



Smear Layer Removal Efficacy Of Newer Irrigants : A Review

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Abstract

Smear layer consists of residual organic and inorganic components which form a layer of debris on the surface of the substrate. Proper removal of the smear layer is of utmost importance for the longevity of any root canal treatment. For thorough debridement of the smear layer, various irrigating solutions are available in the market. The most commonly used irrigants are 5.25 % sodium hypochlorite, 17% EDTA, 2% Chlorhexidine. But these irrigants have certain disadvantages like they are not effective in smear layer removal from the apical third of the root canal. They are cytotoxic and also exhibits dentinal erosion. So nowadays research work is going on to develop newer irrigants like nano-chitosan, phytic acid, Q-Mix, fumaric acid, glycolic acid. The purpose of this review is to address the efficacy of these newer irrigants in smear layer removal.

Keywords: NIL

Introduction

Chemo-mechanical preparation is an integral part of non surgical endodontic treatment. Whenever tooth structure is undergoing shaping and cleaning, residual organic and inorganic components form a layer of debris on the surface of substrate, which is termed **smear layer**^[1]. Mechanical preparation results in the formation of smear layer on root canal surfaces which might interfere with the adaptation of obturating materials specially at the apical third of the canal^[2]. It has been found that failure to remove the smear layer may lead to failure of retrograde root filling with glass ionomer cement during apicectomy. So removal of the smear layer is extremely important for good endodontic treatment outcome^[3].

Various irrigants such have been used for removal of the smear layer resulting in better sealing at the apical third of the root canal which in turn leads to higher success rate of root canal treatment^[4].

Some most commonly used chelating agents are cytotoxic, less efficient in the apical 3rd of the root canal and also cause dentin erosion^[5]. The purpose of

this review is to address the smear layer removing ability of newer root canal irrigants. Among the newer irrigants nano-chitosan, phytic acid, Q-Mix, fumaric acid, glycolic acid have shown promising results. These irrigants also have the capacity to overcome the shortcomings of commonly used irrigants like 17% EDTA, 5.2% sodium hypochlorite and 2% chlorhexidine.

Why Newer Irrigants?

The commonly used irrigants like 17% EDTA, 2.5% sodium hypochlorite, 2% chlorhexidine have shown very good results clinically. But they have certain disadvantages or drawbacks. The drawbacks are given below

1) 2.5% Sodium hypochlorite

- It does not remove the smear layer's inorganic part^[6]
- It shows cytotoxicity and caustic effects on healthy periradicular tissues on inadvertant extrusion.

- It has unpleasant taste.

2) 17% EDTA

- It is less efficient in smear layer removal in the apical third of root canal
- Erosion of both intertubular dentin occurs if it is used for more than one minute^[7]

3) 2% Chlorhexidine

- Chlorhexidine lacks tissue dissolving capacity
- It does not remove smear layer alone, hence should be used in conjunction with other irrigants^[8]

Hence, nowadays research work is going on to develop newer irrigants.

Newer Irrigants

The newer irrigants that have been developed in recent times for smear layer removal are-

1. 0.7% fumaric acid
2. 5% glycolic acid
3. Oxum
4. 1% phytic acid
5. Q Mix
6. 2 % Nano chitosan
7. 2.4% chloroquick
8. Novel silver citrate
9. Carisolv III
10. 5% Desi clean

Among these newer irrigants , some are mild chelating agents and others are strong chelating agents. The strong chelating agents remove smear layer more effectively^[9].

The mild chelators are 2.4% chloroquick, Carisolv III, Twin kleen.

The strong chelators are 0.7% fumaric acid, 5% glycolic acid, oxum, 1% phytic acid, Q-Mix, 2% Nano chitosan novel silver citrate^[10].

These newer irrigants have shown less cytotoxicity and comparatively more effective smear layer removal than the commonly used irrigants.

ADVANTAGES AND DISADVANTAGES OF THE NEWER CHELATING AGENTS

Oxum

- It is the commercially available superoxidized water
- It is a powerful anti-microbial agent which is rich in reactive oxygen with a neutral pH.^[11]
- It mainly contains oxidized solution (H₂O), sodium hypochlorite, hypochlorous acid, hydrogen peroxide, ozone, chlorine dioxide, sodium hydroxide, sodium carbonate and sodium chloride.
- The molecules are broken into ions and free radicals, which rapidly react and denature protein of bacterial cell wall.

Advantages

- 1) It is stable
- 2) It has longer shelf life
- 3) It causes less erosion
- 4) Better smear layer removal is seen than EDTA in the apical third of the root canal

Disadvantages

- cant be stored for long term
- efficacy diminishes on contact with the micro-organisms to be killed

0.7% Fumaric acid

- Fumaric acid (Butene-1,4-dioic acid) is a trans isomer of maleic acid.
- It is the key intermediate product in citric acid cycle during glucose metabolism, and its esters have been used successfully for the treatment of psoriasis and multiple sclerosis^[12].
- Fumaric acid has shown significantly better smear layer removal because the two carboxylic groups are always opposite to each other in their three-dimensional

orientation^[13] and can bind with more of Ca⁺⁺ present in intraradicular dentin than the cis form of maleic acid where the carboxylic group (-COOH) are always at the same side .

- When 1 proton (H⁺) is removed from them, a strong intramolecular H-bonding is formed with the nearby remaining carboxyl group and can bind with less number of Ca⁺⁺ present in the intraradicular dentin.

Advantages

- 1) It is non toxic
- 2) It has anticarcinogenic as well as anti-inflammatory action.
- 3) It is non-absorbable
- 4) It has growth modulatory action
- 5) It is biocompatible

Disadvantages

- complete removal of smear layer not seen^[14]
- the biologic and physical properties of fumaric acid have to be evaluated within the root canal system and at the periapical tissues before considering it for clinical use

5% glycolic acid

- The glycolic acid (GA) is an alpha hydroxy acid (AHA) extracted from sugar cane and other sweet vegetables^[15].
- It is uncolored, odourless and can be easily dissolved in water.
- In dentistry, recent studies like the one done by Barcellos *et al* (2020) showed that Glycolic acid can be suitable for enamel and dentin etching in restorative procedures and can be as efficient as EDTA in removing smear layer from root canals walls^[16]

Advantages

- it shows greater ability of smear layer removal
- it has greater penetration potential
- it has less toxic effects

Disadvantage

- reduction of microhardness of dentin is seen^[17]

1% phytic acid

Phytic acid (IP6, inositol hexakisphosphate) is an organic acid that is extracted from rice bran^[18].

According to Shamsuddin AM *et al* (2002), it is composed of six phosphate groups which are attached to the carbon atoms of a simple carbohydrate ring.

A recent study done by Nassar M *et al* (2015) demonstrated that phytic acid could be used as an alternative chelating agent for the removal of the smear layer due to the effective chelation of multivalent cations, such as calcium, magnesium and iron^[19].

Advantages

Studies done by Araştırma Görevlisi *et al* (2019), Nassar M *et al* (2015) suggest that 1% phytic acid with an application time of one minute is more effective as smear layer removal agent at each level of the root canal than the more commonly used irrigating solutions like 17% EDTA and 1.25% sodium hypochlorite

Disadvantages

it is not as effective in smear layer removal from apical third of root canal as it is in removing the smear layer from the middle third of the root canal^[20]

More research needs to be conducted to be able to evaluate the effects of phytic acid solution on the root canal dentin.

According to studies done by Tay *et al* (2010)^[21], Nassar M *et al* (2015), 1% phytic acid solution causes more dentin erosion than 17% EDTA and 1.25% sodium hypochlorite^[22,23].

Hydroxyethylidene bisphosphonate (HEBP)

- HEBP is also known as etidronic acid or etidronate.
- It is used as a single step irrigant.
- According to the manufacturer's guidelines, HEBP solutions need approximately 300 seconds to remove the smear layer completely from the dentinal surface^[24]

Advantages

- 1) It shows lower cytotoxicity^[25]
- 2) It has better tissue dissolution capacity
- 3) It prevents accumulation of dentinal debris in the root canal
- 4) HEBP is a weak chelating agent that attacks less dentin surface and hence causes less dentinal erosion^[26]
- 5) Faster removal of smear layer is seen with HEBP

Disadvantages

It is a weak chelating agent and hence cannot be used as final rinse.

HEBP has a property to reduce the action of sodium hypochlorite solution after 1 hour of their mixture.^[27]

Q-Mix

QMix is a new root canal irrigating solution containing a mixture of a bisbiguanide an antimicrobial agent, a polyaminocarboxylic acid, a calcium-chelating agent, saline, and a surfactant^[28]

Advantages

1. Study done by Eliot *et al.* (2014) suggested that effectiveness of all three QMix formulations were superior to EDTA in smear layer removal in the root canal system.^[29]
2. Stojicic *et al.* (2012) evaluated efficacy of a novel root canal irrigant, QMix, against *Enterococcus faecalis* and it was concluded that QMix and NaOCl were superior to CHX and MTAD under laboratory conditions in killing *E. Faecalis*^[30]

Disadvantages

1. Study done by Arnanda Garcia *et al* (2013), suggested there is reduction of microhardness of dentin on applying Q-Mix as irrigating agent^[31]
2. Studies done by Arslan *et al* (2015)^[32], Mohammadi *et al* (2015)^[28] showed that the presence of orange brown precipitate in the root canals irrigated with Q-Mix

2% nano-chitosan

1. Nano-chitosan has significant smear layer removal capability^[33].
2. Because of its smaller particle size, it has smaller contact angle with the root canal wall (hence

better wettability and smear layer removal) and has better penetration to the apical third of the root canal of a tooth^[34].

Advantages

- 1) It has excellent chelating capacity and hence excellent smear layer removal capacity^[35]
- 2) It is cost effective
- 3) It is biocompatible
- 4) It shows good antibacterial activity^[36]

Disadvantages

1. Mechanical resistance is less
2. May contract
3. Preparation by cross linking can affect the intrinsic properties of chitosan
4. Low solubility in neutral and alkaline pH.

2.4% chloroquick (Twin Klean)

Hydroxyethylidene bisphosphonate (HEBP) combined with sodium hypochlorite leads to the formation of Twin Klean^[37].

Advantages

1. It has the ability to remove smear layer.
2. The combination of HEBP with sodium hypochlorite has a combination pH of 11.86 which makes the survival of *E. faecalis* bacteria in the oral cavity difficult as it cannot survive beyond pH of 11.5^[25].

Disadvantages

- 1) It is a weak chelating agent, and hence it shows less efficient in smear layer removal
- 2) It has a slow as well as weak action against the inorganic components of the smear layer^[26].

Novel silver citrate

- Ricardo Tonnini *et al* (2020) suggested that Novel silver citrate can be used as an effective root canal irrigating solution^[38].
- The presence of silver particles renders it to be highly bactericidal as the silver ions penetrate the cell walls of both gram positive and gram negative bacteria and denatures the deoxyribonucleic acid^[39,40].

Advantages

- 1) It has a strong antibacterial activity^[40]
- 2) It is a suitable smear layer removal agent which allows for penetration to apical portion of the root canal^[42,43]

Disadvantages

- 1) It is cytotoxic^[39]
- 2) It shows dentin discoloration

1. Carisolv III

1. According to Banerjee A *et al.*(2017)^[44], Kochhar GK *et al* (2011)^[45], Carisolv III system consists of Carisolv III gel and Carisolv III tools, which are designed to maximize the protection of healthy dental tissues and remove carious debris.
2. Carisolv I and II contain sodium hypochlorite and 3 different amino acids (glutamic acid, leucine, and lysine)^[46]
3. The Carisolv III system is available in gel form.
4. The delivery of Carisolv III in solution enhances its wetting ability and cleaning capability to remove the root canal smear layer more effectively^[47].

Advantages

- 1) It is biocompatible
- 2) It does not discolour dentin
- 3) It has the ability to strengthen the adhesion between obturation materials and root canal wall^[48]
- 4) It has the ability to remove smear layer without damaging healthy dentin

Disadvantages

- 1) It is viscous
- 2) It cannot penetrate effectively in the apical third of the root canal^[49,50]
- 3) It causes discolouration of tooth

2. 5% Desi clean

- Turk *et al* (2015) suggested that Desi Clean can be used as an effective irrigating agent in endodontics^[51].

- It is an environmental friendly sterilizing agent without chlorine, formaldehyde and alcohol
- Desy Clean's pH is 2.5–3.5 .Its acidic nature helps removing the smear layer effectively.
- It should be used for one minute.
- It can react easily with macromolecules such as membrane lipids in the cell all of bacteria and denture the bacterial DNA. Hence it is highly effective against bacteria.

Advantages

- 1) It posses promising antibacterial action^[37,51]
- 2) It has very good biocompatibility
- 3) Minimal erosion of dentin is seen
- 4) It can remove smear layer effectively from coronal, middle and apical third of the root canal

Disadvantages

1. Weak chelating agent
2. Does not exhibit substantivity
3. More research is needed for considering the effectiveness of Desi Clean solution as irrigating agent

Conclusion

The commonly used irrigants in clinical practice like 2.5% sodium hypochlorite, 2% chlorhexidine, 17% EDTA have given promising results as an irrigant. But they have certain disadvantages like they are cytotoxic and are not effective in smear layer removal from the apical third of the root canal. So nowadays, research work is performed to develop newer irrigants. The newer irrigants that are developed are 0.7% fumaric acid, Q-Mix, oxum, novel silver citrate, 5% glycolic acid, 2 % nano-chitosan etc. Literature has revealed that these newer irrigants are biocompatible and show comparable results or even better results in smear layer removal. Hence, these newer irrigants can well be used in place of the commonly used irrigants in day to day clinical practice.

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