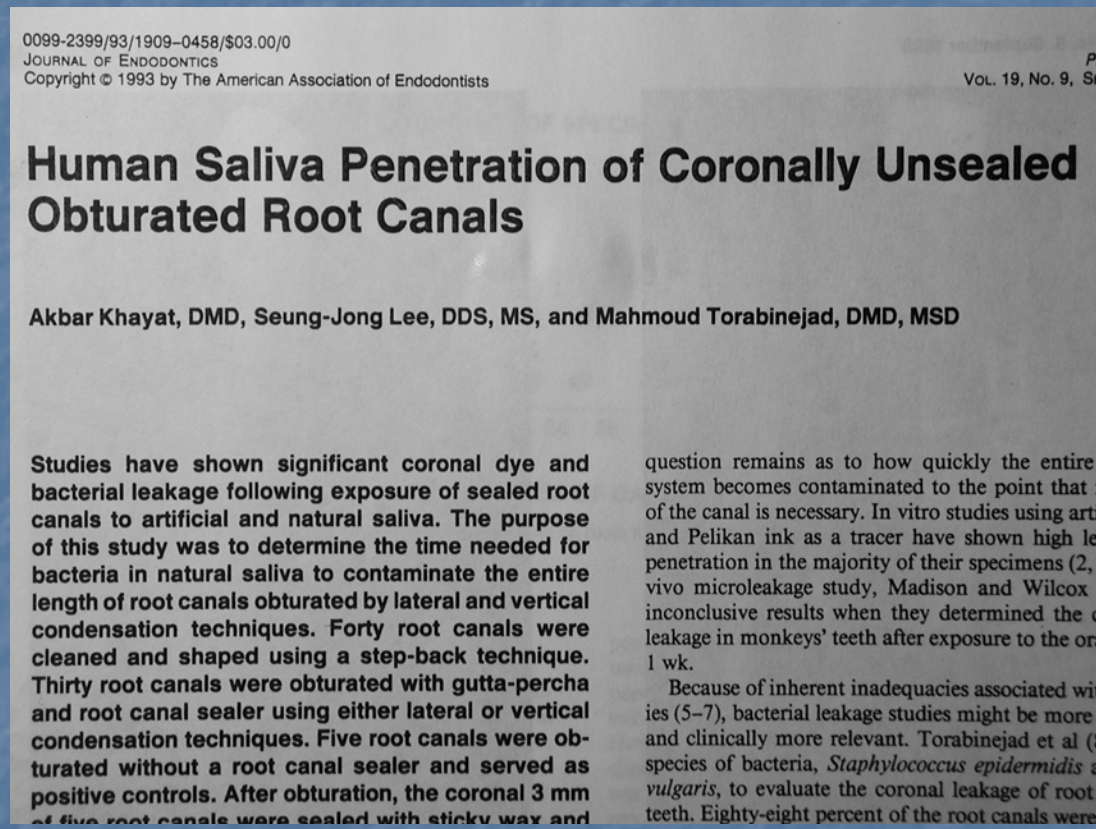
In addition to dyes, radioisotopes have been used to st
microleakage in alloy, resins, temporary filling substan
and root canal filling materials (4–9).

Although isotopes may be a good tool for comparing r
tive leakage, they cannot give a true picture of the leak
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 appropr
than dye or isotope penetration for studying leakage in v
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



0099-2399/93/1909–0458/$03.00/0
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VOL. 19, No. 9,

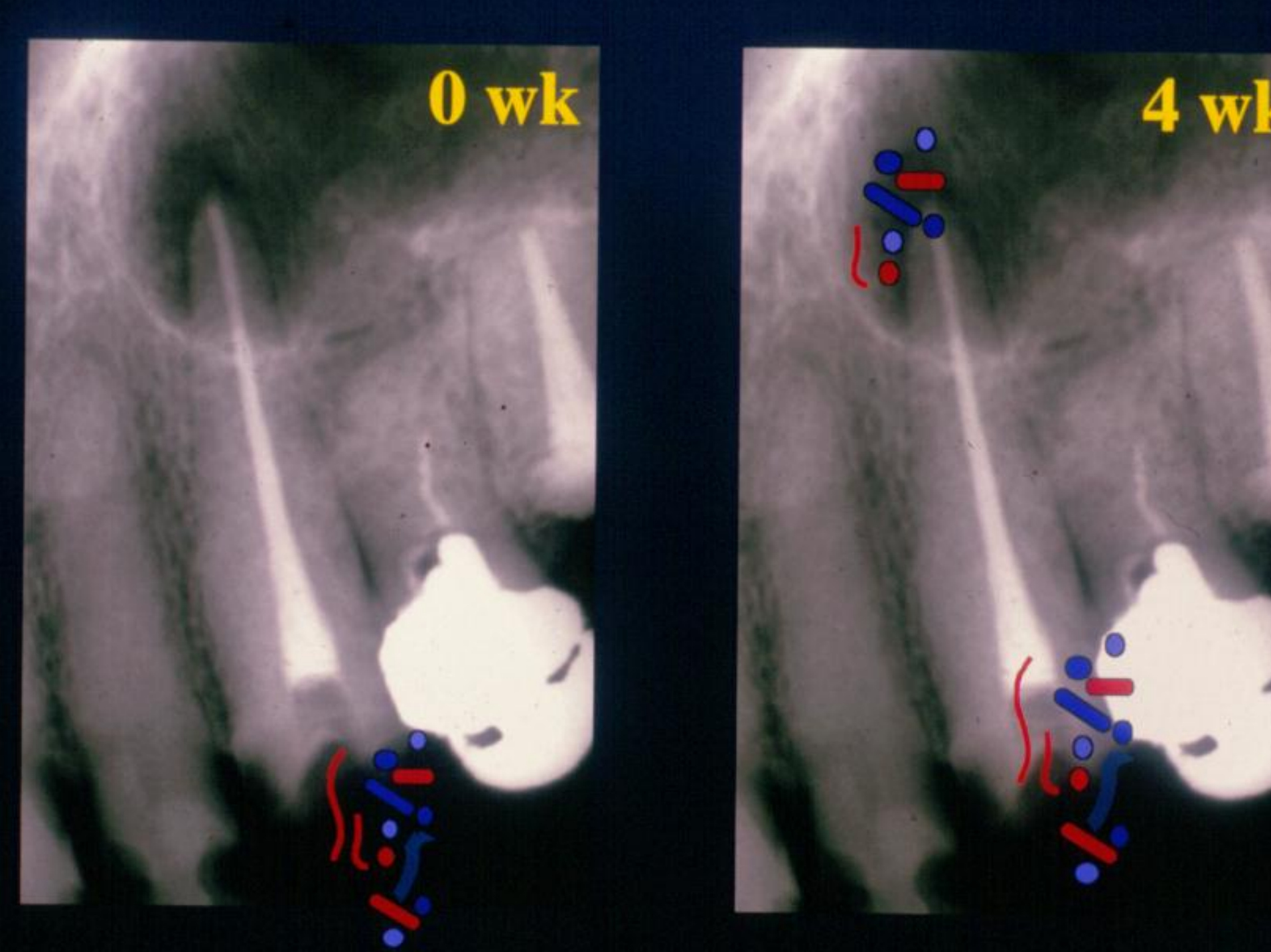
Human Saliva Penetration of Coronally Unsealed Obturated Root Canals

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 of five root canals were sealed with sticky wax and

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


0 wk
4 wk

What is more important?

- A good root filling or a good coronal restoration

International Endodontic Journal (1995) **28**, 12–18

Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration

H. A. RAY, & M. TROPE

Department of Endodontology, Temple Dental School, Philadelphia, PA 19140, USA

- 1010 endodontically treated teeth examined radiographically
- Good endodontic treatment (GE)
- Poor endodontic treatment (PE)
- Good restoration (GR)
- Poor restoration (PR)
- Absence of periraducular inflammation (API)
- Presence of periradicular inflammation (PPI)

Table 1. Periradicular status for each category of treatment quality

Group	Endo	Coronal	No. teeth	PPI	API	%API
1	Good (GE)	Any	495.0	120.5	374.5	75.7
2	Poor (PE)	Any	490.5	252.0	238.5	48.6
3	Any	Good (GR)	633.0	126.5	506.5	80.0
4	Any	Poor (PR)	352.5	246.0	106.5	30.2

* PPI, presence of periradicular inflammation

* API, absence of periradicular inflammation

Table 2. Periradicular status for various combinations of treatment quality

Group	Endo	Coronal	No. teeth	PPI	API	%API
1	Good (GE)	Good (GR)	330.5	28.5	302.0	91.4
2	Good (GE)	Poor (PR)	164.5	92.0	72.5	44.1
3	Poor (PE)	Good (GR)	302.5	98.0	204.5	67.6
4	Poor (PE)	Poor (PR)	188.0	154.0	34.0	18.1

PPI, presence of periradicular inflammation.
API, absence of periradicular inflammation.

Conclusion:

The technical quality of the coronal restoration was significantly more important than the technical quality of the endodontic treatment for apical periodontal health

Influence of coronal restorations on the periapical health of endodontically treated teeth

Tronstad L, Asbjørnsen K, Døving L, Pedersen I, Eriksen HM. Influence of coronal restorations on the periapical health of endodontically treated teeth. Endod Dent Traumatol 2000; 16: 218–221. © Munksgaard, 2000.

L. Tronstad, K. Asbjørnsen, L. Døving, I. Pedersen, H. M. Eriksen

Department of Endodontics, Faculty of Dentistry, University of Oslo, Oslo, Norway

- Duplicate the study by Ray & Trope

Table 2. Periradicular status of groups of teeth with good endodontic treatment, poor endodontic treatment, good coronal restorations and poor coronal restorations

Endodontic treatment	Coronal restoration	*n*	Failure	Success	Success in percent
GE	Any	506	111	395	78%*
PE	Any	495	216	279	56%*
Any	GR	663	201	462	70%**
Any	PR	338	126	212	63%**

GE=Good Endodontics; PE=Poor Endodontics; GR=Good Restoration; PR=Poor Restoration; Any=Any Quality.

* The difference between the success rate of teeth with Good and Poor Endodontics was statistically significant ($P<0.0001$).

** The difference between the success rate of teeth with Good and Poor Restoration was stastistically significant ($P<0.0001$).

Table 3. Success rate of endodontic treatment of good or poor quality in teeth with good or poor coronal restorations

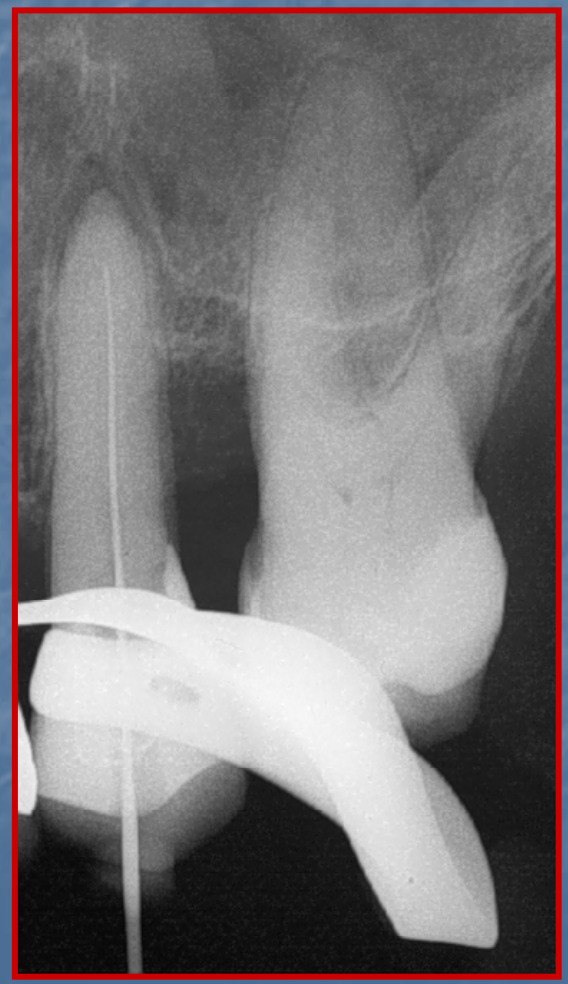
Endodontic treatment	Coronal restoration	*n*	Failure	Success	Success in percent
GE	GR	364	70	294	81%*
GE	PR	142	41	101	71%*
PE	GR	299	131	168	56%*
PE	PR	196	85	111	57%*

GE=Good Endodontics; PE=Poor Endodontics; GR=Good Restoration; PR=Poor Restoration.

* The difference between the success rate with Good Endodontics and Poor Endodontics was statistically significant ($P<0.0001$) regardless of the quality of the coronal restoration (GR or PR).

Leakage under endodontic therapy

- Instrumentation

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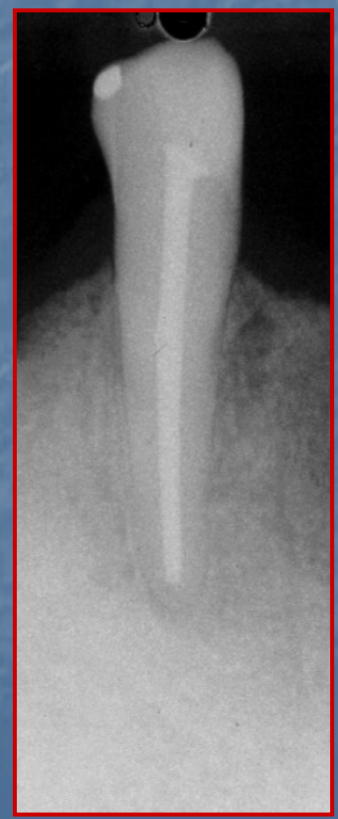
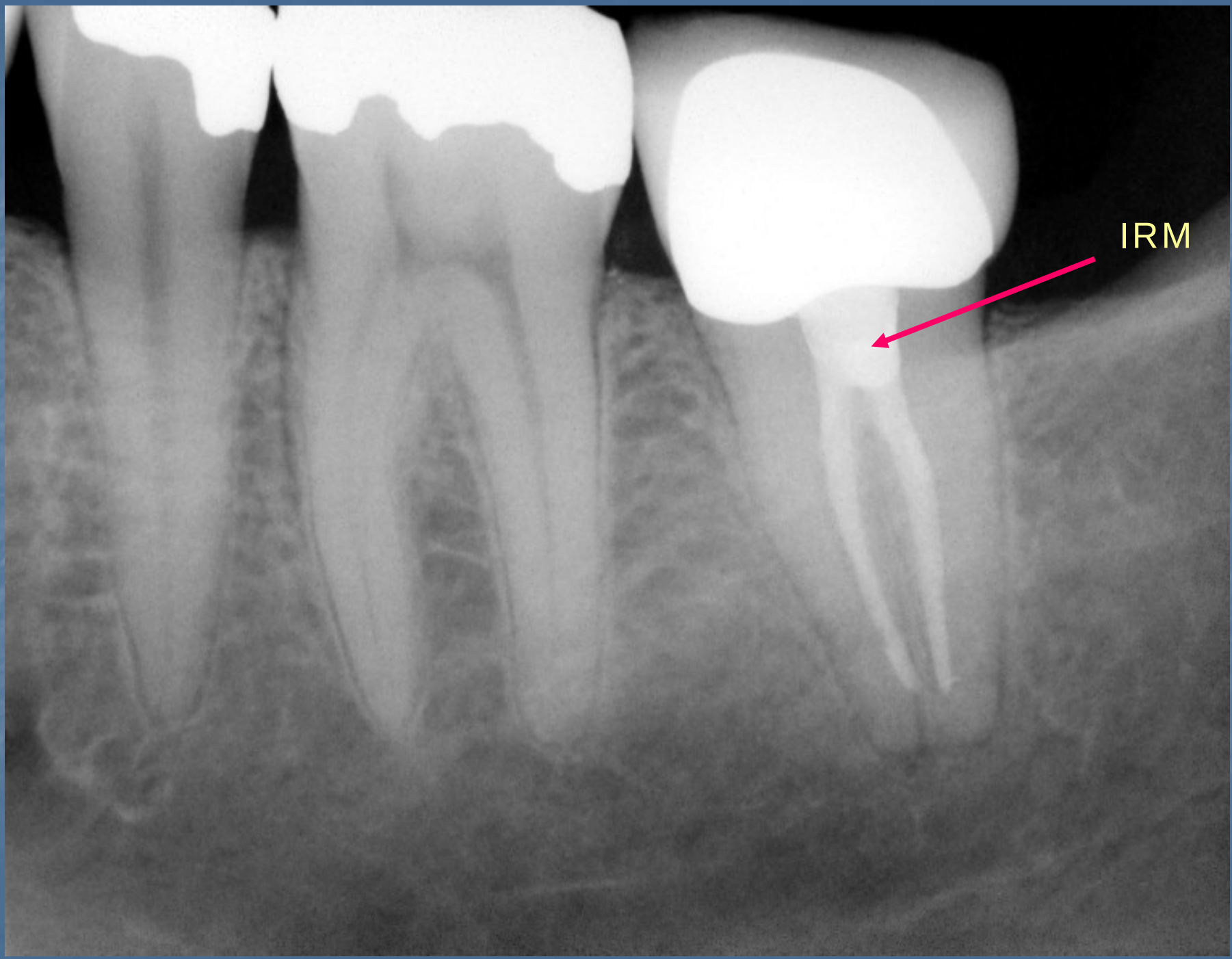
Leakage under endodontic therapy

- Intrumentation
- Intraappointment dressing

Leakage under endodontic therapy

- Intrumentation
- Intraappointment dressing
- Postoperative

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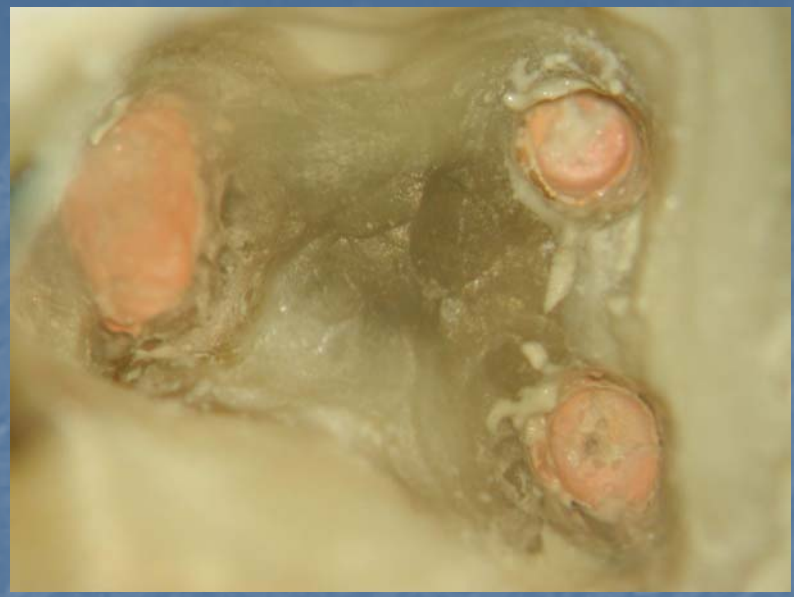

what prevents microorganisms from penetrating a root filled tooth?

- Sealer

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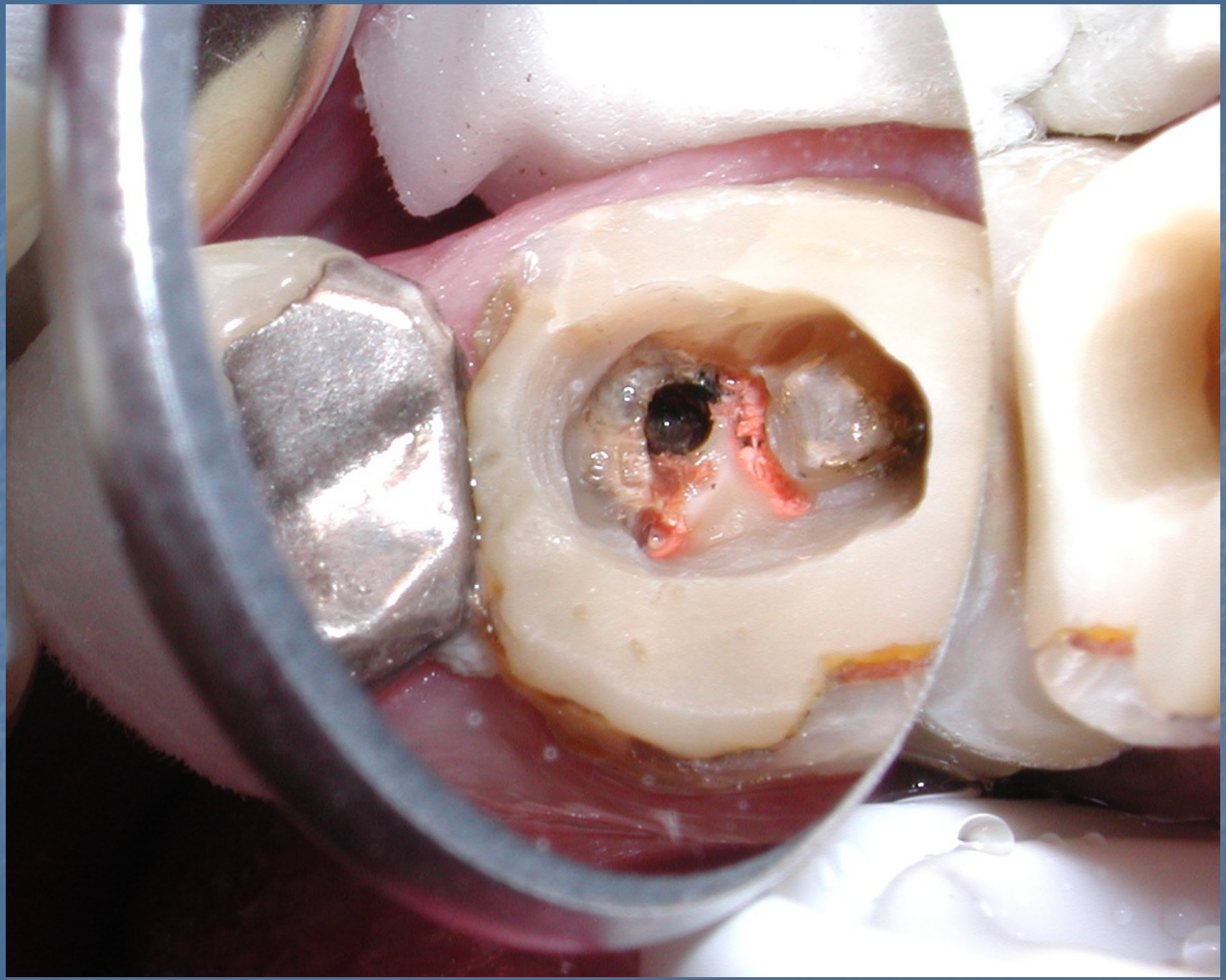
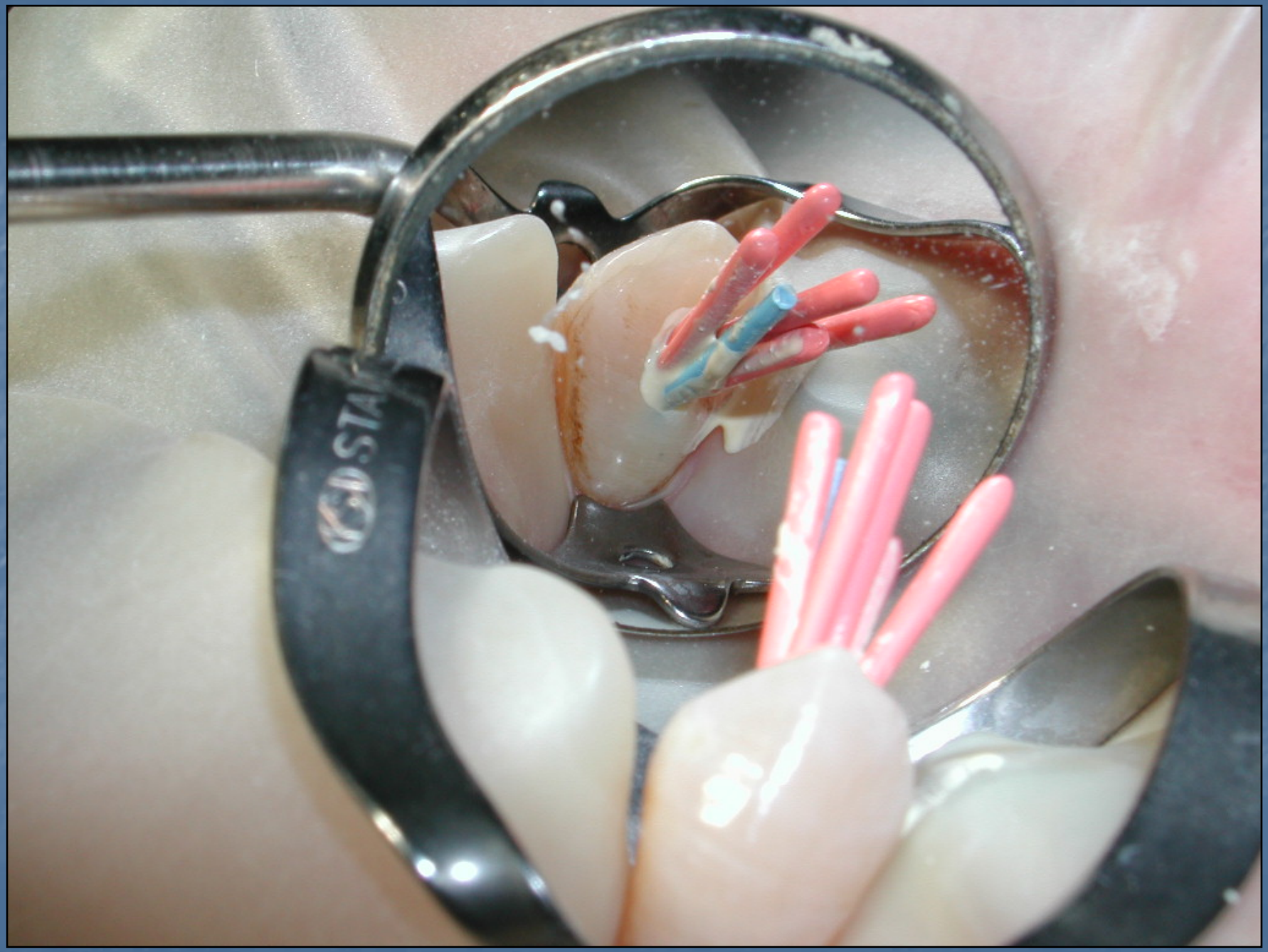
- Sealer
- Core material
- Filling technique

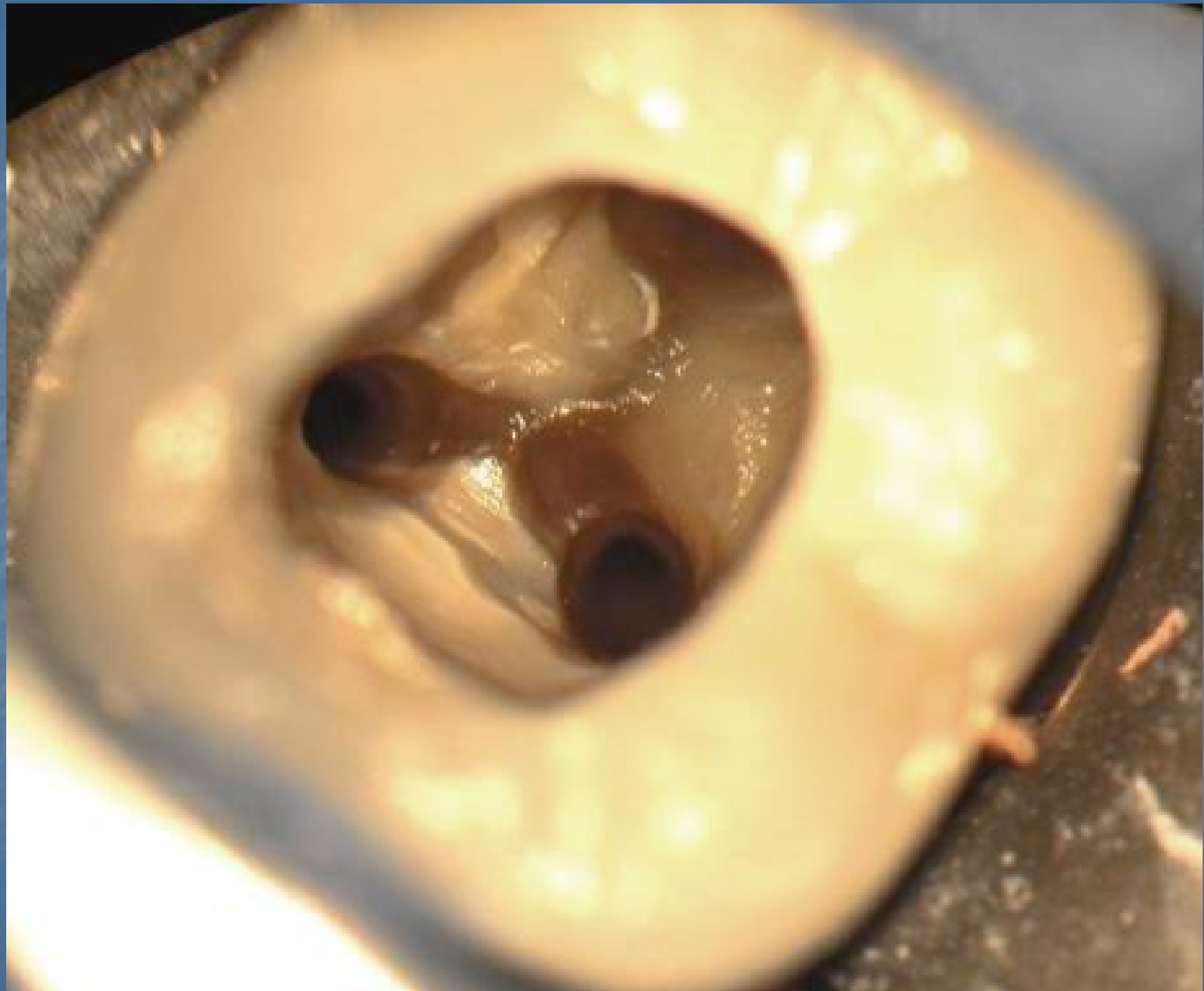


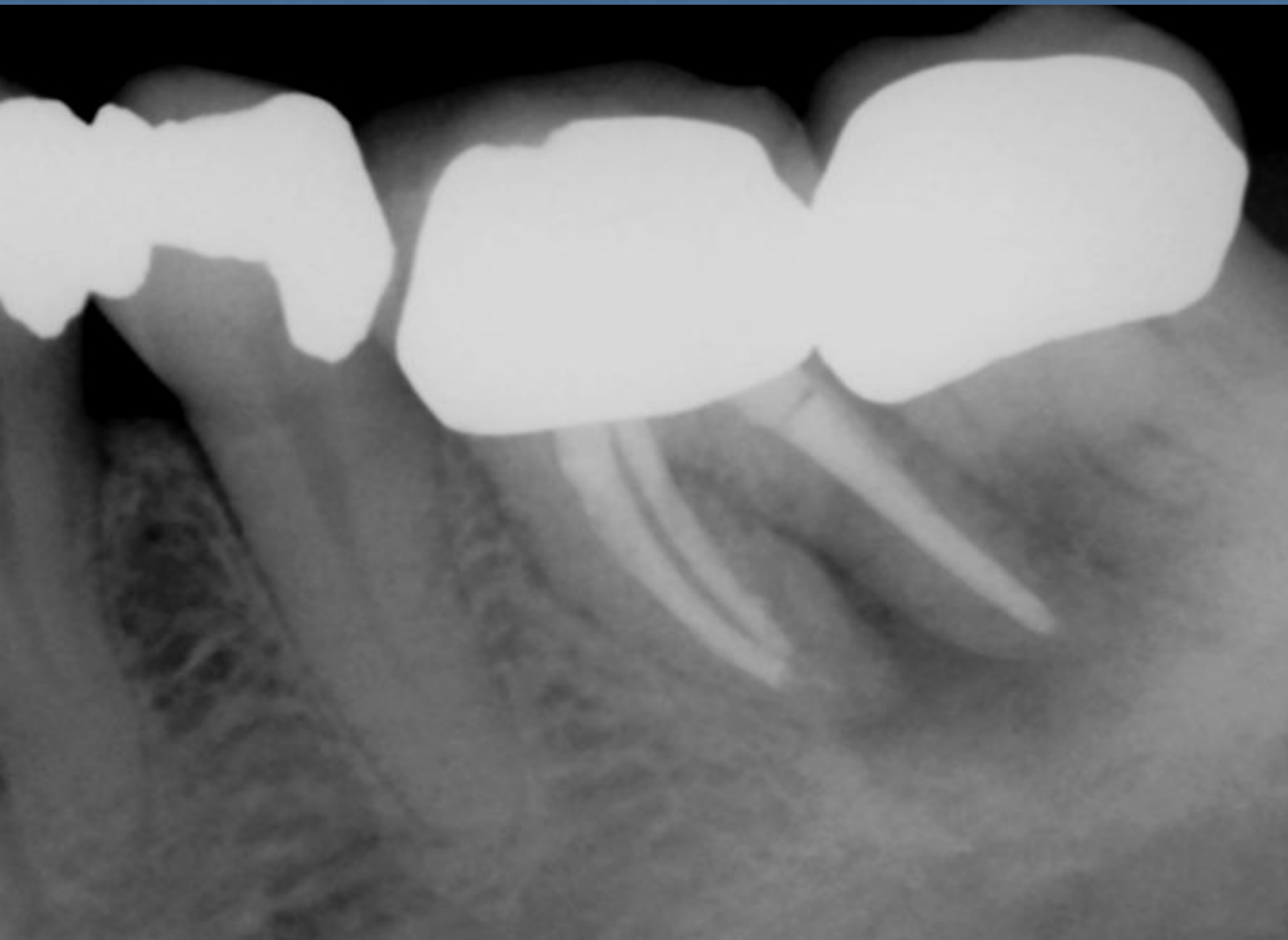


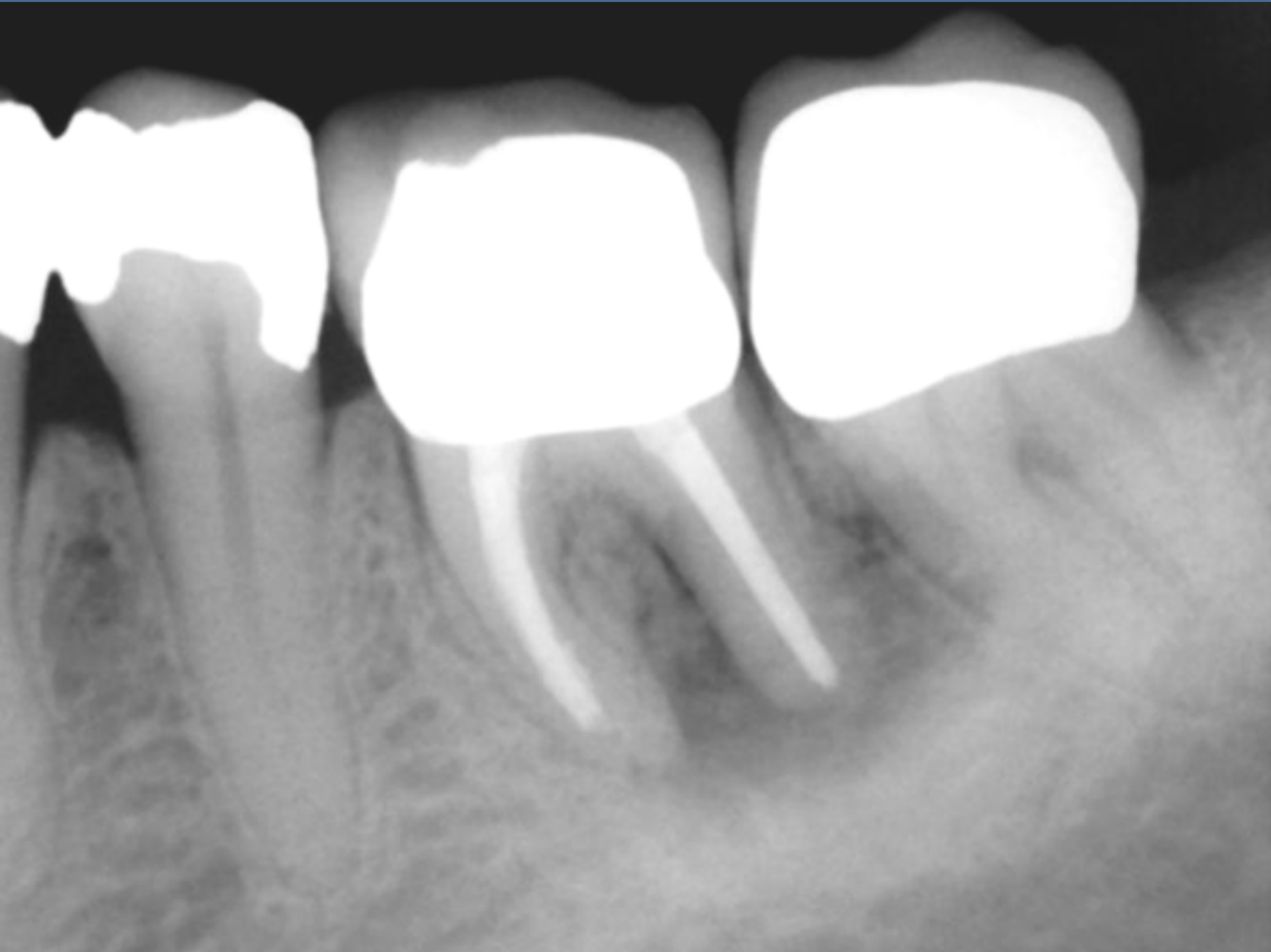

GATES
LARGO

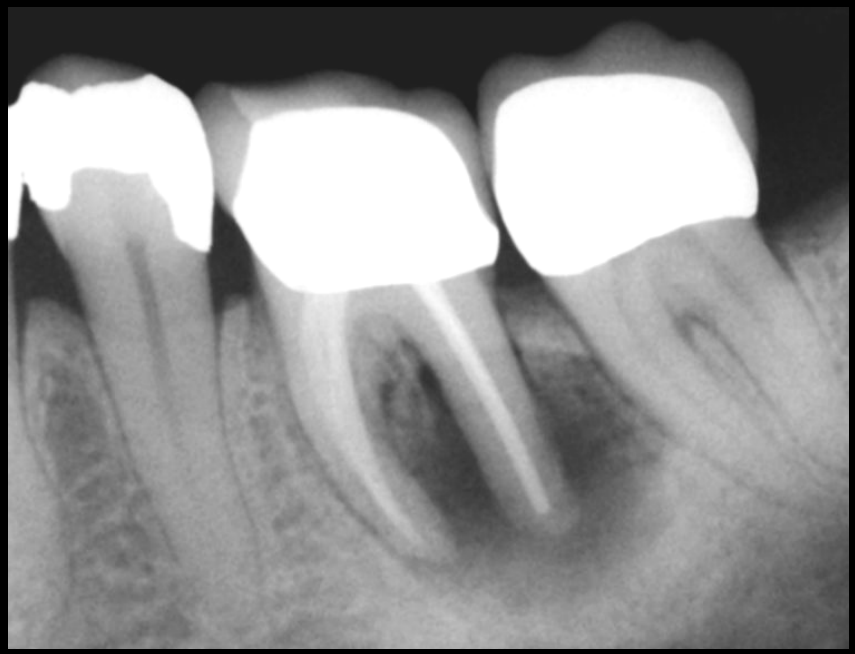
what prevents microorganisms from penetrating a root filled tooth?

- Sealer
- Core material
- Filling technique
- Restoration







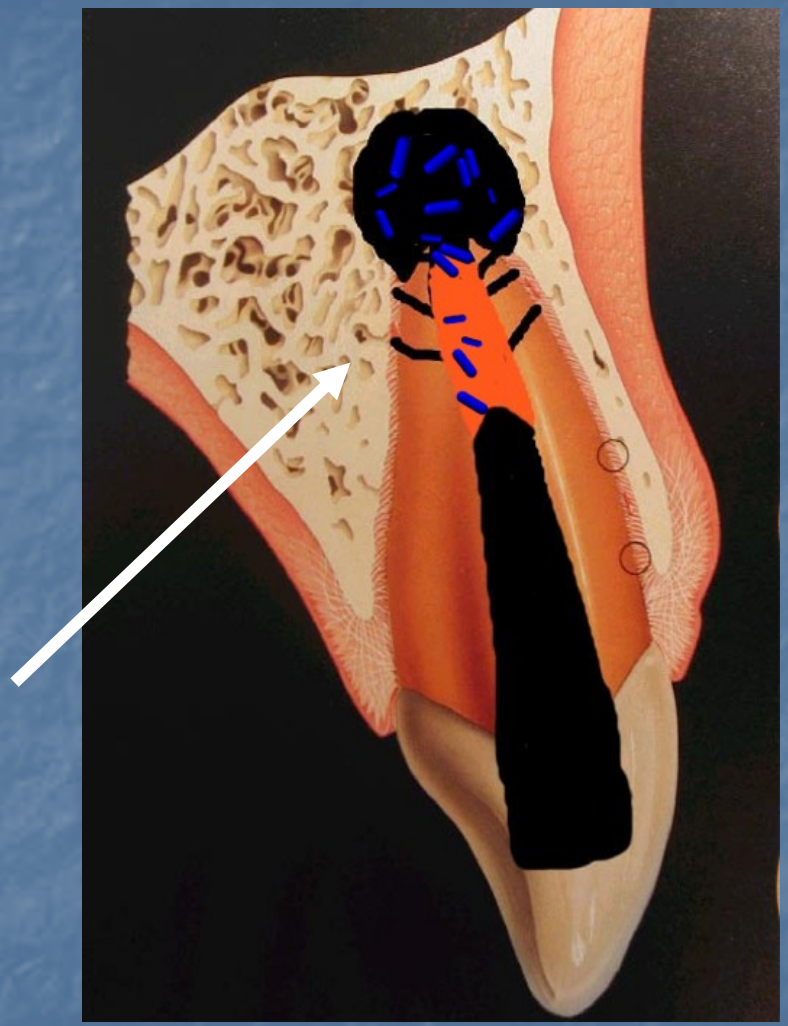


Microleakage

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

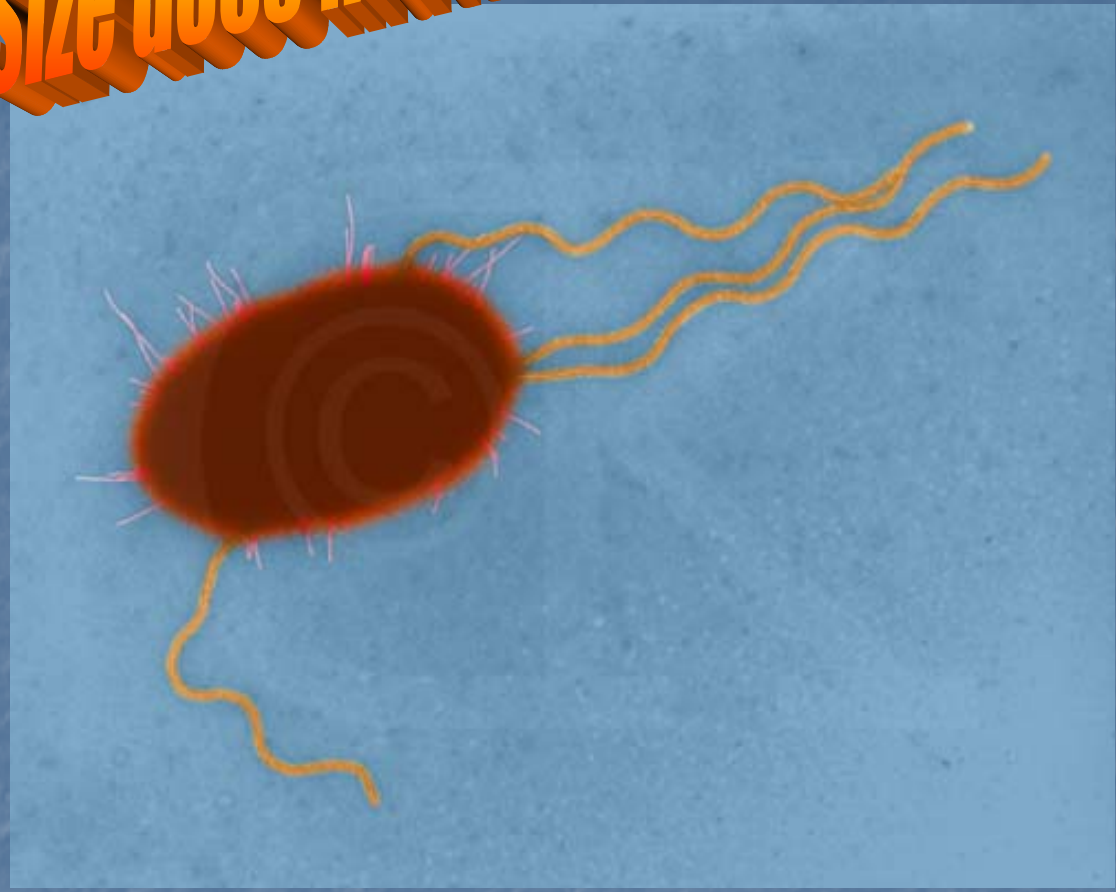
Bacterial metabolites, toxins and degradation products are much smaller than bacteria and could penetrate faster

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



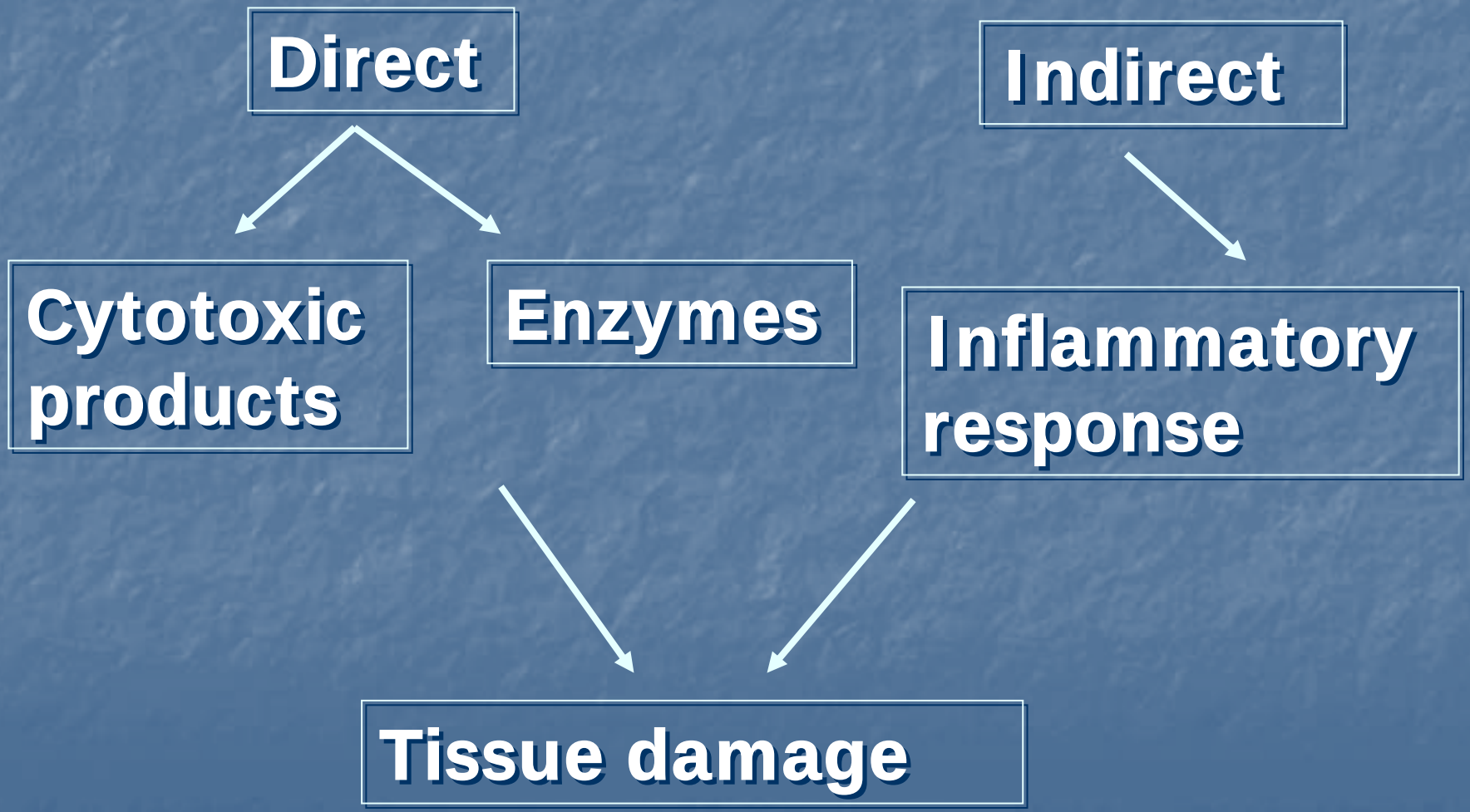
Escherichia coli is approximately 1 µm in diameter

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