Lecture G

D. de Groot - Like

Radboudumc

Contents

- Lecture D •
  Microbiology pulpitis, pulp necrosis and apical periodontitis •
  Natural and iatrogenic threats • Morphology
  of the pulp cavity • Dangers for
  the pulp • Mechanical
  trauma • Lecture G: •

Endodontic
  treatment

Contents

- Lecture D
  - Microbiology pulpitis, pulp necrosis and apical periodontitis
  - Natural and iatrogenic threats
  - Morphology of the pulp cavity
  - Dangers for the pulp
  - Mechanical trauma
- Lecture G:
  - Endodontic treatment

pulp

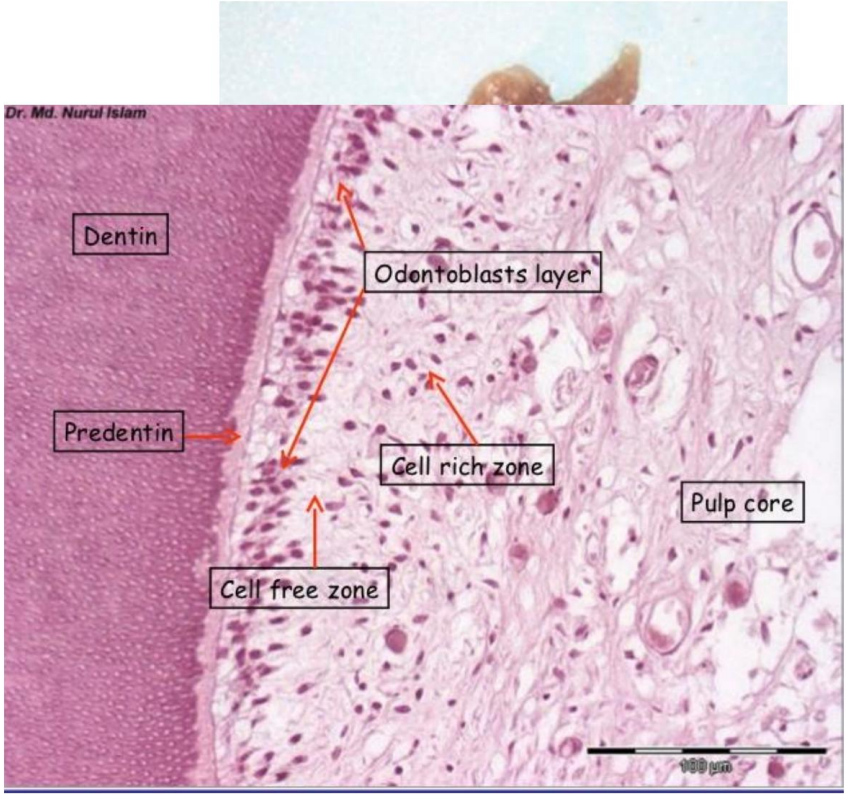
- Unique
  - Odontoblasts (nowhere else in the body)
  - Odontoblasts (only cells that make dentin)
  - Almost completely enclosed by hard tissue

pulp

- Outer layer of the pulp • Odontoblasts
- Odontoblasts extend into dentinetubuli
- Between dentin and odontoblasts ligt het predentine
- Dentine-pulpacomplex

Morphology

- Central pulp core •
  - Connective tissue (fibroblasts and undifferentiated cells)
  - • Larger blood vessels and nerves
- Cell rich zone •
  - Undifferentiated cells • Differentiation into odontoblasts, fibroblasts, osteoclasts
  - • Immune cells
    - • Including APCs



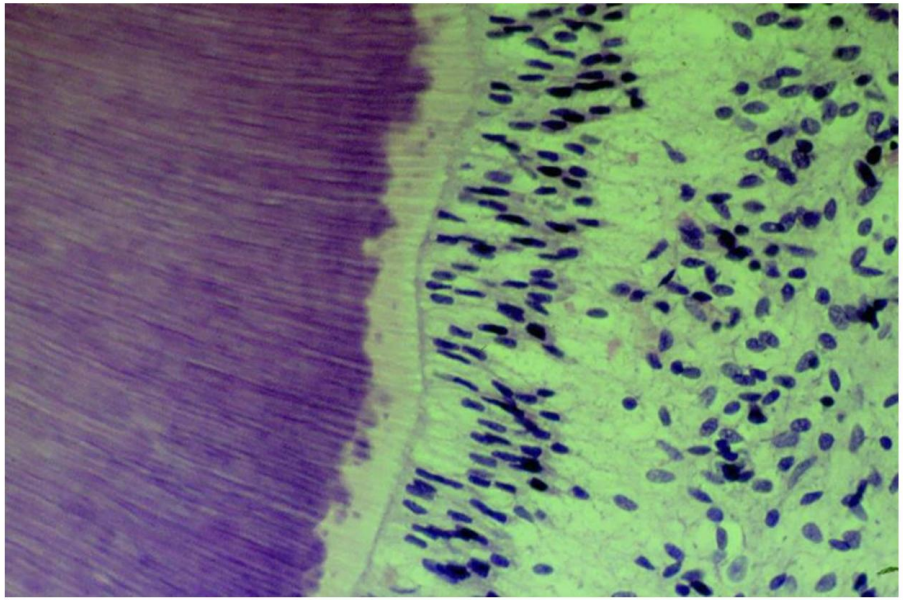
Morphology

- Celarme zone van Weil
  - Capillary blood vessels •

    Unmyelinated nerve branches
- Odontoblast layer
  - Odontoblasten
    .

      Arranged in rows • No

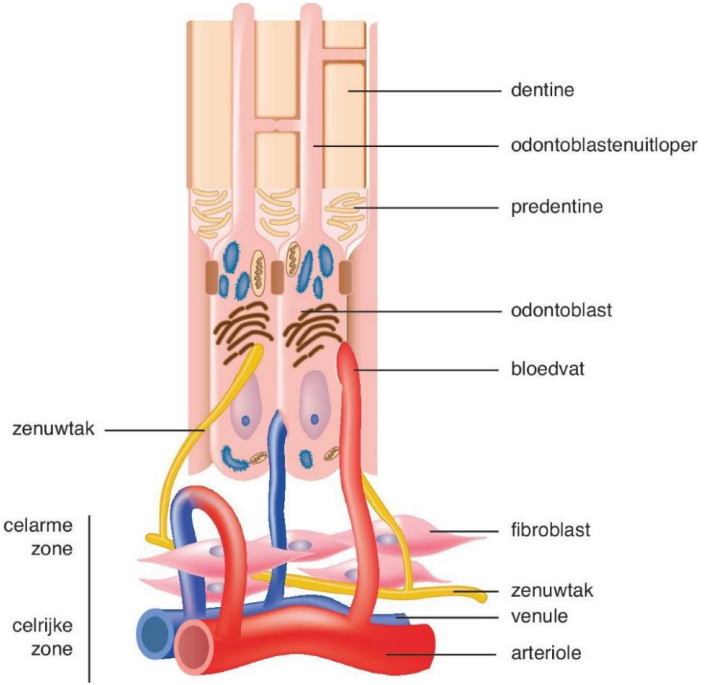
    longer capable of cell division



Morphology

- Odontoblast layer
  - Celuitloper in dentinetubulus:
    fiber from Tomes
- Dentin tubules contain sensory nerve endings

- Primary dentin (before eruption)
- Secondary dentin (after eruption)
- Tertiary dentin (response to external stimulus)



Extracellular matrix (pulpa kern)

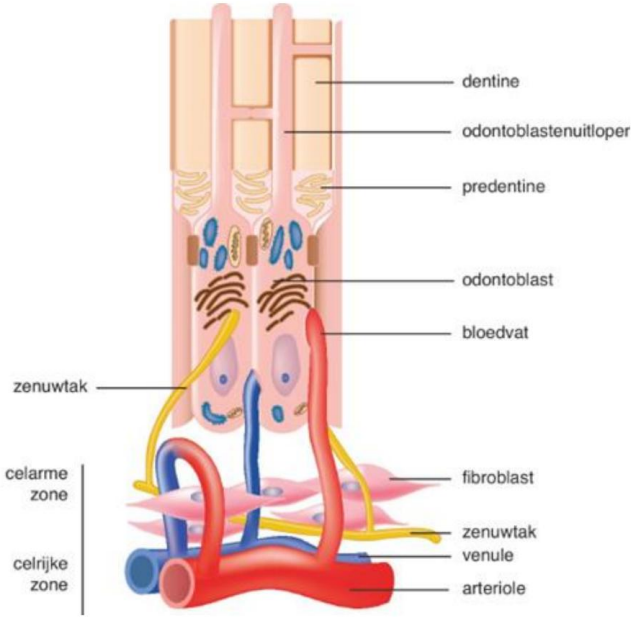
- Collagen fibers
- Fibroblasts
- Immune cells
- Undifferentiated cells

- Older pulp
  - Increased fibers
  - Fewer & smaller fibroblasts

- Pulp firmness
  - Ground substance

Innervation

- Trigeminal nerve • Raschkow's plexus • A delta • C fibers • Sympathetic fibers •
  - Blood circulation
    - Terminate on blood vessels
    - Inflammation of the pulp • vasodilation



Innervation

- A-delta
  - • Myelin sheath • Fast conduction • Fast sharp pain • Easy to localize
- C fibers •
  - No myelin sheath • Slow conduction • Slow dull pain • Difficult to localize

Innervation and Blood Vessels

• Blood vessels + myelinated nerve fibers • A nerve fiber sometimes innervates multiple elements

• Arterioles
• Venules •

Drainage through lymphatic vessels

Innervation and blood vessels

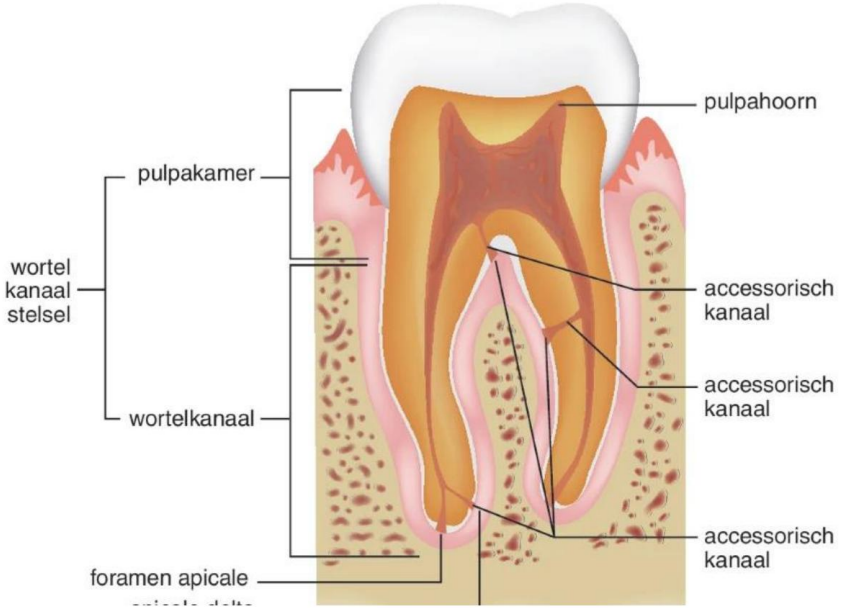
- Branches from the central pulp cord
  - Cell-poor zone of Weil •

  Branches into a dense network of capillaries, lymphatic vessels and nerve fibers
- From this capillary network
  - loops between the odontoblasts

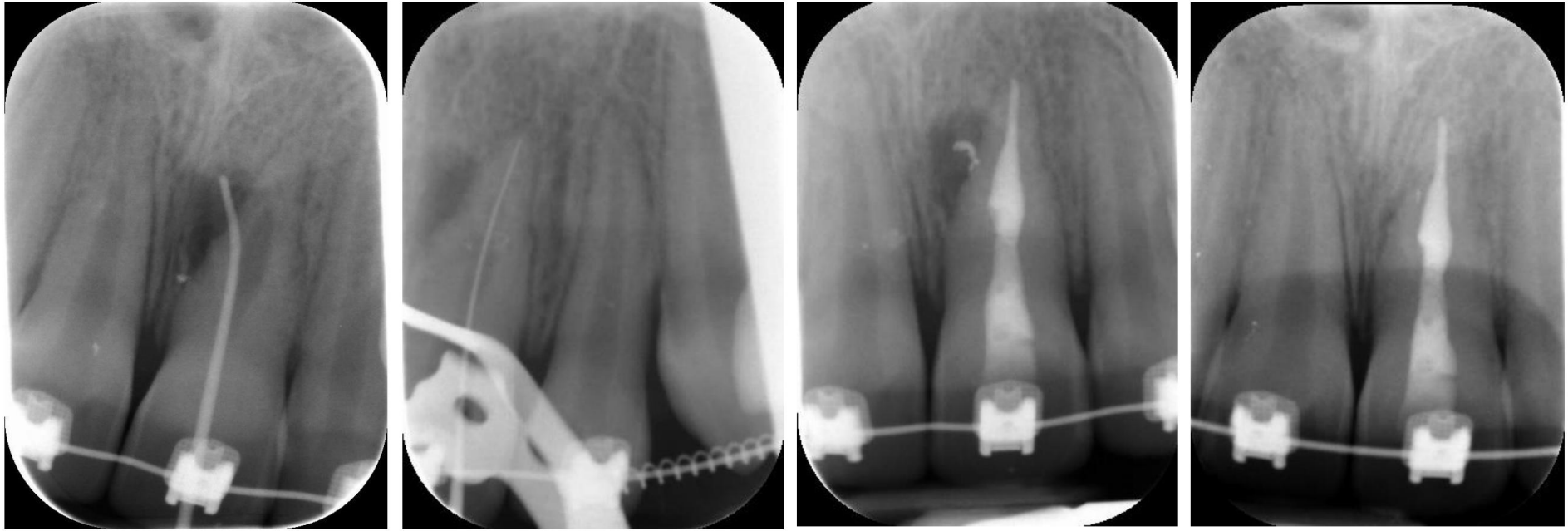
- Van Raschkow's plexus
  - fibers between odontoblasts in some dentinal tubules

Blood vessels

- Accessory canals
  - Fork
  - Apical third



Accessory channels



Defense

- Odontoblast reaction •

Pulpitis •

Pulp necrosis •

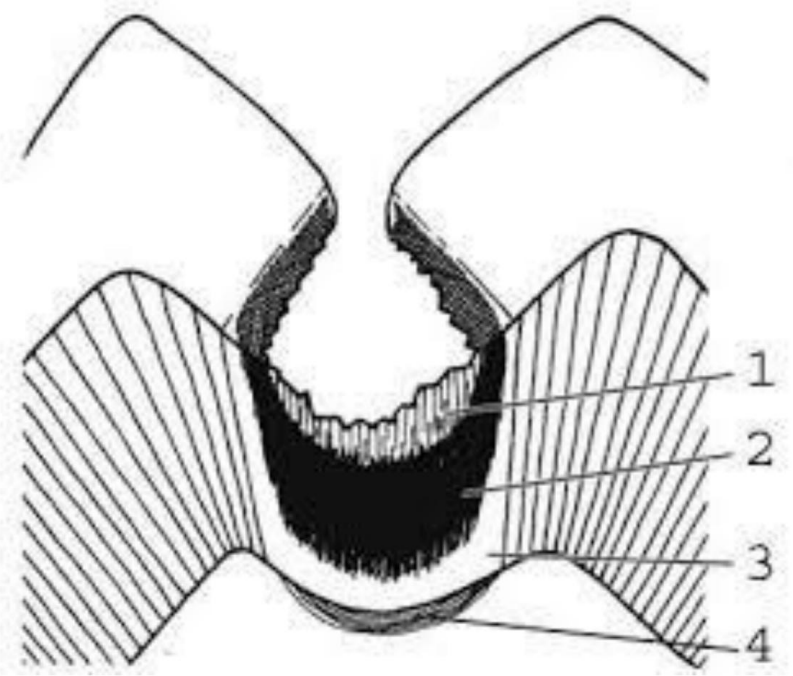
Pulp polyp

- Odontoblast reaction
  - Peritubular dentin • Tertiary dentin

Odontoblast reaction

- Peritubulair dentine (sclerotisch dentine)
  - First response to noxious stimulus
  - Deposition of peritubular dentin against inside tubules
  - Lower permeability

- Mild stimulus
  - Attritie
  - Chronic caries



Odontoblast reaction

- Odontoblast layer is disrupted
  - Number of cell layers decreases
  - Shape of odontoblasts changed
  - Dead track (dentine tubule with dead odontoblasts spur, only in acute caries attack) • Aspiration of odontoblasts (cells in tubules)
- Odontoblasts die
  - New odontoblasts
  - Atubulair dentine
  - Tertiary dentin

Reactions of the pulp: odontoblasts

- Primary dentin: dentin that has already been formed during eruption (physiological)
- Secondary dentin: dentin that is constantly produced during life (physiological)
- Peri-tubular dentin: deposition of dentin in dentin tubules (pathological)
- Sclerotic dentin: dentin in which peritubular dentin is formed (pathological)
- Atubular dentin: thin first layer of dentin produced by 2nd generation odontoblasts (pathological)
- Tertiary dentin: dentin produced beneath the atubular dentin (pathological)

Trauma

Infraction

Enamel fracture

Enamel-dentin fracture

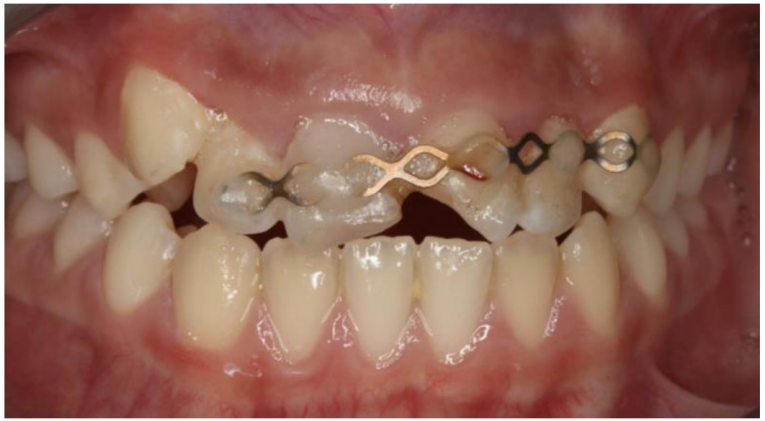
Enamel-dentin-pulp fracture

Crown-root fracture without pulp involvement

Crown-root fracture with pulp involvement

Root fracture

Alveolar fracture



Concussion

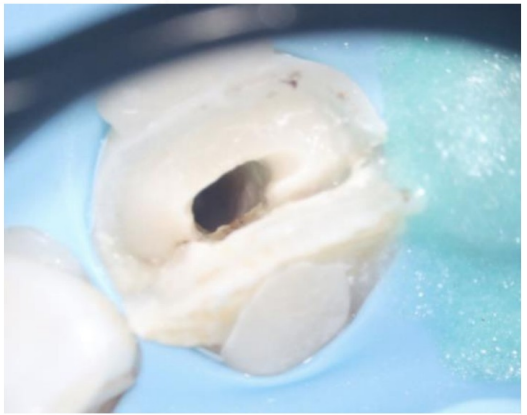
Subluxation

Extrusion

Lateral luxation

Intrusion

Avulsion



X-ray

Radiographic representation of apical periodontitis

- The positive predictive value of radiologic signs in dogs was 100% and the negative predictive value of radiologic signs was 55%. (Rowe & Binnie 1974)
- So: if you see something in the photo, there is a lesion in 100% of the cases.
- If there is an abnormality, it cannot be seen in 55% of the cases

Radiographic representation of apical periodontitis

- Lesions within cancellous bone do not show on common radiographs.
  Most lesions are present within cancellous bone.
  Katebzadeh et al. *J Endod* 1999;25:364-8

- So: if the lesion is only in the cancellous bone, it is not visible on the Photo.

- Most of the lesion are in the cancellous bone.

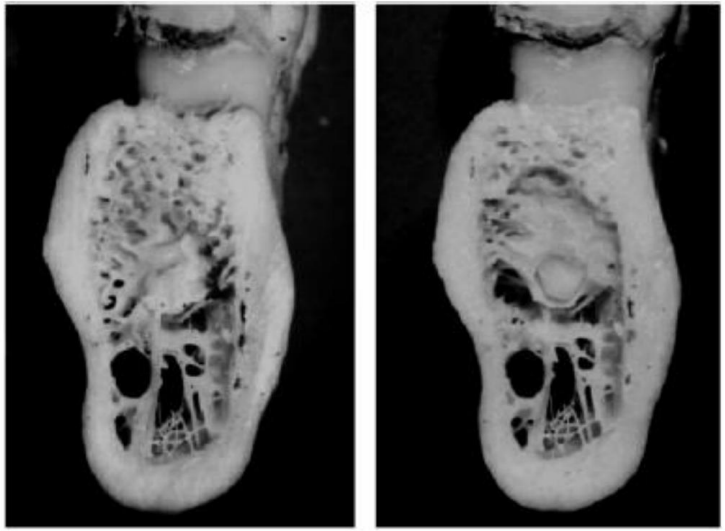


Fig. 4. Cross-sectional view of mandible before (left) and
after removal of bone around the distal apex of the molar.

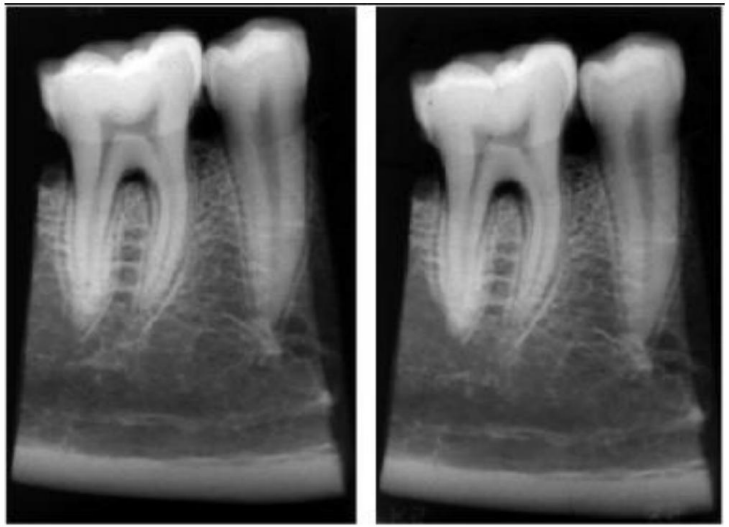
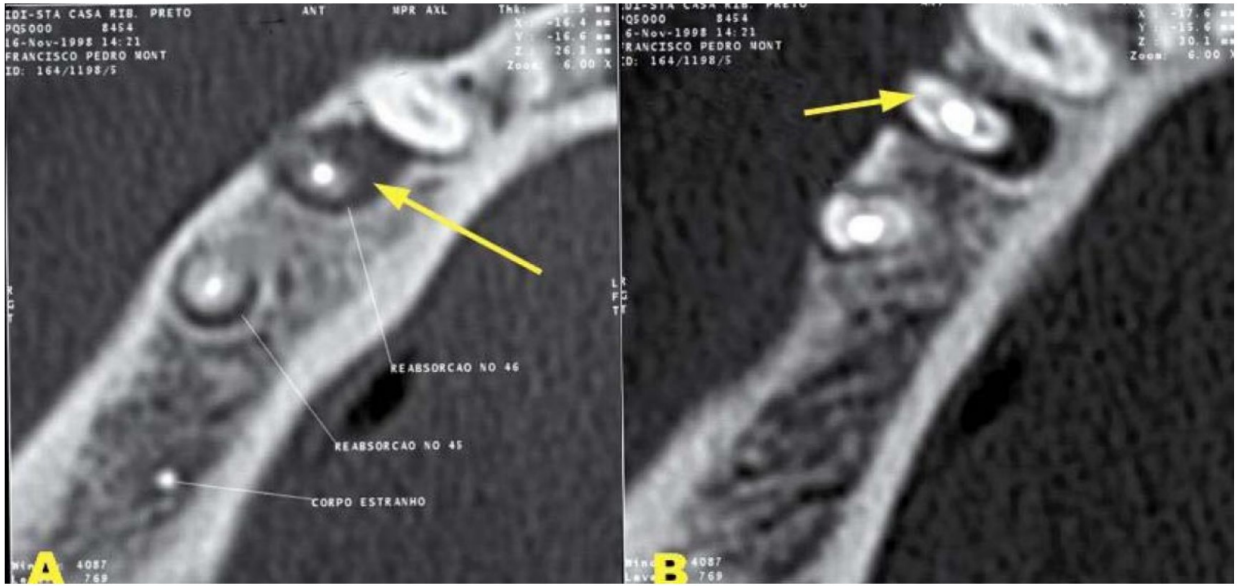


Fig. 5. Radiographs before and after bone was removed.

Gröndahl & Huumonen *Endod Topic* 2004;8:55-67



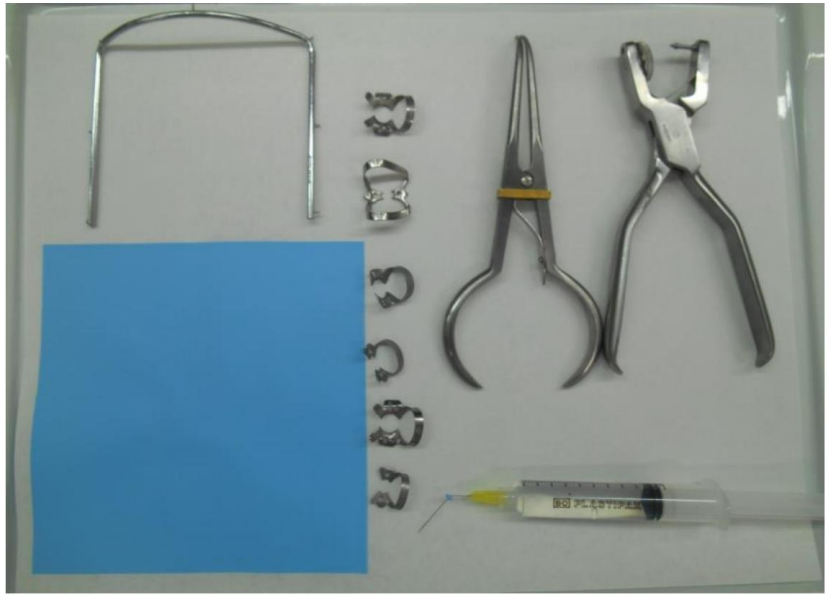
- So you can have the symptoms of apical periodontitis without it that this is visible on the X-ray.
- You always make a diagnosis by combining clinical and radiological examination.

Steps of endodontic treatment

- Diagnosis
  - Preconditions: caries-free/good restoration/DETI
- Endodontic opening •
Rubber dam •
Coronal phase •
Final Length determination
- Preparation: apical
phase • Canal
filling • Final coronal closure •
Control

Rubberdam

- Apply rubber dam after:
  - Complete pulp chamber access
  - No pulp chamber access after correct opening (obliteration)

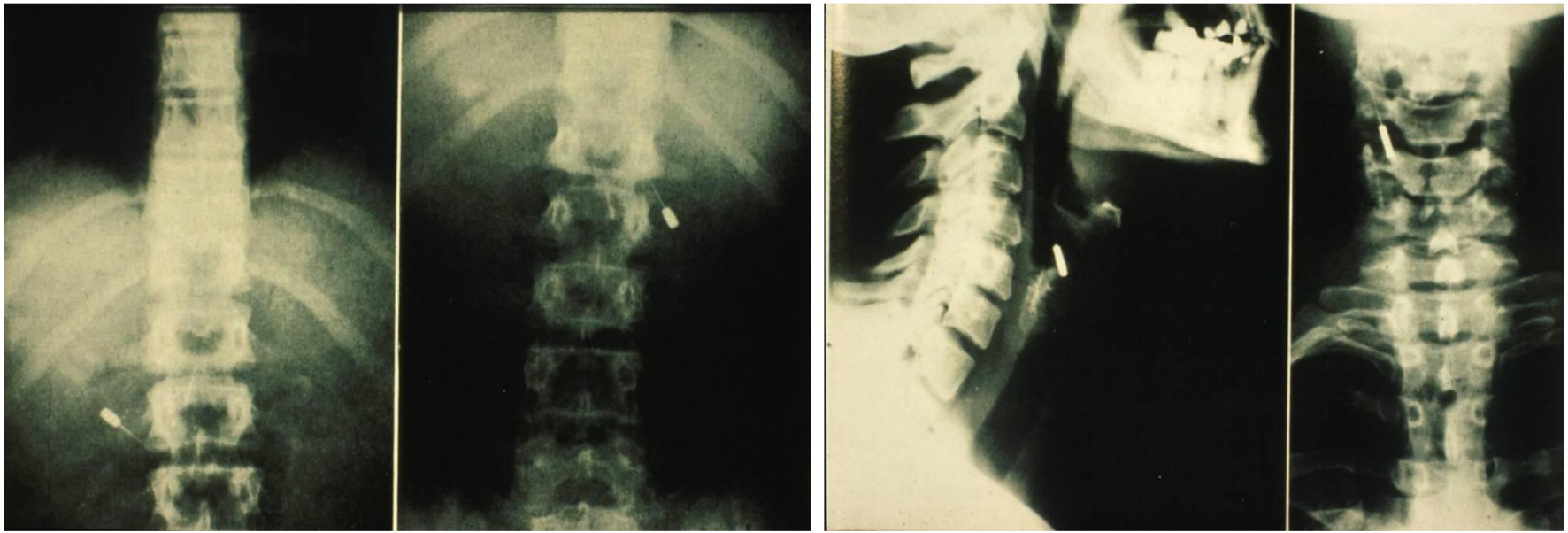


Rubberdam

- Why rubber dam? • 1

  ml of saliva contains millions of bacteria •
  The treatment becomes easier • The
  treatment becomes safer •
  Rubber dam can (almost always) be applied within 30 seconds

Rubberdam



Rubberdam

- Takes a lot of time
- Cofferdam is not always possible
  - It's so annoying for the patient
  - It's annoying for me

Rubberdam

Rubberdam

No endodontic treatment without a rubber da

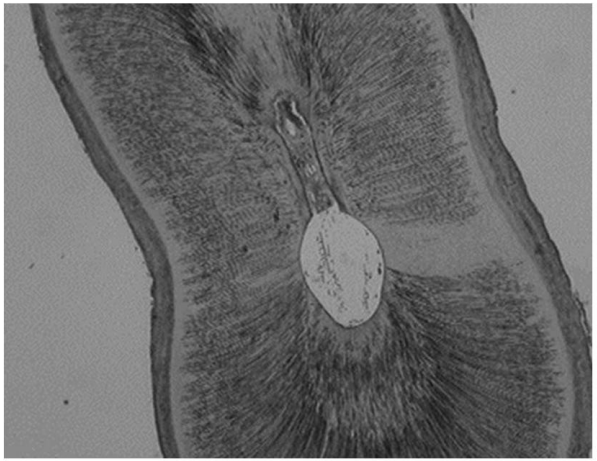
Disinfection

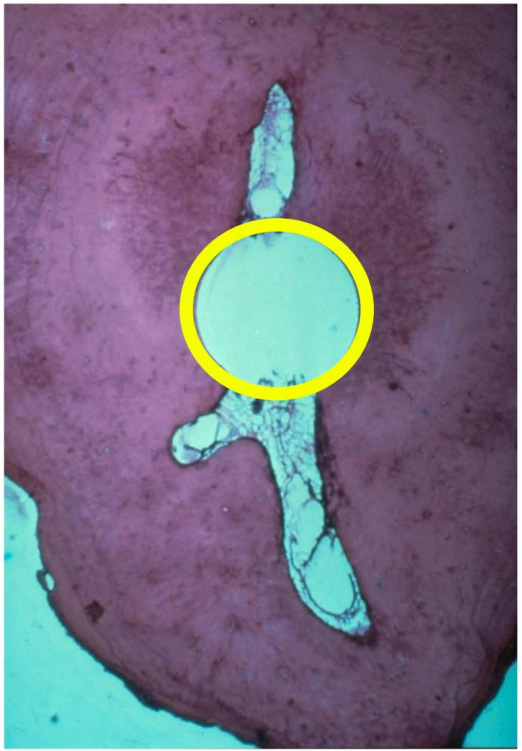
- Why?
  - Apical periodontitis is always accompanied by a biofilm (also in tubules)

- Making the root canal system accessible for disinfection procedures

Disinfection

- File
  - You never touch all the canal walls





Disinfection

Disinfection

- Chemical dissolution, inactivation and mechanical removal of:
  - Pulp tissue •
  - Microorganisms + products •
  - Biofilm •
  - Smear layer
  - Debris
- Files create space for irrigation

Disinfection

- Rubber dam
- Pulp chamber flushing
- After each file •

After completion of preparation

Ideal rinse aid

- Has a broad antimicrobial spectrum and high effectiveness against anaerobic and facultative anaerobic microorganisms.
- Dissolves organic (pulp) tissue remains
- Disrupts or removes the biofilm
- Inactivates endotoxins
- Prevents the formation of a smear layer during instrumentation or removes the smear layer.
- Safe to use.

Rinse aids

Rinse aids

- EDTA gel
- Sodium hypochlorite
- Chlorhexidine
- Iodine
- Potassium iodide
- EDTA
- Alcohol
- *Hydrogen peroxide*
- *Citric acid*
- …

Chlorhexidine

- Broad antimicrobial spectrum, high effectiveness against anaerobic and facultative anaerobic microorganisms
- Strengthening of biofilm structure -> more difficult biofilm removal •

Adhesion to canal wall • +

longer effectiveness

- adhesion of canal filling?

• Relatively harmless to living tissue • Inactivates edotoxins • Does not dissolve tissue • Interaction with NaOCl (crystal formation)

EDTA and citric acid

• Weak antimicrobial effect • Not tissue dissolving •

Prevents smear layer formation and removes smear layer

• No inactivation of endotoxins •

Safe to use •

Inactivation of NaOCl

Sodium hypochlorite

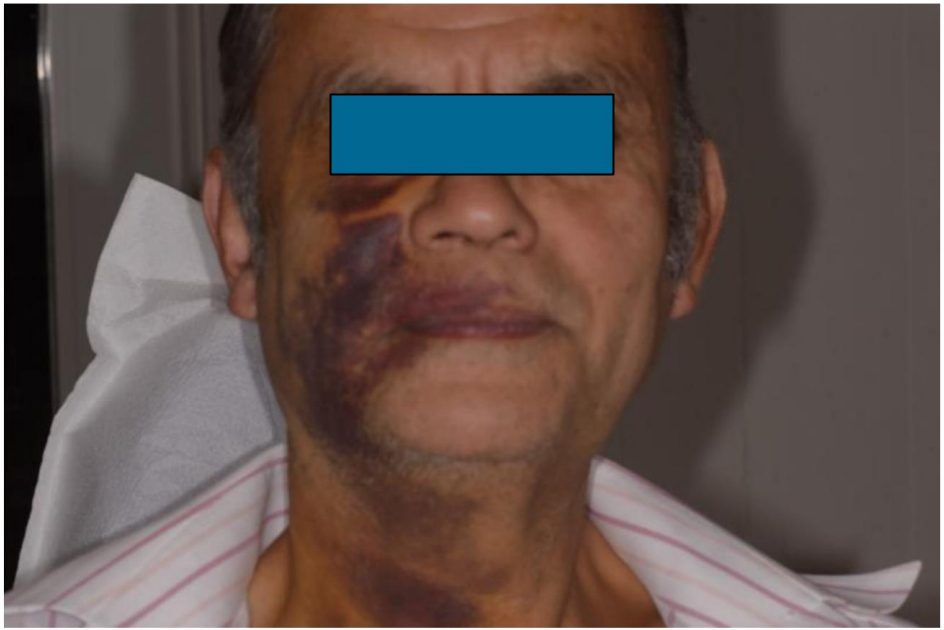
- Broad antimicrobial spectrum, high effectiveness against anaerobic and facultative anaerobic microorganisms
- Dissolves organic pulp residues
- Very powerful and fast-acting, removes planktonic micro-organisms and biofilm
- Inactivation endotoxins •

Lubricating effect •

Does not remove smear layer

- Safe to use (if used properly)

Natriumhypochloriet accident



Natriumhypochloriet accident

Main causes:

• incorrectly estimated working length (initial photo!) • needle jamming in the canal • presence of a perforation • presence of resorption defect

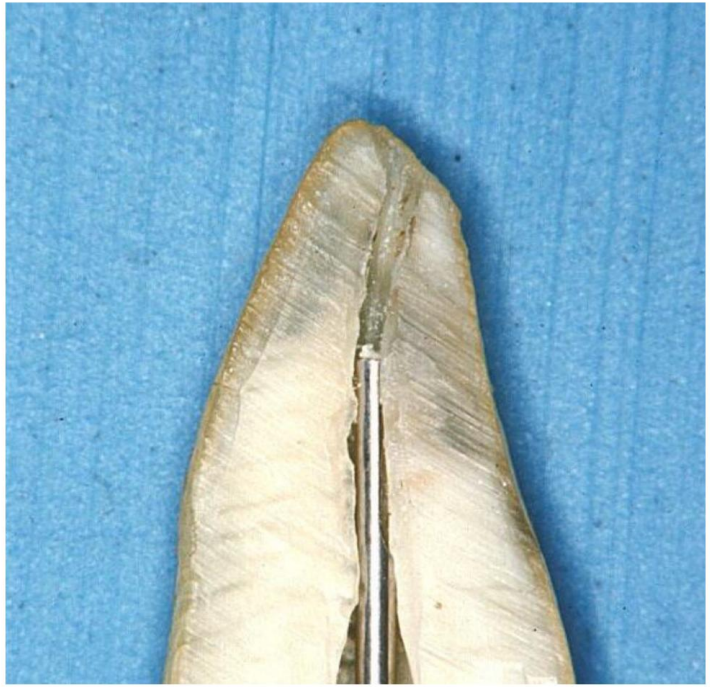
Natriumhypochloriet accident

- Set bobbin needle to correct length

  (WL -1 mm)
- Use 'safe end' needles
- Never leave the end of the needle open

  get stuck in the canal!
- Flushing to length is usually only possible once

  the canal preparation is complete.



Natriumhypochloriet accident

- What are you doing? • Complete treatment • Determine the extent of swelling and bruising • Ulceration and necrosis present? • Inform the patient • Prescribe pain relief • Monitor carefully during the first few days
- Eventually it heals (generally) without residue

Natriumhypochloriet accident

Tabel 11.2: Samenvatting van bevindingen tijdens anamnese en klinisch onderzoek en bijbehorende categorie

Symptomen	Mate van ernst		
	Mild	Matig	Ernstig
Pijn (VAS)	0-3	4-6	7+
Zwelling	<30%	30-50%	>50%
Ecchymose	Lokaal	Diffuus	Diffuus
Ulceratie	Geen ulceratie	Intra orale ulceratie	Intra-orale ulceratie
Necrose	Geen necrose		Intra-orale necrose
			Luchtweg obstructie
			Neurovasculaire schade
Vervolgbehandeling	AP/TE	Consultatie of verwijzen naar MKA chirurg	Verwijzen naar MKA-chirurg

To rinse

- Sodium hypochlorite must be constantly present and replaced regularly

Sodium hypochlorite

- Broad antimicrobial spectrum, high effectiveness against anaerobic and facultative anaerobic microorganisms
- Dissolves organic pulp residues
- Very powerful and fast-acting, removes planktonic micro-organisms and biofilm
- Inactivation endotoxins •

Lubricating effect •

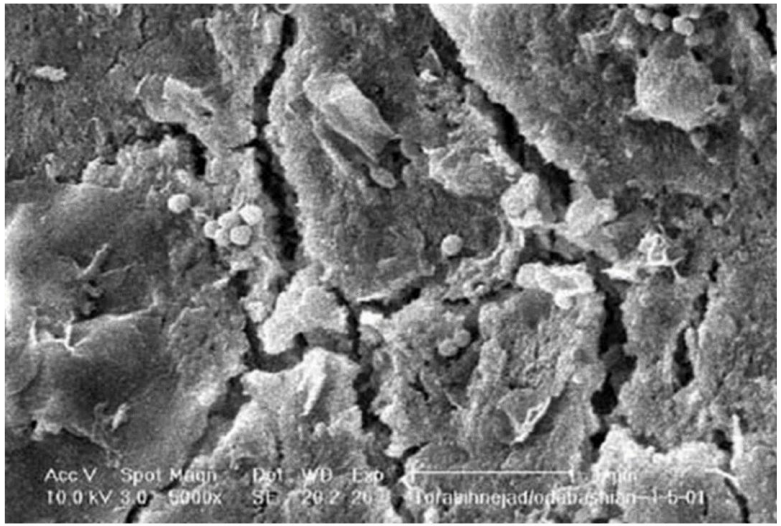
Does not remove smear layer

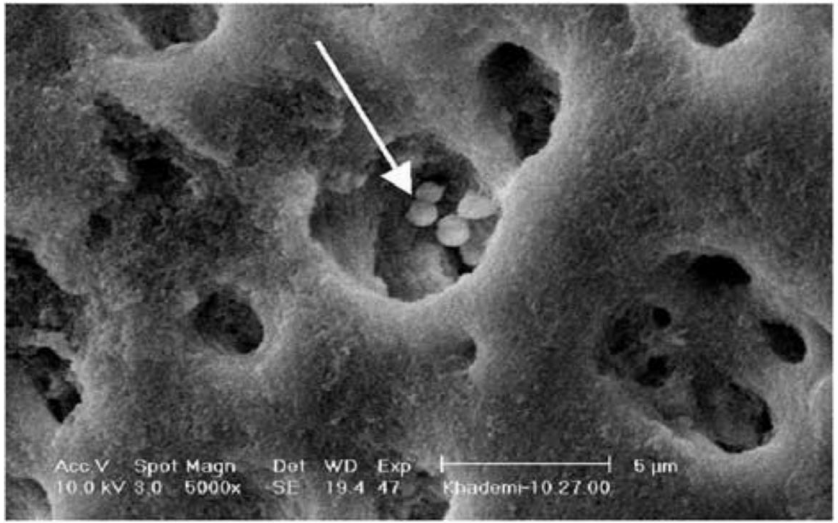
- Safe to use (if used properly)

Smear layer

- Created by instrumentation of the root canal
- Layer thickness of 1-5 µm
- Consists of dentin, pulp tissue remains and micro-organisms
- Seals dentin tubules in the canal wall, preventing tubules from accessible for flushing fluid and sealer

Smear layer





Smear layer

- Dissolve the smear layer after completing the preparation
  - Dry the canal •

  Apply EDTA to the canal with a rinsing syringe • Apply

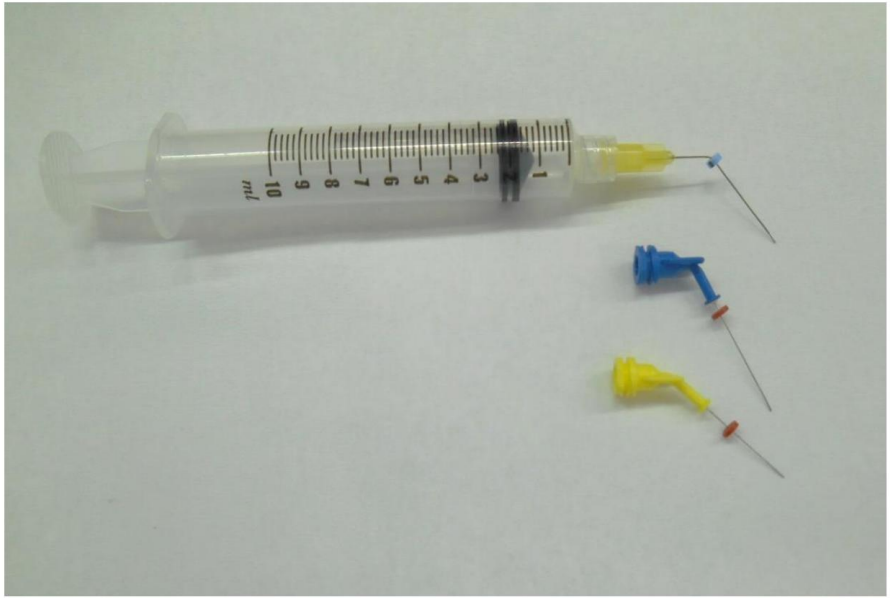
  alone
  - Allow EDTA to work for 1-3 minutes

Disinfection

- Irrigation during preparation: 2 cc NaOCl 2.5% after each instrument
- After completing preparation: dissolve the smear layer with EDTA (10-17%) or citric acid (10-20%), for 1 minute
- Passive ultrasonic irrigation with NaOCl (3 x 20 sec per channel). Removing debris, also from unprepared canal parts.

Disinfection

- After complete preparation of the canal, the intention is that the bobbin needle comes to 1 mm from the working length



Ultrasonic rinsing

Ultrasonic rinsing appears to be more effective than manual rinsing in removing debris from artificially created grooves

The influence of volume, type of irrigant and flushing method on removing artificially placed dentine debris from the apical root canal during passive ultrasonic irrigation

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[1]Department of Cariology, Endodontology and Pedodontology, Academic Centre for Dentistry (ACTA), Amsterdam, The Netherlands and [2]Institute for Clinical Dentistry, University of Rome 'La Sapienza', Rome, Italy

Ultrasonic rinsing

- 2 ml NaOCL in the canal
- 20 seconds US
- 2 ml NaOCL in the canal
- 20 seconds US
- 2 ml NaOCl in the canal
- 20 seconds US

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REVIEW

Passive ultrasonic irrigation of the root canal: a review of the literature

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Abstract

van der Sluis LWM, Versluis M, Wu MK, Wesselink PR. Passive ultrasonic irrigation of the root canal: a review of the literature. *International Endodontic Journal*, 40, 415–426, 2007.

Ultrasonic irrigation of the root canal can be performed with or without simultaneous ultrasonic instrumentation. When canal shaping is not undertaken the term passive ultrasonic irrigation (PUI) can be used to describe the technique. In this paper the relevant literature on PUI is reviewed from a MEDLINE database search. Passive ultrasonic irrigation can be performed with a small file or smooth wire (size 10–20) oscillating freely in the root canal to induce powerful acoustic microstreaming. PUI can be an important supplement for cleaning the root canal system and, compared with traditional syringe irrigation, it removes more organic tissue, planktonic bacteria and dentine debris from the root canal. PUI is more efficient in cleaning canals than ultrasonic irrigation with simultaneous ultrasonic instrumentation. PUI can be effective in curved canals and a smooth wire can be as effective as a cutting K-file. The taper and the diameter of the root canal were found to be important parameters in determining the efficacies of dentine debris removal. Irrigation with sodium hypochlorite is more effective than with water and ultrasonic irrigation is more effective than sonic irrigation in the removal of dentine debris from the root canal. The role of cavitation during PUI remains inconclusive. No detailed information is available on the influence of the irrigation time, the volume of the irrigant, the penetration depth of the instrument and the shape and material properties of the instrument. The influence of irrigation frequency and intensity on the streaming pattern as well as the complicated interaction of acoustic streaming with the adherent biofilm needs to be clarified to reveal the underlying physical mechanisms of PUI.

Keywords: biofilm, cleaning, dentine debris, irrigation, review, root canal, ultrasound.

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Introduction

With the endodontic procedures at our disposal it is impossible to shape and clean the root canal completely. This is mainly due to the complex anatomy of the root canal system (Ricucci & Bergenholtz 2003, Peters 2004, Nair *et al.* 2005). Irregularities of the root canal wall in particular are a major concern, including oval extensions, isthmuses and apical deltas (Wu & Wesselink 2001, Ricucci & Bergenholtz 2003, Peters 2004, Nair *et al.* 2005). In fact, within oval canals only 40% of the apical root canal wall area can be contacted by instruments when a rotating technique is used (Wu *et al.* 2003). Therefore, irrigation is an essential part of a root canal treatment as it allows for cleaning beyond the root canal instruments.

The goal of irrigation is to remove pulp tissue and/or microorganisms (planktonic or biofilm) from

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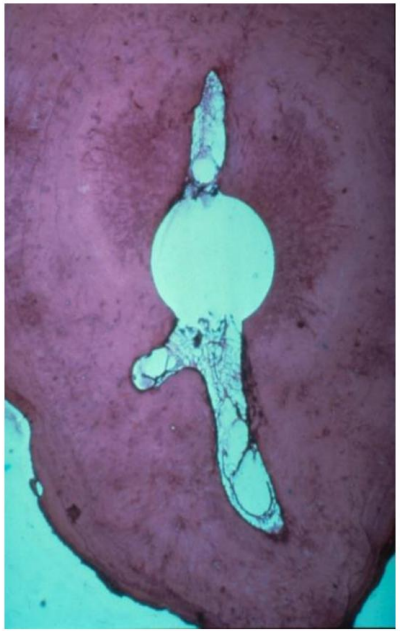
Ultrasonic rinsing

- Hand activated irrigation
- Sonically activated irrigation (<6,000 Hz)
- Ultrasonic activated irrigation (>20,000 Hz)
- Hydrodynamically activated irrigation
- Laser activated irrigation



Ultrasonic rinsing

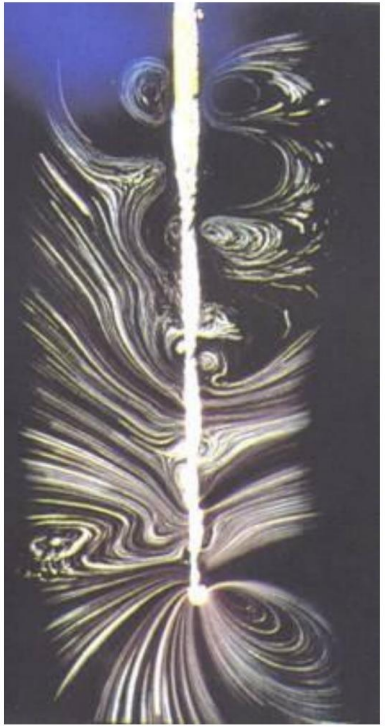
- Vibration with a frequency between 20 kHz and 30 kHz.
- Acoustic microflow and cavitation. •
  Ensures disintegration of debris.
- Removal of debris in places where instruments cannot reach
- Biofilm is loosened from the walls
- Increases the temperature and therefore the effectiveness of the flushing fluid

Ultrasonic rinsing

(Satelec on position 4 to 5)

Ultrasonic rinsing

- To obtain effective acoustic flow, the irrigation instrument must be able to move / vibrate freely in the root canal
- Contact with the duct wall is not desirable due to the uncontrolled dentin loss and disruption of fluid flows and cavitation.



To ask?