

Root Canal Irrigation

- Studies have shown that mechanical instrumentation, whether using 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 using of irrigation solutions.

Requirements of ideal irrigant solution:

- 1- Have a broad spectrum antimicrobial activity.
- 2- able to effectively sterile the canal (or at least disinfect them).
- 3- Have the ability to dissolve necrotic tissue and debride the canal.
- 4- Lubricant solution.
- 5- Low level of toxicity.
- 6- Have low surface tension to be able to penetrate into inaccessible areas.
- 7- Prevent the formation of smear layer during or after instrumentation.
- 8- Inhibiting bacterial toxins such as endotoxin.

Functions of irrigants

- 1- Removal of dentinal shavings by physical flushing to prevent their packing at the apical region of the root canal.

- 2- Canal wetting material which effectively increase the efficacy of root canal instruments. Instruments are less likely to break when the canal walls are lubricated by irrigant.
- 3- Irrigants act as a solvent for necrotic tissue, so they loosen debris, pulp tissue and microorganisms from irregular dentinal walls.
- 4- Irrigants facilitate the removal of debris from inaccessible regions of root canals.
- 5- Most irrigants have germicidal and antibacterial properties.
- 6- Irrigants also have bleaching action to lighten teeth discolored by necrotic pulp tissue, caries or restorative material.
- 7- Irrigants facilitate the removal of smear layer and opening of the dentinal tubules. Factors that modifying the activity of irrigating solution

There are several factors that can be controlled to increase the efficacy of irrigant solutions:

- 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. Therefore, it is critical that the canal diameter should be mechanically enlarged to facilitate the delivery of the irrigant solution up to the apical region of the prepared canal.
- 3- Presence of organic tissue: the organic tissue must be removed mechanically or chemomechanically to increase the efficacy of

intra canal 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.
- Each time a flush of fresh potent irrigant plays an action.

5- Gauge of irrigating needle: usually the 27 or 28 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:

There are several irrigation solution that are currently used in root canal chemomechanical debridement nowadays. But none of these irrigants fulfil all the required criteria. The main irrigants include sodium hypochlorite, chlorhexidine and ethylene diamine tetraacetic acid. A combination of several irrigants can be used to get maximum action.

Some of the commonly used irrigation solutions

Chemically non-active solution

- Water
- Saline
- Local anesthetic

Chemically active materials:

- Alkalis: Sodium hypochlorite 0.5-5.25 percent
- Chelating agents: Ethylene diamine tetra acetic acid (EDTA)
- Oxidizing agents: Hydrogen peroxide, carbamide peroxide
- Antibacterial agents: Chlorhexidine, Bisdequalinium acetate
- Acids: 30 percent hydrochloric acid
- Enzymes: Streptokinase, papain, trypsin
- Detergents: Sodium lauryl sulfate

Normal saline:

Normal saline as 0.9% W/V is commonly used irrigant in endodontics. It is very mild in action and can be used in adjunct to chemical irrigant. It causes gross debridement and lubrication of the root canal. Normal saline basically acts in flushing action. It can also be used as a final rinse for root canals to remove the chemical irrigant left after root canal preparation.

Advantages: it is a biocompatible solution with no adverse effect even if extruded periapically, because its osmotic pressure is the same as that of the blood.

Disadvantages:

- It has no dissolution, disinfectant and antimicrobial properties.

- Too mild to thoroughly clean the canal.
- Does not remove smear layer.

Sodium hypochlorite (NaOCl):

NaOCl encompasses many desirable properties of the main root canal irrigant and has therefore been described as the most ideal irrigant solution. It can be used with different concentrations (0.5 to 6%) but the recommended concentration in many studies is 5.25%. Commercially available household bleach (Clorox) contains 6.15% NaOCl.

- NaOCl dissolve organic material such as pulp tissue, collagen, organic material in smear layer and bacteria. With lower concentrations (0.5%) it dissolve only necrotic tissue, however in higher concentrations dissolve both necrotic and vital which is not always a desirable property.
- NaOCl possess 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. This depends on its concentration and the contact time. With higher concentration and longer contact time its antimicrobial action increase.
- NaOCl minimally remove dentin debris or smear layer. Therefore, the use 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 has an undesired side effect by decreasing the flexural strength and

modulus of elasticity of dentin. Therefore it has to be flushed out by using normal saline after the end of instrumentation visit.

- NaOCl also has bleaching action by the function of the hypochlorite ions which is important in whitening the discolouration caused by pulp necrosis or endodontic and restorative material such as some endodontic sealers, and amalgam restoration. However, NaOCl cause bleaching in contact with clothes, so cautions have to be taken during its use.

- Although NaOCl is nontoxic during intracanal use, it could cause serious tissue damage if it injected periapically especially with higher concentration. This is associated with severe pain, swelling and periapical bleeding. Medication like antibiotics, analgesics, antihistamine should be prescribed accordingly. In addition to these, reassurance to the patient is the prime consideration. Thus irrigation with NaOCl should always be performed passively especially in cases with larger apical diameters and needles with very small diameter.

Advantages of NaOCl:

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

Disadvantages:

- 1- Because of high surface tension, its ability to wet dentin is less.
- 2- Irritant to tissues, if extruded periapically, it can result in severe cellular damage.
- 3- If comes in contact, it cause inflammation of gingiva because of its caustic nature.

- 4- It causes clothes bleaching in contact.
- 5- It has bad odor and taste
- 6- Vapours of NaOCl can irritate the eyes.
- 7- It has a corrosive effect to instruments.

Chelating agent:

After root canal instrumentation, a layer of cutting remnants will cover the dentinal tubules which contain both organic and inorganic materials. This layer is called the smear layer. A big controversy still exist whether to remove or maintain the smear layer which may affect permeability of dentin and root canal treatment. However, most of studies have recommended the removal of this layer because it is the source of microorganism. Also its removal increase the adaptation and adhesiveness of root filling materials.

EDTA (ethylenediaminetetraacetic acid) is the most commonly used chelating agent, which composed of 4 acetic acid groups attached to ethylenediamine. These acetic acid groups create stable calcium complexes with dentin, smear layer or calcific deposits along canal walls. This will aid in dissolving these calcific debris for easily flushing-out the root canal. The effect of EDTA on dentin depends on its concentration and the contact time. With higher concentration and longer contact time its action is increase. Studies recommended 17% concentration with neutral pH for better decalcification results.

The functions and uses of EDTA:

- 1- Lubrication for easily manipulating instruments.
- 2- Emulsification and dentin dissolving properties which reduce canal debridement time.
- 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. At low concentration chlorhexidine acts as a bacteriostatic, whereas at higher concentrations it causes coagulation and precipitation of cytoplasm therefore acts as bactericidal. Although the 0.2% chlorhexidine concentration is used in mouth washes for controlling plaque, the recommended concentration as a root canal irrigation is 2% for better results.

Disadvantages:

- 1- It is not considered as the main irrigant in standard endodontic therapy.
- 2- It is unable to dissolve necrotic tissue remnants.
- 3- It is less effective on gram-negative than on gram-positive bacteria.

Methods of irrigation

There are different methods available in delivering and activating the irrigants within root canal:

Irrigation syringe and needle:

Plastic syringe of different sizes (1-20ml) are used for irrigation. The preferable sizes is between 1- 5ml to maximize safety and control instead of larger syringes which required more pressure.

Although needle gauge 27 is the recommended size in many research, there are also smaller sizes available nowadays (30 and 31 gauge). The 27-G is corresponding to size 0.42mm and 30-G to size 0.31. Also several modifications of the needle tip design have been introduced, such as rounded tips and side holes to facilitate moving irrigant sideway in the canal rather than pushing the irrigant apically to reduce side effects.

Disadvantages: the irrigant solutions cannot be pushed beyond the tip of the irrigation needle because of the dead-water zone or air bubbles trapping in the apical canal region.

Ultrasonic

The use of ultrasonic energy for oscillating file with the present of irrigant have been shown to clean root canal better than conventional hand instrumentation. The ultrasonically oscillated file cause an energy which passes to the irrigant solution and exert 'acoustic streaming or scrubbing' effect on the canal walls. This mechanical energy dislodge the debris and smear layer from the canal walls.

Disadvantages:

- 1- Ultrasonic preparation of the canal is found to be unpredictable.
- 2- It can lead to excessive cutting of canal walls and may damage the finished preparation.

Sonic:

The irrigation solution also can be activated sonically to create kinetic energy which could facilitate debridement of the root canal. EndoActivator is one of these irrigation facilitator 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.