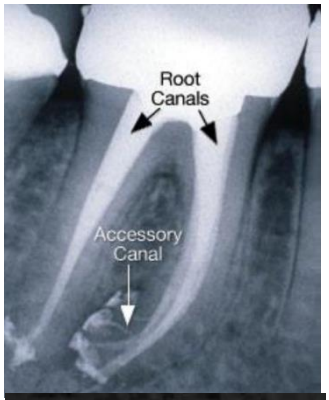
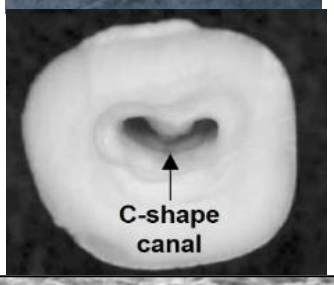
Root Canal Irrigation

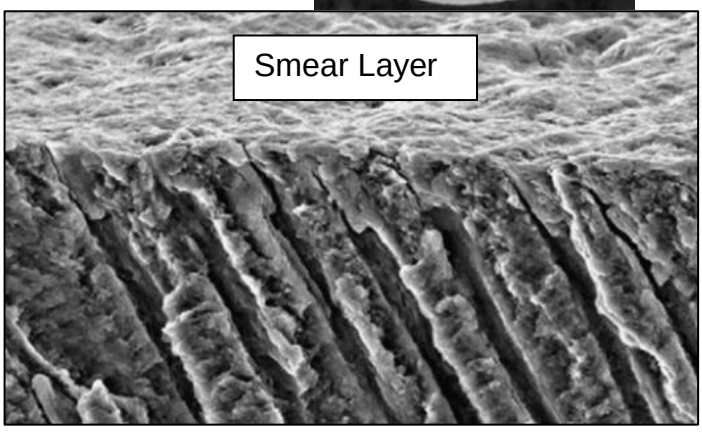
Mechanical instrumentation, whether manual or rotary instruments, can not sufficiently debride and disinfect root canals.
Every root canal system has spaces that cannot be cleaned mechanically.
The only way for cleaning webs, fins and anastomoses is through the effective use of irrigation solutions.



Requirements of ideal irrigant solution:
1- Have a broad spectrum antimicrobial activity to sterilize or disinfect root canals.
2- Ability to dissolve necrotic tissue and debride the canal.
3- Lubricant solution.
4- It should not be toxic.
5- Have low surface tension to be able to penetrate into inaccessible areas.
6- Remove the smear layer during or after instrumentation.
7- Inhibiting bacterial toxins such as endotoxin.



None of the available irrigants can fulfil all these requirements. A combination of two or more irrigants can be used to obtain most of them.



Root canal instrumentation produces a layer of inorganic and organic materials that may also contain bacteria and their by-products. This layer called **smear layer**.

It can prevent the penetration of intracanal medicaments into dentinal tubules and influence the adaptation of filling materials to canal walls.

Functions of irrigants
1- Removal of dentinal debris by physical flushing to prevent their packing at the apical region of the root canal and open dentinal tubules, isthmus and lateral canals.
2- Canal wetting and lubrication to increase efficacy of instrument and decrease instrument breakage.
3- Dissolve necrotic tissue (loosen debris, pulp tissue and microorganisms).
4- Have germicidal and antibacterial properties.
5- Bleaching action to lighten teeth discolored by necrotic pulp tissue, caries or restorative material.

Factors that modify the activity of irrigating solution

1- Concentration: The dissolving capacity of some irrigation solution, such as sodium hypochlorite, can be increased with higher concentration (5.2 rather than 2.5%). However the cytotoxicity of higher concentrations is extremely higher.

2- Contact: The irrigant must contact the intracanal substrate (organic tissue or microbes) to be effective, otherwise it won't be able to dissolve or flushout the debris. Larger canal diameter allows better irrigation to apical region.

3- Presence of organic tissue: The organic tissue must be removed mechanically or chemomechanically to increase the efficacy of intracanal irrigation. This can be obtained by simultaneous use of instruments and irrigating solutions.

4- Quantity and frequency of the irrigant used:

- More irrigation causes better tissue debridement.
- Multiple flushing between each file removes more debris.

5- Gauge of irrigating needle: Usually the #27 (D0 = 0.4 mm) or #28 (D0 = 0.3 mm) irrigation needle is preferable for better penetration into the canal.

6- Surface tension of irrigation solution: The lower surface tension, the better wettability and the more penetration into narrowest areas of the canals, and even into the dentinal tubules.

7- Level of penetration of the irrigant: Maximum actions of irrigant occurs on coronal part of root canal whereas minimal on apical end.

8- Age of irrigant: Freshly prepared solution is more effective than older one.

Irrigant solutions

The commonly used irrigants are divided into:

<u>1- Chemically non-active solutions</u>

a) Distilled water

b) Normal saline.

<u>2- Chemically active materials</u>

a) Antibacterial agents as Sodium hypochlorite NaOCl (0.5-5.25%), Chlorhexidine 2%, MTAD (Mixture of Tetracycline isomer, acid and detergent)

b) Chelating agents as Ethylene diamine tetracetic acid (EDTA) 17%, citric acid 10%.

c) Oxidizing agents as Hydrogen peroxide H_2O_2, Carbamide peroxide.

Normal saline

- Normal saline as 0.9% W/V is commonly used irrigant in endodontics.
- Very mild in action and can be used with other chemical irrigants.
- Causes physical flushing and debridement and mild lubrication of the root canal.
- Used as a final rinse for root canals to remove the chemical irrigant left after root canal preparation.

<u>Advantages:</u>

Biocompatible solution with no adverse effect even if extruded periapically, because it is an isotonic solution which means its osmotic pressure is similar to that of the blood.

Disadvantages:

- No dissolution, nor antimicrobial properties.
- Limited cleaning of the canal.
- Does not remove smear layer.

Sodium hypochlorite (NaOCl)

Different concentrations (0.5 to 5.25%); recommended concentration is **5.25%**. Commercially household bleach (Clorox) contains 6.15%.

- NaOCl dissolve organic material such as pulp tissue, collagen and bacteria in the smear layer.
- It has a broad-spectrum antimicrobial activity against endodontic microorganisms and biofilms, including microbiota difficult to eradicate from root canals, such as *Enterococcus, Actinomyces,* and *Candida* organisms.
  With higher concentrations and longer contact time its antimicrobial action increase.
- NaOCl does not dissolve dentin debris or smear layer. Therefore, the use of dentin demineralizing agent (EDTA) is recommended post instrumentation to eliminate smear layer and enhance cleaning of difficult-to-reach areas such as dentinal tubules and lateral canals.
- When using NaOCl over extended periods of time during treatment, it decreases the flexural strength and modulus of elasticity of dentin. Therefore, it should be flushed out of the canal after the end of the process by an inert irrigant such as normal saline.
- NaOCl also has bleaching action by the function of the hypochlorite ions which is important in whitening the discolouration.
- Toxicity of NaOCl is controlled when it is used inside the root canals it could cause serious tissue damage if it extruded periapically especially with higher concentration. This condition called NaOCl accident. If this condition occurs it can be managed by copious irrigation with normal saline prescribing anti-inflammatory injections of steroids

Advantages of NaOCl:

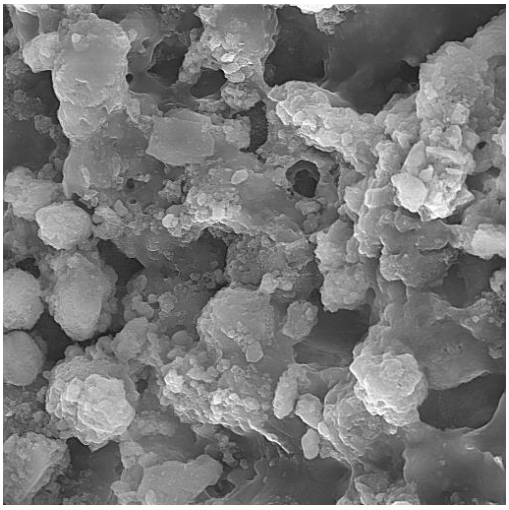
1. It has antibacterial and bleaching action.
2. It helps in canal debridement by dissolution of the organic debris.
3. It causes lubrication of canals.
4. Economical.
5. Easily available.

Disadvantages of NaOCl:

1. Because of high surface tension, its ability to wet dentin is limited.
2. Irritant to tissues, if extruded periapically or when in contact with gingiva.
3. It causes clothes bleaching when in contact.
4. It has bad odor and taste.
5. Vapours of NaOCl can irritate the eyes.

It has a corrosive effect to instruments.

Chelating agent

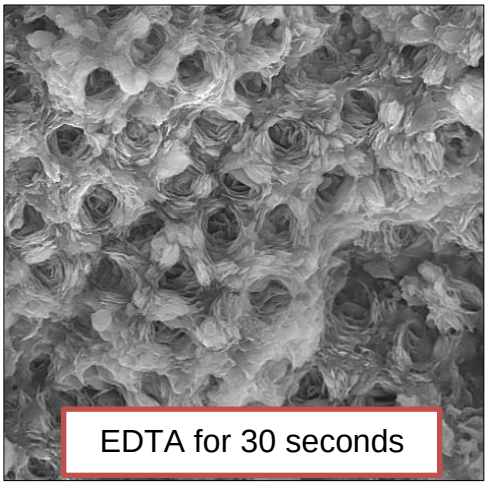


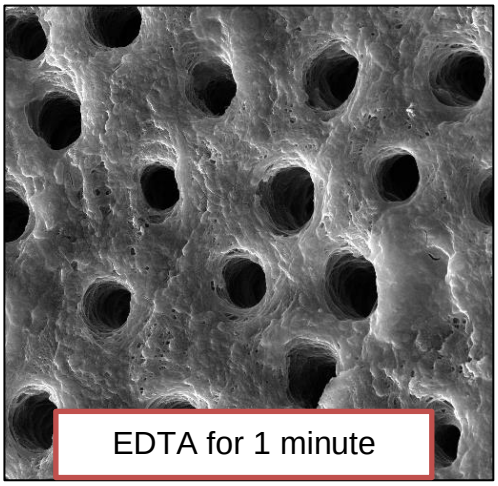
- Smear layer is composed of remnant of dentin debris after root canal instrumentation which is composed of organic and inorganic material.
- It may block the dentinal tubules and lateral canals which may harbour microorganisms.
- Its removal increases the adaptation and adhesiveness of root filling materials.

EDTA

It is ethylenediaminetetraacetic acid and it is the most commonly used chelating agent used in endodontics.

- The solution reacts with calcium ions in the dentin debris of the smear layer and forms calcium chelates.
- This will aid in dissolving these calcific debris for easily flushing-out the root canal.
- The recommended concentration is 17% with neutral pH and for 1 minute for better decalcification.





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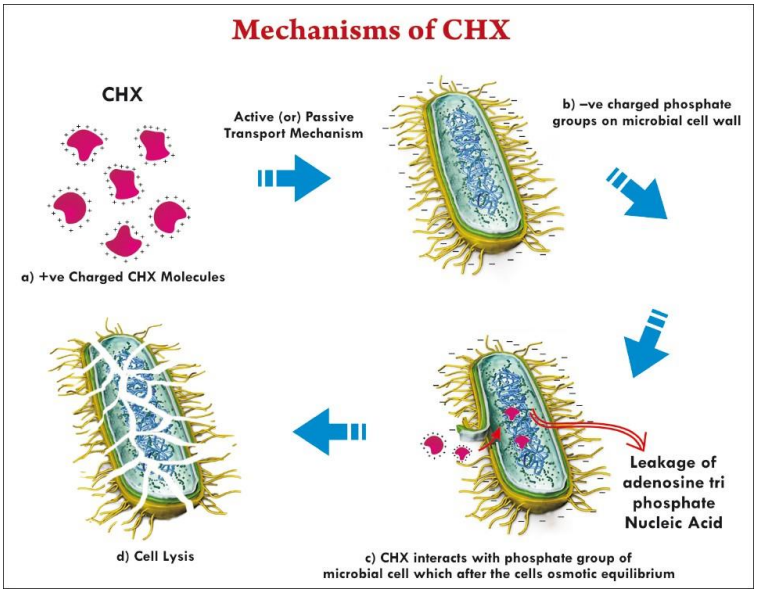
<u>Functions and uses</u>

1- Lubrication for easily manipulating instruments.
2- Dentin debris dissolution.
3- It helps in enlarging narrow canals.
4- Smear layer removal for better adhesion and dentinal tubules penetration of root filling material.

Chlorhexidine

It is a broad spectrum antimicrobial agent and its activity is related to the cationic molecular structure, which can be absorbed by the anionic bacterial cell membrane and causes leakage of intracellular components.



Low concentration (0.2%) → bacteriostatic → mouth washes.
Higher concentrations (2%) → bactericidal → root canal irrigation.

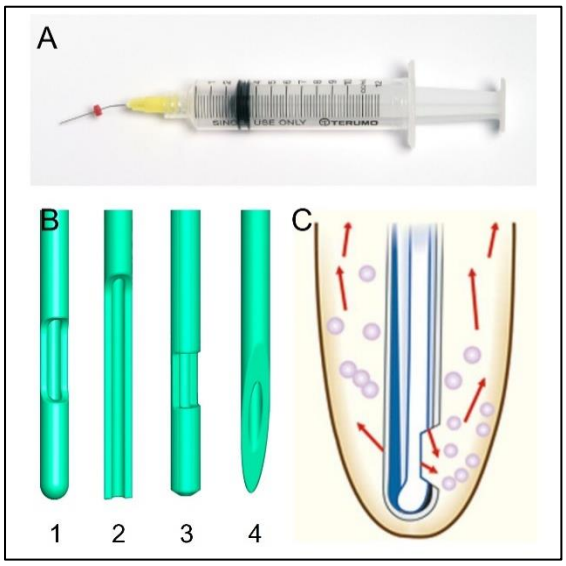
Advantages
1- Prolonged bactericidal effect in concentration of 2%.
2- Prolonged binding to dentin.
3- It has less toxicity than NaOCl.
4- It has potent matrix metalloproteinase (MMP) inhibitor which decreases anticolagenolytic effect.

Disadvantages:
1- It is unable to dissolve necrotic tissue remnants.
2- It is less effective on gram-negative than on gram-positive bacteria than NaOCl.

Methods of irrigation

Irrigation syringe and needle

- Plastic syringe of different sizes (1-20ml) (A)
- Size of the endodontic irrigation needle should be either #27 (0.4mm) or #30 (0.3mm).
- Rounded tips and side holes of irrigation needle to facilitate moving irrigant sideway in the canal rather that pushing the irrigant apically to reduce side effects (B).
- The needle of the syringe should enter to 2mm from the apex to ensure proper irrigation of the apical part of the root canal {C}.



- Between the episodes of irrigation air bubbles are formed in the apical area so a #10-15 file is placed to the working length to allow the irrigant to enter to the cementodentinal junction.

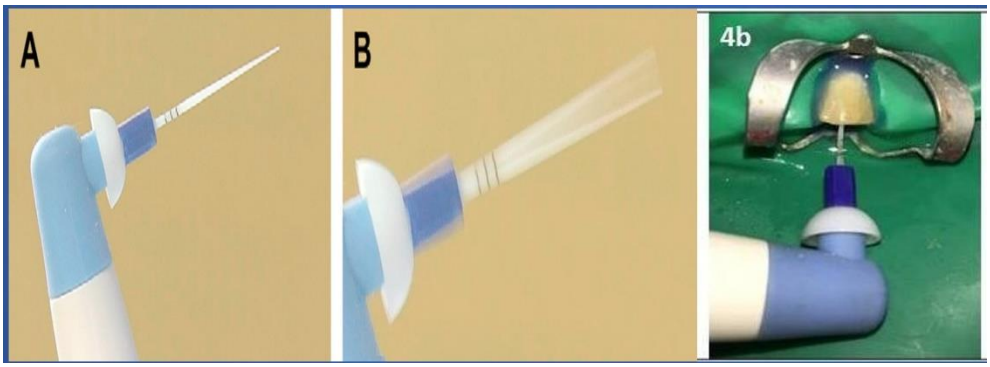
Ultrasonic vibration

- Ultrasonic energy is used to oscillate a file in the presence of the irrigant.
- The ultrasonically oscillated file causes an energy which passes to the irrigant solution and exert acoustic streaming effect on the canal walls.
- This mechanical energy dislodges the debris and smear layer from the canal walls.
- Ultrasonic energy to remove dentin obscuring narrow orifices or pulp stone.

Sonic vibration

The irrigation solution can be activated sonically to create energy which could facilitate debridement of the root canal.

EndoActivator is one of these irrigation agitation methods. It is based on sonic vibration (up to 10,000 cpm) of a plastic tip in the root canal after delivery of the irrigant by using irrigation syringe.



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