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AN INVITRO STUDY TO EVALUATE AND COMPARE SURFACE TENSION OF SYNTHETIC IRRIGANTS WITH AN ALCOHOL BASED HERBAL IRRIGANT

Endodontic

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ABSTRACT

Aim: To evaluate and compare the surface tension of commonly used root canal irrigants with newer irrigants.
Material and methods: The test solutions -Saline (control group), 3% Hyposol , Qmix and ethanolic neem extract were evaluated and compared for their surface tension. Test solutions of each group were divided into 15 samples of 50 ml each and surface tension was measured using the Du Nouy ring method with the help of Kruss Digital Tensiometer K9. Data was analysed using Kruskal Wallis to compare the mean surface tension between the study groups followed by Mann Whitney U test as the post hoc analysis.
Results: The highest surface tension was found in the saline group whereas lowest surface tension was found with the ethanolic neem extract.
Conclusion: Ethanolic neem extract has the least surface tension than the old and new synthetic irrigants, thus can penetrate deeper into dentinal structures and narrow canals.

KEYWORDS

Irrigants, surface tension, Qmix, ethanolic neem extract

INTRODUCTION:

A successful root canal treatment is achieved by the combined approach of instrumentation, irrigation and obturation. The primary function of an endodontic irrigant is to flush out the dentinal debris and residual tissues in the complicated and irregular structures like fins, lateral canals and apical delta, which is not achieved by mechanical debridement.[2,1] So, one or more efficient irrigants are to be used that possesses flushing action, lubrication, wide antimicrobial activity, lower toxicity and optimum physical-chemical properties like lower surface tension and higher wettability.[3,1]

Literature evidences that the number of infected tubules and depth of penetration of bacteria are highly variable and may range from 150 µm to 50 percent of the distance between the main root canal and cemento-dentinal junction.[1] Studies have also shown that the mesiobuccal root canal of the maxillary first molar reported an average of 40.0% -47.4% of untouched areas after instrumentation.[4] Hence the endodontic irrigants should have maximum contact with the canal wall to promote dissolution and to carry out its antimicrobial properties.[4] The intimacy of this contact depends on the wettability of the irrigant on solid dentin and this property of the liquid is strictly correlated to its surface tension.[3] To achieve optimal wettability, the surface energy of the substrate must be as high as possible and the surface tension of the liquid contacted with the substrate must be low as possible.[5]

In current dental practice irrigants like saline, sodium hypochlorite, EDTA, chlorhexidine have been used commonly based on their functionality but least importance have been given to the physico-chemical properties of these irrigants .

Saline, also known as saline solution is a mixture of sodium chloride in water. Normal saline is an isotonic solution to the body fluids and is being universally used as an irrigating material in all the surgical procedures. A concentration of 0.9% of saline is generally used in endodontics.[6] It lacks tissue dissolving and anti-bacterial property so it's used as intermediate flush between two irrigants.

Sodium hypochlorite, a straw coloured reducing agent, ranging in concentrations from 0.5% to 5.25% appears to be the most ideal, as it covers more of the requirements for endodontic irrigant than any other compounds. They are sporicidal and virucidal and show far greater tissue dissolving effects on necrotic than on vital tissues.[7] Newer generation 5.25% sodium hypochlorite solutions modified with surfactants , Hypoclean A and Hypoclean B have been introduced which have significantly lower surface tension than 5.25% sodium hypochlorite alone.[5]

Newer irrigants like MTAD and Qmix with surface active agents have been introduced with greater potentialities. QMiX, a non-antibiotic single solution contains EDTA, chlorhexidine (CHX) and a detergent (cetrimide) used as a final rinse after NaOCl for one-step smear layer removal and disinfection. This irrigant has demonstrated antibacterial activity comparable to NaOCl and superior activity against planktonic and biofilm bacteria compared to 2% CHX and MTAD.[8]

Constant increase in antibiotic resistance and side effects caused by synthetic irrigants shifted the research towards developing herbal alternatives.[9] They have become popular today due to their high antimicrobial activity, biocompatibility, anti-inflammatory and anti-oxidant properties. A wide variety herbal product has been used in the past in medicine.

Azadirachta indica (Neem) has anti-viral, anti-fungal, anti-bacterial and anti-carcinogenic activity makes it a potential agent for root canal irrigation. Being a bio-compatible anti-oxidant, use of neem is advantageous as it is not likely to cause the severe harms to patients that might occur through sodium hypochlorite accidents.[10]

Many studies have demonstrated that the commonly used irrigating solutions are not completely effective in removing hard and soft tissue debris.[2] But little information exist with respect to the surface tension of these solutions as a potential factor that may contribute to such inefficiencies.[1]

Therefore the purpose of this study is to evaluate and compare conventional root canal irrigants with newer irrigants.

MATERIALS AND METHODOLOGY

Preparation of ethanolic neem extract:

Mature neem leaves were collected washed and shade dried. Then the leaves were powdered and stored in an air tight container. 100 gms of neem powder were added to 100ml of ethanol. Mixture is macerated for one hour and the extract was strained through a fabric strainer for coarse residue. Extraction process was repeated again using coarse residue and 50 ml ethanol. Both the extracts were combined together and filtered through fast filter paper and stored in airtight container. The above procedure was used to prepare 750ml of ethanolic neem extract.

Preparation of the samples to be tested:

The sample solutions were categorized into 4 groups - GROUP A: Saline (Abaris Health care PVT. LTD), GROUP B: 3% Sodium hypochlorite(Prevest Dentpro PVT.LTD), GROUP C: Qmix (Dentsply

Tulsa), GROUP D: Ethanolic neem extract (Dogma Global, Bangalore).

Test solutions of each group were divided into 15 samples of 50 ml each and were tested to evaluate the surface tension. The temperatures of all groups were maintained at room temperature (25°C) during the study.

Surface tension analysis of the samples:
The surface tension analysis was done using the platinum ring method also called the Du Nouy ring method. Digital Tensiometer K9 (Kruss,Hamburg,Germany) was used to perform the technique. Before testing each sample, the platinum-iridium ring has to be immersed in acetone and wiped with dry, clean gauze and dried in a Bunsen burner.

Statistical Analysis:
The mean surface tension of each group has been calculated . Data were analysed with Statistical Package for Social Sciences [SPSS] for Windows, Version 22. Descriptive analysis of all study parameters was done using mean, standard deviation and the range. Kruskal Wallis test followed by Mann Whitney U test as the post hoc Analysis was used to compare the mean surface tension [in mN/m] between the four groups. The level of significance [P-Value] was set at P<0.05.

RESULTS :

Table 1: Mean Surface Tension Values For All Test Solutions

GROUPS	TEST SOLUTION	MEAN (mN/m)
Group A	Saline	69.2
Group B	3% Hyposol	57.6
Group C	Qmix	31.2
Group D	Ethanolic Neem Extract	26.2

Table 2 : Comparison of mean surface tension [in mN/m] between four study groups using Kruskal Wallis Test

Comparison of mean surface tension [in mN/m] between four study groups using Kruskal Wallis Test								
Groups	**N**	**Mean**	**SD**	**Std. Error**	**Min**	**Max**	**KW x^2**	**P-Value**
Saline	15	69.20	0.22	0.06	68.6	69.5	55.823	<0.001*
3% Hyposol	15	57.67	0.31	0.08	56.9	57.9		
Qmix	15	31.29	0.13	0.03	31.2	31.6		
E. Neem Ext.	15	26.25	0.09	0.02	26.1	26.4		

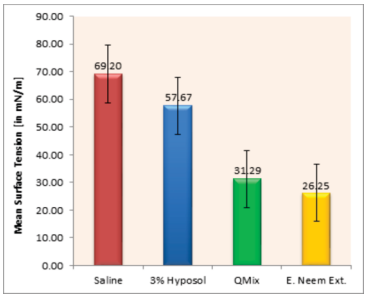
Table 3: Multiple comparison between different study groups by Post hoc method using Mann Whitney U test

Multiple comparison between different study groups by Post hoc method using Mann Whitney U test						
Group	GA Vs GB	GA Vs GC	GA VsGD	GB Vs GC	GB Vs GD	GC Vs GD
Mean Diff	11.53	37.91	42.95	26.38	31.42	5.04
P-Value	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

* - Statistically Significant

Note: GA - Saline, GB - 3% Hyposol, GC- Qmix, GD –Ethanolic Neem Extract

GRAPH 1: Comparison of mean surfaced tension between four study groups



The test results demonstrated a statistically significant difference in the mean surface tension scores between different study groups [P<0.001], with saline showing a mean surface tension of 69.20 ± 0.22, 3% Hyposol with 57.67 ± 0.31, QMix with 31.29 ± 0.13 & ethanolic neem extract, having 26.25 ± 0.09.

Multiple comparisons by post hoc analysis using Mann Whitney U test revealed that ethanolic neem extract demonstrated significantly least mean surface tension compared to other study groups at P<0.001, followed by QMix & 3% Hyposol. Contrastingly, a significantly higher mean surface tension score was found in Saline group compared to other study groups at P<0.001.

Hence we can infer that Ethanolic neem extract group has least surface tension, followed by Qmix & 3% Hyposol, however the reference group [saline group] showed relatively higher surface tension as compared to other test groups.

DISCUSSION:
The human root canal system is micro structure with anatomic complexities beyond our cognizance. The aim of performing endodontic therapy is to address these anatomic complexities as well as the main canal and eliminate the microorganisms by executing proper cleaning and shaping techniques.

During root canal treatment the clinician commonly encounters bifurcating canals, fins, deltas, loops, cul-de- sacs, inter-canal links, lateral and accessory canals in most teeth.[11] In such clinical situations it's impossible to access and instrument these aberrations and can be cleaned only through effective irrigation with suitable antimicrobial solution.[12] A proven theory for the cause of failure in root canal treatment is that the bacteria that invades deep into the dentinal tubules and accesory canals are protected from the action of instrumentation and the irrigants are only active on the walls of the main canal.[13] This prominences the importance of irrigation in removal of debris, bacteria, toxic products and substrates necessary for bacterial growth from the inaccessible and uninstrumented surfaces.[1] The quest for an ideal irrigating solution that possesses anti-microbial and tissue dissolving properties, biocompatibility with periradicular tissues and optimal physico-chemical properties continues to be a subject of many studies.[2]

Studies show that the efficacy of irrigating solutions can be increased by reducing their surface tension; hence increasing wettability and greater penetration of irrigants into the dentinal tubules.[4] Surfactants like polysorbate 80, tween 80, cetrimide, and propylene glycol are added to irrigants to achieve this property.

For a proper assessment of the surface tension of root canal irrigants, an accurate technique is of great importance.[1] In this study, the most widely used method for surface tension was applied, the Du Nouy ring method. The principle of the instrument depends on the fact that the force necessary to detach a ring immersed at the surface is proportional to the surface tension.[2] The advantage of the ring method is that it is prompt quick, uncomplicated and does not need to be calibrated using solutions of known surface tension. The ring used for measuring surface tension is made of an alloy of platinum and iridium with a precise geometry. Platinum iridium is the choice of material for the ring, as this alloy is optimally wettable due to its very high surface energy and therefore generally forms a contact angle θ= 0 with liquids. Additionally this material is chemically inert and easy to clean. This ring is very fine in structure and prone to deformations if not properly handled. Such deformations should be avoided and it must be ensured that the ring lies flat on a latent surface.The ring must be thoroughly cleaned using acetone or pure water and dried when using for the first time or after each use or when using a surfactant solution.This is because presence of small impurities or surfactants can cause a significant error in the measurement.

Another important parameter that has been taken into consideration in this study is the temperature of the sample solutions. Studies show that increasing the temperature of irrigants lowers its surface tension and increases its efficacy.[14] All the groups in this study were evaluated for surface tension at room temperature at the particular place. A temperature of 24.1°C was recorded as the room temperature using a powered digital electronic instrument Humitherm 842M (Instrument Research Associates PVT.LTD, Tamil Nadu).

The results of this study showed the surface tension in the following descending order:
Saline > Sodium Hypochlorite >Qmix>Ethanolic neem extract.

A significantly high surface tension was noted in the saline group. Sodium Chloride is a strong electrolyte and dissociates into sodium

cations Na^+ and Cl^- ions when placed in water. The sodium cations with partial negative oxygen and the chloride anions with partial positive hydrogens interacts resulting in more ionic component to over all hydrogen bond-dominated interactions between the water molecules, resulting in higher surface tension of the solution.[15] Even though saline is used as an intermediate flush, with high surface tension it won't be efficient enough to penetrate the narrow areas of the root canal to remove traces of synthetic irrigants like NaOCl, unless advanced irrigation techniques are used to facilitate this action.

Sodium hypochlorite, an irrigant with gold standards in endodontics showed a significantly higher surface tension but significantly lower than saline. A high surface tension value of 57.6 of 3% sodium hypochlorite , as seen in the present study could affect the ability of the solution to penetrate into dentine and thus reduce its antibacterial effectiveness within dentinal tubules.[5] By adding surfactants to NaOCl , the surface tension can be reduced from 57.6 to 33.1. Studies show that new generation sodium hypochlorite irrigants with surfactants demonstrated a more effective antibacterial action against E-faecalis than NaOCl alone.[5]

In the present study the newer irrigants showed significantly lower surface tension than the other two groups.

Qmix, the dual function irrigant which is highly recommended for its fast working and effective irrigation.[16]The surface active agent “cetrimide” present in Qmix reduces surface tension allows greater wettability and penetration into the root canal. Inspite of all these advantages, studies show that cetrimide can result in allergic contact dermatitis in hypersensitivity patients.[17] Furthermore, studies have also reported that chlorexihine resulted in hypersensitivity reactions in some patients.[18]

Due to the disadvantages among the synthetic irrigants, there is a paradigm shift in the phase of research towards ethnopharmacological approach in endodontic treatment. In the present study ethanolic neem extract was used and the surface tension was significantly lower than the other three groups. The neem has been recognised by the US National academy of sciences where neem is entitled as a tree for solving problems.[20] Biological activities and pharmacologic actions of neem are very well established with crude extracts and their different fractions from its leaf, bark, flowers, roots, seed and oil.[21] Using neem as an endodontic irrigant might be advantageous because of its biocompatibility to human periodontal ligament fibroblasts thus favouring its clinical application.[22] The bitter taste associated with this plant can be altered by different formulations by adding of sweeteners and flavours to increase the patience compliance and acceptibility.[23]

The present study showed a low surface tension value of 26 mN/m of the neem extract. This may due to the presence of ethanol used to prepare the neem extract, which has a very low surface tension. Ethanol is volatile, flammable, colourless liquid which is the principal type of alcohol found in alcoholic beverages. Ethanol kills organisms by denaturing their proteins and dissolving their lipids and is effective against most bacteria and fungi and many viruses but its ineffective against bacterial spores.[19] In a study done invitro it showed adding ethanol as a surface tension depressant to sodium hypochlorite significantly increased the ability of the irrigant.[20]It has also been shown that ethyl alcohol will spread when placed on a dentin surface. Thus a combination of neem and ethanol will help the irrigant to penetrate narrow canals and dentinal tubules to enable its antimicrobial action and can be an alternative to chemical irrigants.

The results of the present study showed that ethanolic neem extract had the lowest surface tension among all the tested irrigants which suggests that it shall be able to penetrate into the deeper structures of the root dentin and elaborate a vast array of biologically active compounds that are chemically diverse and hinder the vitality of the bacteria. However further research and clinical trials are required when herbal alternatives are used as endodontic irrigants.

REFERENCES:

1. Desai AV, Taneja S, Desai NA, Kumari P. Surface tension evaluation for different root canal irrigants: an in-vitro study. Int J Oral Care Res 2014;2(4):16-20.
2. Tasman F, Cehreli ZC, Ogan C, Etican I. Surface tension of root canal irrigants. J Endod. 2000;26(10) :586-7.
3. Giardino L, Ambu E, Becce C, Rimondini L, Morra M. Surface tension comparision of four common root canal irrigants and two new irrigants containing antibiotics. J Endod. 2006;32:1091-3.
4. Lopes HP, De Faria AR, Alves FRF, Elias CN. Wettability of irrigants used in root canal treatment. Dentistry.2015; 5: 283.
5. F. Palazzi, M. Morra, Z. Mohammadi, S. Grandini, L. Giardino. Comparison of the surface tension of 5.25% sodium hypochlorite solution with three new sodium hypochlorite-based endodontic irrigants. Int Endod J. 2012 Feb; 45(2): 129–135.
6. Qazi SS, Manzoor AM, Qureshi R, Khan HH. Comparison of postoperative pain — normal saline vs sodium hypochlorite as irrigants. Pak.oral dent.j. 2005;25(2).
7. Agrawal Vineet S, Rajesh M, Sonali K and Mukesh P. A contemporary overview of endodontic irrigants – a review. J Dent App. 2014;1(6): 105-115.
8. Giardino L, Andrade FB, Beltrami R. Antimicrobial effect and surface tension of some chelating solutions with added surfactants. Braz Dent J. 2016 Sep-Oct;27(5):584-588.
9. Arora T, Kang RS, Mann JS, Khurana NS, Aggarwal R, Walia G. Antimicrobial activity of herbal extracts against recalcitrant endodontic pathogens: An original in vitro study. Saint Int Dent J 2015;1:28-32
10. Pratishta J, Ranjan M. Role of herbs in root canal irrigation-A review. IOSR J Pharm Biol Sci 2014;9:6-10.
11. Tikku AP, Pandey PW, Shukla I. Intricate internal anatomy of teeth and its clinical significance in endodontics: A review. Endodontology 2012;24:160-9.
12. Carrotte P. Endodontics: part 4. Morphology of the root canal system. Br Dent J. 2004 Oct 9;197(7):379-83.
13. Berutti E, Marini R, Angeretti A. Penetration ability of different irrigants into dentinal tubules. J Endod. 1997;23:725–727.
14. Abou-Rass M, Patonai FJ Jr. The effects of decreasing surface tension on the flow of irrigating solutions in narrow rootcanals. Oral Surg Oral Med Oral Pathol. 1982; 53:524-526.
15. Chemical principles/atoms, molecules and ions. Available from https://en.wikibooks.org/w/index.php?title=Chemical_Principles/Atoms,_Molecules,_and_Ions&oldid=3225710 (accessed September 19, 2017)
16. Fouad AF. Endodontic Microbiology and Pathobiology. Dental Clinics of North America. 2017;61(1):1–15.
17. Lee JY, Wang BJ. Contact dermatitis caused by cetrimide in antiseptics. Contact Dermatitis. 1995;33(3):168–71.
18. Calogiuri GF, Di Leo E, Trautmann A, Nettis E, Ferrannini A, et al. Chlorhexidine Hypersensitivity: A Critical and Updated Review. J Allergy Ther 2013; 4:141.
19. Phaff, H. J., & Mrak, E. M. (2016). Ethyl alcohol. In AccessScience. McGraw-Hill Education. https://doi.org/10.1036/1097-8542.243400
20. Neelakantan P, Jagannathan N, Nazar N. Ethnopharmacological approach in endodontic treatment: A focused review. J Dr NTR Univ Health Sci. 2011; 3(4):68-77.
21. Biswas K, Ishita C, Ranajit KB, Uday B. Biological activities and medicinal properties of neem (Azadirachta indica). Curr Sci 2002;82:1336-45.
22. Subapriya R, Nagini S. Medicinal properties of neem leaves: a review. Curr Med Chem Anticancer Agents. 2005;5:149–6.
23. Behl H, Sidhu O, Kumar V, Singh D, Saimbi C. Efficacy of neem active metabolites for prevention of dental plaque and gingivitis. Neem Foundation 2002.