ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 01 | January - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

"COMPARATIVE EVALUATION OF THE WETTABILITY OF THREE IRRIGATING SOLUTIONS USING CONTACT ANGLE."

Dentistry

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ABSTRACT

Context: Estimating wettability of irrigating solutions. **Aims:** To evaluate and compare wettability of three irrigating solutions using contact angle. **Methods and Material:** In this study three groups of irrigating solutions ie., Group A: 2.5% sodium hypochlorite + 8.5% Etidronic acid or Hydroxy ethylidene disphosphonic acid (HEDP), Group B: 2.5% sodium hypochlorite + 8.5% ethylene glycol bis –N N N N' – tetraacetic acid (EGTA) and Group C: 2.5% sodium hypochlorite (NaOCl), with a sample size of 15 each were taken. A drop of each solution was placed on the glass slide using a micropipette. The photograph was made with an SLR camera, and the contact angle was measured using AutoCAD software. **Statistical Analysis Used:** Chronbach's alpha coefficient and One-way ANOVA **Results:** One-way ANOVA test revealed a significant difference (p=0.001) among tested groups, i.e. between Group A & C, Group A & B. But there was no significant difference between group C & B. **Conclusions:** Sodium hypochlorite in combination with HEDP showed better wettability comparatively than the other two irrigating solutions

KEYWORDS

Contact angle, Wettability, AutoCAD

INTRODUCTION:

In endodontic treatment, irrigation is one of the most crucial phases for removing the smear layer and necrotic contaminated material from the root canals. Different irrigating solutions like sodium hypochlorite, hydrogen peroxide, chlorhexidine, Qmix, Ethylenediaminetetraacetic acid (EDTA), herbal agents like Propolis, Morinda citrifolia, Triphala, Green tea, Meswak, Turmeric, HEDP, EGTA etc. were being used in the dentistry from past few decades.[1]

An irrigating solution used during root canal preparation must be in contact with the canal walls to promote

- Dissolution of organic tissues
- Disinfect the dentin and its tubules
- Increase the solvent capability in non instrumented canals.

During biomechanical preparation of root canals, 'the untouched areas' is the most common problem faced even with rotary preparation. Several studies reported that mesiobuccal root canals of maxillary first molars are the frequently untouched areas. The average being 40.0%-47.4%.[1,2,3] To solve this problem, an irrigating solution for endodontic use must exhibit considerable wetness. This increases its capability of dissolving organic and inorganic tissues. It also improves antimicrobial activity in non-instrumented areas of the root canal.[4]

Wettability of a solution governs the ability of its penetration both into primary and lateral canals and also dentinal tubules.[5,6,7] The wettability of a liquid can be assessed by measuring the contact angle of the liquid with a solid surface and its surface tension.

Formation of a contact angle expresses the tendency of a liquid to spread on a solid surface. The contact angle is thus defined as the angle formed by the intersection of the liquid-solid interface and liquid-vapour interface. Measuring the contact angle can provide a better understanding of the interaction between solids and liquids. It also plays a crucial role in understanding not only material wettability but also wetting, spreading and adsorption of fluids to be tested.

The commonly used irrigating solution is sodium hypochlorite (NaOCl). But because of its limited effect on smear layer removal, it is recommended with chelating agents like EDTA. So chelating agents like EDTA were been added to increase the wettability.[8] HEDP and EGTA were considered as a substitute for traditional chelators because of their fewer adverse effects on dentin. The aim of the present study was to assess and compare the wettability of these weak chelating agents in combination with NaOCl.

SUBJECTS AND METHODS:

Materials Used:

- 2.5% NaOCl + 8.5% HEDP
- 2.5% NaOCl + 8.5% EGTA
- 2.5% NaOCl

Armamentarium Used (Fig 1):

- Glass slides
- Micropipette
- SLR camera (Fig 2)
- AutoCAD software

Figure 1: Materials and armamentarium

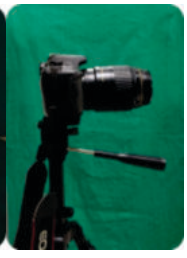


Figure 2: SLR Camera

Methodology:

18% HEDP was prepared by dissolving 18 grams of pure chemical in 100 ml of distilled water. 17% EGTA was prepared by dissolving 17 grams of EGTA in 100ml of distilled water with the aid of NaOH, and then the pH was adjusted to 7.5 by adding hydrochloric acid.

Grouping Was Done As Follows Based On Irrigant:

- GROUP A: 8.5% HEDP + 2.5% NaOCl
- GROUP B: 8.5% EGTA + 2.5% NaOCl
- GROUP C: 2.5% NaOCl

Contact angle of the above three different solutions were tested as follows

Placing Solution On The Specimens:

A droplet of size 50µl was placed on a glass slide using a micropipette by stabilizing the hand elbow.

Making Photographs:

Horizontal view of the slide with a liquid drop over that was captured using SLR camera as soon as the liquid drop was placed using a micropipette. The camera was held at the level of the liquid drop and glass slide interface using the tripod stand, with a fixed distance between the slide/droplet.

The above two procedures were repeated for all the three solutions, and for each solution, 15 samples were taken. Each time the glass slide was changed; the droplet was placed and then photographed as mentioned above. All the photographs taken were loaded into AutoCAD software, and the contact angle was measured as follows:

Contact angle measured using AutoCAD software (Fig 3): Lines were digitally drawn using AutoCAD software on JPEG images, which were captured with SLR camera.

- A line was drawn digitally on the photograph along with the liquid-solid interface extending up to three-phase boundary (air, liquid & solid).
- Other line was traced along the outer surface of the liquid drop extending up to the three-phase border.
- Intersection of these two lines gives the contact angle value of a liquid drop with the glass surface.
- Obtained values were statistically analyzed.

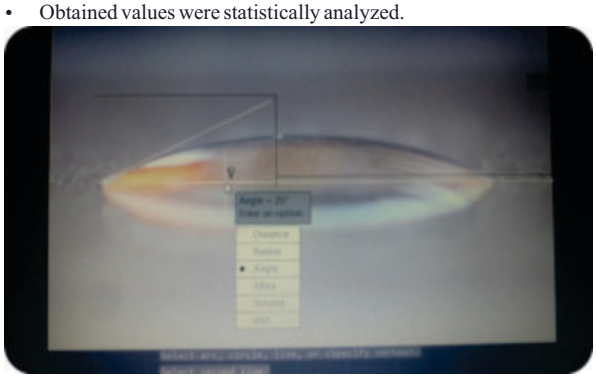


Figure 3: Measuring Of Contact Angle With AutoCAD Software

RESULTS:

15 slides/each solution i.e., 15 droplets were placed on 15 slides/each solution and 15 photographs were taken & measurements on AutoCAD were made by two examiners.

The inter examiner reliability between the three solutions was measured using chronbach`s α coefficient (Table 1) which showed a good agreement with group A and group B solutions where as group C showed a moderate agreement.

Then the mean and standard deviation of the contact angle was measured along with that ANOVA and p value were assessed (Table 2). The variance analysis (ANOVA) revealed that there is a statistically significant difference among the tested irrigants (p=0.001)

Among the mean values obtained from different solutions, NaOCl and HEDP showed lower values of contact angle comparatively.

Pair wise comparison of mean contact angle values was done using Tukey's post hoc test (Table 3) which showed a significant difference between group A and B and also between Group A and C.

When the mean contact angle values were observed graphically, there was a significant difference between group A and group B and also between group A and group C, but not with group B & C (Graph1).

Table 1: Inter Examiner Reliability

	NaOCl	NaOCl + HEDP	NaOCl + EGTA
Examiner 1	α =0.646	α = 0.749	α =0.795
Examiner 2	Moderate agreement	Good Agreement	Good Agreement

α= Chronbach's alpha (Indicator of reliability between examiners)

Table 2: Mean Values Of Contact Angle

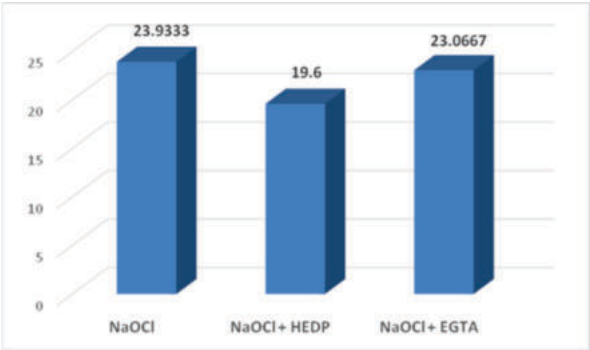
	Mean	Std. Deviation	ANNOVA F Value	p value
NaOCl	23.9333	2.73774	9.933	0.001*
NaOCl + HEDP	19.6000	3.01899		
NaOCl + EGTA	23.0667	2.68506		

p value is statistically significant < 0.05

Table 3: Pair Wise Comparison Of Mean Contact Angle Values Using Tukey's Post Hoc Test

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	p value
NaOCl (C)	NaOCl + HEDP (A)	4.33333*	1.02889	.000*
	NaOCl + EGTA (B)	.86667	1.02889	.679
NaOCl + HEDP (A)	NaOCl (C)	-4.33333*	1.02889	.000*
	NaOCl + EGTA (B)	-3.46667*	1.02889	.005*
NaOCl + EGTA (B)	NaOCl (C)	-.86667	1.02889	.679
	NaOCl + HEDP (A)	3.46667*	1.02889	.005*

p value is statistically significant < 0.05



Graph 1: Shows Mean Contact Angle Values Of The Three Different Solutions

DISCUSSION:

The quality of root debridement can be influenced by irrigating solutions associated with root canal instrumentation. So chemical solution used must exhibit substantial wetness, which increases its solvent capability and improves antimicrobial activity in non-instrumented areas of the root canal system.[3]

The contact angle is an indicator of the wettability of irrigants. The experimental values of the contact angle can be obtained by direct measurement of the tangent of the angle between the liquid droplet and the solid surface of the substrate.[9] A low value of the contact angle indicates that the liquid has high wettability, whereas a high value indicates a low wettability. It has been determined that if the contact angle is less than 90°, there is wetting of the surface; if it is greater than 90°, there is no wetting, and a contact angle equal to zero represents complete wetting.[10]So in the present study contact angle was taken as a measuring tool for wettability.

The commonly used irrigating solution is sodium hypochlorite with EDTA, which is a halogen substance, which has pronounced antimicrobial activity and tissue solvent capacity. But the disadvantage of NaOCl is that it removes only organic but not the inorganic structure of smear layer produced during mechanical instrumentation. Chelating agents like EDTA are required for effective removal of inorganic part of the smear layer, which allows deeper penetration of NaOCl into the dentinal tubules.[11] Even the combination of EDTA and NaOCl forms an exothermic reaction, showing aggressive action on dentin leading to erosion, and evaporates freely available chloride ions.[12]To overcome this, weak chelating agents can be added to NaOCl. Among the chelating agents, weak chelating agents are HEDP & EGTA.[11] HEDP belongs to bisphosphonates family, which has been widely used, in the treatment of osteoporosis, Paget's disease and hypercalcemia associated with malignancies. It was considered as a substitute for traditional chelators because of its fewer adverse effects on dentin.[13] On the other hand, HEDP also has an advantage over EDTA due to its less demineralizing action; further, it can be mixed chairside with NaOCl without affecting the chloride ions in NaOCl and also it can be used as final irrigant as it shows less action on the mineral content of root dentin. It is a potential alternative to EDTA (or) citric acid.[13]

EGTA or ethylene glycol bis –N N N N' – is effective in the removal of smear layer, because of its calcium ion specificity.[13] It also showed better tissue dissolving property than EDTA in combination with

sodium hypochlorite without affecting the chloride ions in NaOCl. So EGTA is preferred to EDTA because of its precise action on calcium ions and also causes lesser erosion than EDTA on dentin.[12,14,15]

So the present study evaluated and compared the wettability using contact angle of NaOCl in combination with above weak chelators like HEDP and EGTA, which were proved to be efficient in their properties.[12,13] So by knowing the contact angle we can better evaluate and judge the irrigating efficacy of irrigants.

The contact angles of the three solutions in the study were evaluated by placing the drop on the glass slides. Some studies assessed the contact angle of the substance with the dentin after pre-treatment.[8,16,17] In one of these studies, the values for contact angles were significantly reduced after the pre-treatment of the dentin for 10 min with 5.25% NaOCl and 3% H2O2 in comparison with 17% EDTA. The latter substance showed no significant difference compared to the control (distilled water).[16] Another study using a similar methodology did not find a difference in wettability after pre-treatment of dentin with 2.5% NaOCl or 17% EDTA.[8] The difficulty of standardizing this surface/substrate may explain the discrepancy among the results from different studies. In the present study, the standardization of the surface allowed the comparison of the contact angle of solutions controlling this bias which is also in accordance with Lopes HP et al. 2015.[6]

Contact angle can be measured by various methods like windrop++ software,[5] goniometer,[6] dynamic contact angle analyzer as per the study conducted by Evangelos et.al [9, 18, 19] and AutoCAD.[20,21,22] In the present study contact angle was measured using AutoCAD which is in accordance with Kastamonu U et al.[20] Contact angle measurements determine the wettability of the substratum.[23,24]

The variance analysis (ANOVA) revealed that there was a statistically significant difference among the tested irrigants (p=0.001). Among the mean values obtained from different solutions, NaOCl and HEDP showed lower values of contact angle. No studies were reported on contact angle of NaOCl in combination with weak chelating agent. But a study conducted by Hélio PLopes et al assessed the contact angle and the surface tension of different chemical irrigants like: 2.5% sodium hypochlorite (NaOCl); 2% chlorhexidine (CHX); BioPure MTAD®; and 0.9% sterile physiological saline solution, as the control, in which BioPure MTAD® showed the best wettability in relation to the other tested irrigant, followed by two percent of CHX and 2.5% NaOCl.[6]

In a study conducted by Luciano Giardino et al there was superior wettability of Hypoclean and Chlor-Xtra in comparison to pure NaOCl and distilled water.[4] Poornika Gandhi in her study reported that AH Plus sealer showed better wettability with Dual Rinse® HEDP than distilled water. This could be because Dual Rinse® HEDP is a bisphosphonate and is highly adsorbed to hydroxyapatite surface, leading to increase in surface free energy.[25]

CONCLUSION:

Sodium hypochlorite in combination with HEDP showed significantly lower contact angle indicating better wettability.

Key Messages:

Irrigating solutions with weak chelating agents may be a better option to increase wettability and there is a need to evaluate a better combination.

REFERENCES:

1. Hubscher W, Barbakow F, Peters OA. Root-canal preparation with FlexMaster: Canal shapes analysed by micro-computed tomography. Int Endod 2003;36:740-7.
2. Peters OA, Peters CI, Schönenberger K, Barbakow F. ProTaper rotary root canal preparation: effects of canal anatomy on final shape analysed by micro CT. Int Endod J 2003;36:86-92.
3. Zhao D, Shen Y, Peng B, Haapasalo M. Micro-computed tomography evaluation of the preparation of mesiobuccal root canals in maxillary first molars with Hyflex CM, Twisted Files, and K3 instruments. J Endod 2013;39:385-8.
4. Giardino L, Ambu E, Becce C, Rimondini L, Morra M. Surface tension comparison of four common root canal irrigants and two new irrigants containing antibiotic. J Endod 2006;32:1091-3.
5. Mulay S, Ajmera K, Jain H. The wetting ability of root canal sealers after using various irrigants. J Orofac Sci 2017;9:95-8.
6. Lopes HP, De Faria AR, Alves FRF, Elias CN. Wettability of Irrigants used in Root Canal Treatment. Dentistry 2015;5:1-3.
7. Cameron JA. The effect of a fluorocarbon surfactant on the surface of the endodontic irrigant, sodium hypochlorite. A preliminary report. Aust Dent J 1986;31:364-8.
8. Dogan Buzoglu H, Calt S, Gumusderelioglu M. Evaluation of the surface free energy on root canal dentine walls treated with chelating agents and NaOCl. Int Endod J.2007;40:18-24.
9. Kumar G, Prabhu KN. Review of non-reactive and reactive wetting of liquids on surfaces. Adv Colloid Interface Sci 2007;133:61-89.
10. Kontakiotis EG, Tzanetakis GN, Loizides AL. A comparative study of contact angles of four different root canal sealers. J Endod 2007;33:299-302.
11. Grawehr M, Sener B, Waltimo T, Zehnder M. Interactions of ethylenediamine tetraacetic acid with sodium hypochlorite in aqueous solutions. Int Endod J 2003;36:411–7.
12. Hegde RJ, Bapna K. Comparison of removal of endodontic smear layer using ethylene glycol bis (betaamino ethylether)-N, N, N', N'-tetraacetic acid and citric acid in primary teeth: A scanning electron microscopic study. Contemp Clin Dent 2016;7:216-20.
13. Tartari T, Duarte Junior AP, Silva Junior JO, Klautau EB, Silva ESJMH, Silva ESJPA. Etidronate from medicine to endodontics: Effects of different irrigation regimes on root dentin roughness. J Appl Oral Sci 2013;21:409-15.
14. Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB, Bozhilov K, *et al.* A new solution for the removal of the smear layer. J Endod 2003;29:170-5.
15. Viswanath D, Hegde AM, Munshi AK. The removal of the smear layer using EGTA: A scanning electron microscopic study. J Clin Pediatr Dent 2003;28:69-74.
16. Hu X, Ling J, Gao Y. Effects of irrigation solutions on dentin wettability and roughness. J Endod 2010;36:1064-7.
17. Yılmaz Z, Aktemur S, Buzoglu HD, Gümüsderelioglu M. The effect of temperature and pH variations on the surface tension of EDTA solutions. J Endod 2011;37:825-7.
18. Mallya L, Acharya S, Ballal V, Prabhu N. A comparative study of contact angle of calcium hydroxide to root canal dentine using different vehicles: An in vitro study. Endodontology 2012;24:59-64.
19. Ballal NV, Tweeny A, Khechen K, Prabhu KN, Satyanarayan, Tay FR. Wettability of root canal sealers on intraradicular dentine treated with different irrigating solutions. J Dent 2013;41:556-60
20. Kastamonu U, Dergisi OF. Investigation of factors influencing on wood adhesion capability. Journal of Forestry 2018;18:99-107.
21. Kandlikar SG, Steinke M E. Contact angles and interface behavior during rapid evaporation of liquid on a heated surface. International Journal of Heat and Mass Transfer 2002;45:3771–80.
22. Jafari M and Jung M. Direct Measurement of Static and Dynamic Contact Angles using a Random Micromodel Considering Geological CO2 Sequestration. Journal of Sustainability 2017;9:2352.
23. Duncan-Hewitt W. Hydrophobic surfaces. In: Doyle R, Rosenberg M, editors. Microbial cell surface hydrophobicity. Comparative wettability of different sodium hypochlorite solutions 61 1st ed. Washington: American Society for Microbiology Press;1990.p.39-73.
24. Donskoi AA, Shashkina MA, Zaikov GE. Contact angle wettability and adhesion, 3. Philadelphia: Coronet Books;2003.p.67-91.
25. Gandhi P, Ballal NV, George JE, George SD, Narkedamalli RK. Effect of chelating agents on the wettability of BioRoot RCS and AH Plus sealers. Saudi Endod J 2020;10:100-5.