European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 9, Issue 8, Autumn 2022

REVIEW ARTICLE

ENDODONTIC IRRIGATION SOLUTIONS: A REVIEW

[1]Ravneet Kaushal, [2]Harleen Kaur, [3]Gaurav Aggarwal, [4]Rohit Wadhwa, [5]Deepika Singla

[1,3,4,5]Senior Lecturer, [2]Reader, Department of Conservative Dentistry &Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, Punjab, India

Correspondence:
Ravneet Kaushal
Senior Lecturer, Department of Conservative Dentistry &Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, Punjab, India
Email: ravneet.kaushal11@gmail.com

Received: 19 February, 2022 Accepted: 23 March, 2022

ABSTRACT
The goal of endodontic treatment is to remove all the vital and necrotic tissues, microorganisms and microbial byproducts from root canal system. This goal can be achieved through chemical and mechanical debridement of root canals. This article narrates the specifics and requirements of the irrigation solutions. Sodium hypochlorite is proposed as the primary irrigants by virtue of its organic tissue dissolution capacity and broad antimicrobial properties. On the other hand, chelation solutions are recommended as auxiliary solutions to remove the smear layer or to hinder its formation on dentin surface. Thus, it's hoped that sealers and root canal fillers can penetrate to dentin tubules and obturate the canals hermetically. There are new studies on traditional irrigants especially on some irrigants that can replace sodium hypochlorite. This article reviews the new irrigants which can be used in future endodontic practice, and their advantages and limitations. Moreover, actions and interactions of recently used irrigants are adverted.
Keywords: Irrigation solutions, chelators, sodium hypochlorite, EDTA, disinfection

INTRODUCTION

The main aim of the root canal treatment is the complete removal of connective tissue or the destruction of microorganisms and to enable an effective seal in order to prevent recolonization of the canal with bacteria.[1] This aim can be achieved by chemical and mechanical cleaning of the root canal system. The anatomy of a root canal is complex and accessory features such as fins, intercanal communications can sometimes make this cleaning difficult.[2]The three main steps of therapy are: root canal preparation, chemo-mechanical debridement, and obturation. Chemical-mechanical debridement requires both instrumentation and irrigation.[3]Before using instruments and during theoperation, irrigation was used as a pre-instrumentation phase to eliminate contaminated necrotic tissue. Water irrigation has been more important for effective root canal therapy in the last two decades. Root canal instrumentation, irrigation, and medication have been the focus of research and clinical practice, followed by obturation and the placement of a coronal seal. When it comes to water purification, instruments shape and irrigants cleanse. It is impossible to physically disinfect or clean every part of a root canal system. Only an irrigation solution can effectively clean these spaces (main canal, lateral, accessory canal and isthmus)

PROPERTIES OF AN IDEAL IRRIGANT ARE[5,6].

- Bactericidal, germicidal, and fungicidal effects
- Ability to serve as a lubricant during instrumentation
- Ability to dissolve organic dentinal tissues (pulp tissue, collagen, and biofilm)
- Ability to dissolve inorganic dentinal tissues
- No irritation of periapical tissues
- Solution stability
- Prolonged and sustainable antibacterial activity after use
- Activity in an environment in which blood, serum, and tissue protein products are present
- Ability to remove the smear layer completely
- Low surface tension
- Disinfection of dentin and dentinal tubules
- No interference with periapical tissue healing
- No staining of tooth tissues
- No weakening of tooth tissues
- No triggering of a cell-mediated immune response
- No antigenic, toxic, or carcinogenic effect on the peripheral tissue cells of the tooth
- No negative effect on the physical properties of the exposed dentin
- No negative effect on the sealing abilities of sealers
- Ease of application and low cost
- Long shelf life.

NORMAL SALINE

In endodontics, normal saline is one of the solutions used as an irrigant. It results in root canal debridement and lubrication. Because of its moderate activity, it may be used in conjunction with chemical irrigants. After root canal preparation, it may be used as a last rinse to flush out any leftover chemical irrigant. The most common saline solution is 0.9 percent W/V normal saline.[7,31]

SODIUM HYPOCHLORITE[8,33]

It is the most widely used irrigant. Concentration ranging from 0.5%-5.25% is widely used, but for clinical use concentration between 0.5% and 1% is recommended.

ADVANTAGES

1. Causes tissue dissolution
2. Remove an organic portion of dentin
3. Removes biofilm
4. Causes dissolution of pulp and necrotic tissue
5. Causes lubrication of canal
6. Antibacterial and bleaching action
7. Economical and easily available

DISADVANTAGES[5]

1. If extruded periapically, it can result in cytotoxicity causing excruciating pain, periapical bleeding, and swelling.
2. Has high surface tension so its ability to wet dentin is less
3. Does not remove the smear layer
4. Can bleach clothes
5. Can corrode instruments

6. Bad odor and taste
7. If comes in contact with gingival, causes inflammation of gingival.
8. Its vapor can irritate eyes.
9. Exudates and microbial biomass inactivated sodium hypochlorite.
10. Should not be used as a final rinse before obturation.

ETHYLENEDIAMINETETRAACETIC ACID (EDTA)

Complete cleaning of the root canal system requires the combined use of organic and inorganic tissue-dissolving irrigation solutions. As NaOCl effectively dissolves only organic tissue, other solutions should be used to remove the smear layer and debris from the root canal system. The use of demineralizing agents, such as EDTA and CA, as auxiliary solutions during root canal treatment is recommended. In 1957, Nygaart-Ostby proposed the use of chelating agents to aid in the preparation of narrow and calcified root canals. The first recommended EDTA solution had a concentration of 15% and a pH of 7.3 [9, 10].

EDTA is used most commonly as a 17% neutralized solution. The solution reacts with the calcium ions in the dentin and forms soluble calcium chelates. Decalcification is a self-limiting process that eventually stops due to the lack of a chelator that will react quickly enough [11].

Calt and Serper showed that 1 min irrigation with 10 ml of 17% EDTA solution effectively removed the smear layer from the canal wall. They observed that dentin demineralization increased with the contact time, the EDTA concentration (from 10% to 17%), and the pH (from 7.5 to 9) [12,34].

The ultrasonic application of 17% EDTA for 1 min is very effective for removal of the smear layer, especially from the apical third of the root, and the continuous use of liquid EDTA during root canal treatment is recommended (28). Under normal conditions, CHX solutions are insoluble in EDTA. The resulting precipitate is a salt formed by electrostatic neutralization of the cationic CHX by the anionic EDTA.

The ionic equation is:

$2HEDTA^{3-}(aq) + 3H_2CHX^{2+}(aq) \leftrightarrow (HEDTA)_2(H_2CHX)_3$

CITRIC ACID (CA) [13,25]

CA is also available on the market and is used at concentrations ranging from 1% to 50%. The use of 10% CA as a final irrigation solution yielded very good results in terms of smear layer removal. CA has shown slightly better performance than EDTA at similar concentrations, although both solutions are highly effective in removing the smear layer from root canal walls. In vitro studies have provided insight into the cytotoxicity of chelators. A 10% CA solution was proven to be more biocompatible than a 17% EDTA solution. In one study, a 25% CA solution failed to destroy Enterococcus faecalis

CHLOROHEXIDINE [14,26]

It is the most potent bisbiguanide. It should be used as 2% in concentration. It is a broad-spectrum antimicrobial agent. A combination of 0.2% chlorhexidine and 2% sodium hypochlorite is commonly used as an irrigant.

1. Mechanism of Action
2. It is a cationic bisbiguanide molecule.
3. This cationic molecule is absorbed by the negatively charged cell membrane.
4. It causes leakage of intracellular components.
5. At high concentration, it acts as bactericidal, and at low concentration act as bacteriostatic.
6. It also has a property of substantivity- a residual antimicrobial activity for up to 7 days.

ADVANTAGES
1. 0.2% is used in controlling plaque
2. 2% is used as a root canal irrigant
3. It is more effective against gram-positive bacteria
4. Used with calcium hydroxide in retreatment cases.

DISADVANTAGES
1. It does not dissolve necrotic tissue
2. Does not show an effect on biofilms
3. Less effective on gram-negative bacteria

OZONATED WATER [15,27]
It is a newer irrigant solution that shows a powerful effect as an antimicrobial agent against bacteria, fungi, protozoa, and viruses at low concentrations (0.001ppm). It is produced easily with an ozone generator and dissolves rapidly in water.

MECHANISM OF ACTION
These act through the Cavitation effect. It is the formation of vapor containing bubble inside fluid causing the formation of pressure or shockwave. A collapse of these bubbles causing implosions that generate shear forces, surface deformation, and removal of surface material.

ADVANTAGES
1. Ease of handling
2. Rapid microbial effects
3. Lack of mutagenicity
4. Its potency

DISADVANTAGES
They are effective against most of the bacteria but show no response against E.coil and on the amount of remaining lipopolysaccharides inside the root canal that have biological effects such as induction of apical periodontitis.

MIXTURE OF TETRACYCLINE ISOMER, ACID, AND DETERGENT (MTAD)
Torabinejad et al. introduced a combination of 3% doxycycline, 4.25% CA, and detergent (Tween-80) as an alternative to EDTA with the aim of improving smear layer removal. This mixture acts as a chelator and has antimicrobial activity. As it has no organic tissue-dissolving effect, its use after NaOCl at the end of chemomechanical preparation is recommended [(16).]
MTAD is a mixture of three substances expected to affect bacteria synergistically [(17).] Its bactericidal effect on E. faecalis biofilm is less than that of NaOCl solution at concentrations of 1%–6%. The CA in the MTAD solution enables smear layer removal and allows doxycycline to enter the dentinal tubules and exert antibacterial effects [(18,28).] In a canal filled with AH Plus and gutta percha, the use of MTAD as a final irrigation solution significantly reduces bond strength compared with the use of EDTA. When MTAD is used instead of EDTA, resistance to tetracycline can develop in bacteria isolated from root canals [(19,20).]
Generally, the use of antibiotics instead of biocides, such as NaOCl and CHX, is not recommended because antibiotics have been developed for systemic use, rather than for local wound healing, and they have a narrower spectrum than do biocides [(21,29).]

HERBAL IRRIGATING SOLUTIONS

Many plant species have been used to disinfect the root canal.

1. Green Tea Polyphenols: They are derived from leaves of tea (CsmelliaSinensis). They show significant antibacterial activity in E.faecalis biofilms grown on dental culture and killing it within 6 minutes.[22]
2. MorindaCitrifolia: It has a very wide range of therapeutic effects, such as antibacterial, antiviral, antifungal, analgesic, anti-inflammatory, antitumor, hypotensive. It has smear layer removal capabilities. It is preferred as an irrigation solution as it is a biocompatible antioxidant.[23]
3. Triphala: It is a plant blend created by drying and pulverizing the fruit of three plants. Triphala kills 100% E.faecalis within 6 minutes. It helps in smear layer removal. When used with other irrigants its effect can be increased synergistically.[24,30]

RECOMMENDED IRRIGATION METHOD

NaOCl solution should be used during root canal preparation. Between fillings, root canals should be irrigated with copious amounts of NaOCl solution. After the completion of shaping, the canals should be irrigated with liquid EDTA or CA.

Generally, each canal should be irrigated for at least 1 min with 5–10 ml of chelating solution. After smear layer removal, irrigation with an antiseptic solution is helpful. CHX is one of the most promising solutions for final irrigation in this context.

CHX has high affinity for dental hard tissues and its antimicrobial activity persists for a long time once it is bound to the surface. After the introduction of MTAD irrigants to the market, a new irrigation method was recommended: initial irrigation with 1.3% NaOCl for 20 min, followed by final irrigation with MTAD for 5 min.

REFERENCES

1. Shen, Y., Stojicic, S., Qian, W., Olsen, I. and Haapasalo, M., 2010. The synergistic antimicrobial effect by mechanical agitation and two chlorhexidine preparations on biofilm bacteria. Journal of endodontics, 36(1), pp.100-104.
2. Vertucci, F.J., 1984. Root canal anatomy of the human permanent teeth. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 58(5), pp.589-599.
3. Chow TW: Mechanical effectiveness of root canal irrigation . J Endod. 1983, 9:475-79. 10.1016/s0099- 2399(83)80162-9
4. Nielsen BA, Craig Baumgartner J: Comparison of the EndoVac system to needle irrigation of root canals . J Endod. 2007, 33:611-5. 10.1016/j.joen.2007.01.020
5. Basrani B, Haapasalo M. Update on endodontic irrigating solutions-Endodontic topics 2012;27:74-102.
6. Agrawal Vineet S, Rajesh M, Sonali K and Mukesh P. A Contemporary Overview of Endodontic Irrigants - A Review. J Dent App. 2014;1(6):105-15.
7. Nisha Garg, Amit Garg: Textbook of Endodontics, second edition .Jitendar P. Vij (ed): Jaypee Brothers Medical Publishers (P) Ltd, India; 2010.
8. Zehnder, M., 2006. Root canal irrigants. Journal of endodontics, 32(5), pp.389-398.
9. Nygaard-Ostby B. Chelation in root canal therapy. OdontolTidskr 1957;65:3-11.
10. Loel DA. Use of acid cleanser in endodontic therapy. J Am Dent Assoc 1975;90:148-51
11. Von Der Fehr FR, Nygaard-Ostby B. Effect of EDTAC and sulfuric acid on root canal dentine. Oral Surg Oral Med Oral Pathol 1963;16:199-205.
12. Calt S, Serper A. Time-dependent effects of EDTA on dentin structures. J Endod 2002;28:17-9.
13. Topbas C, Adiguzel O. Endodontic Irrigation Solutions: A Review. Int Dent Res 2017;7:54-61

14. Gomes, B.P., Vianna, M.E., Zaia, A.A., Almeida, J.F.A., Souza-Filho, F.J. and Ferraz, C.C., 2013. Chlorhexidine in endodontics. Brazilian dental journal, 24(2), pp.89-102.
15. Tomita, Y. and Shima, A., 1986. Mechanisms of impulsive pressure generation and damage pit formation by bubble collapse. Journal of Fluid Mechanics, 169, pp.535-564.
16. Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB. A new solution for removal of smear layer. J Endod 2003;29:170-5.
17. Haapasalo M, Qian W, Portenier I, Waltimo T. Effects of dentin on the antimicrobial properties of endodontic medicaments. J Endod 2007;33:917-25.f
18. Torabinejad M, ChoY, Khademi AA, Bakland LK, Shabahang S. The effect of various concentrations of sodium hypochlorite on the ability of MTAD to remove the smear layer. J Endod 2003;29:233-9.
19. Hashem AA, Ghoneim AG, Lufty RA, Fouda MY. The effect of different irrigating solutions on bond strength of two root canal filling systems. J Endod 2009;35:537-40.
20. Dahlén G, Samuelsson W, Molander A, Reit C. Identification and antimicrobial susceptibility of Enterococci isolated from the root canal. Oral MicrobiolImmunol 2000;15:309-12.
21. McDonnell G, Russell AD. Antiseptics and disinfectants: activity, action, and resistance. ClinMicrobiol Rev 1999;12:147-79.
22. Hamilton-Miller, J.M.T., 2001. Anti-cariogenic properties of tea (Camellia sinensis). Journal of medical microbiology, 50(4), pp.299-302.
23. Murray, P.E., Farber, R.M., Namerow, K.N., Kuttler, S. and Garcia-Godoy, F., 2008. Evaluation of Morindacitrifolia as an endodontic irrigant. Journal of endodontics, 34(1), pp.66-70.
24. Jagetia, G.C., Baliga, M.S., Malagi, K.J. and Kamath, M.S., 2002. The evaluation of the radioprotective effect of Triphala (an ayurvedic rejuvenating drug) in the mice exposed to γ-radiation. Phytomedicine, 9(2), pp.99-108.
25. Kaushal R, Gupta I, Gupta U,Recent Advances in Dental Composite: A Review,International Journal of Health Sciences (2021) 5 (S1) 36-44.
26. Sethi K,Shefally, Raji J,Working Length Determination: A Review,International Journal of Health Sciences (2021) 5 (S1) 45-55.
27. Singla D, Kataria B, Kaur U, Root Canal Cleaning and Shaping : A Review,International Journal of Health Sciences (2021) 5 (S1) 95-112.
28. Pareek A, Sood H, Aggarwal G,Tooth Wear: A Review,International Journal of Health Sciences (2021) 5 (S1) 122-133.
29. Mahajan A, Kaur NP, Ayoub K,Monoblocks in Root Canals: A Review,International Journal of Health Sciences (2021) 5 (S1) 113-121.
30. Arora A, Pareek A, Danish Prabhakar, Liners, Bases and Varnishes: A Review,International Journal of Health Sciences (2021)5 (S1)1-9.
31. Mehta SD, Malhan S, Bansal C,Latrogenic Complications Arising From Cleaning and Shaping – A Review,International Journal of Health Sciences (2021) 5 (S1) 56-62.
32. Sood H, Virk J, Pareek A,Traumatic Injuries of Teeth: A Review,International Journal of Health Sciences (2021) 5 (S1) 23-28.
33. Kaur G, Kaushal R, Danish Prabhakar,Esthetic Restorations and Smile Designing – A Review,International Journal of Health Sciences (2021) 5 (S1) 10-22.
34. Arora A, Gupta U, Gupta I,Dentin Hypersentivity: A Literature Review,International Journal of Health Sciences (2021) 5 (S1) 63-72.