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EFFECT OF THREE DIFFERENT IRRIGATING SOLUTIONS ON HEAT TREATED NICKEL-TITANIUM ENDODONTIC ROTARY INSTRUMENTS- AN IN VITRO STUDY

Dentistry

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ABSTRACT

Aim: -The present study is aimed to evaluate and compare the effect of the corrosion susceptibility of Ni-Ti endodontic instruments immersed in 3% NaOCl, 17% EDTA and triphala both by visual inspection and by scanning electron microscopy.us **Material and Method:** - A total of 90 new neo endo-s rotary files were used in this study, and each selected file was 21 mm in length, with an ISO #25 tip size. All files were immersed in 3%NaOCl, 17% EDTA and triphala and immersion was terminated at three time points, namely 20 min, 45 min and 1 h. All files were taken out of each microtube and prepared for further analysis. Evaluation under scanning electron microscopy after being immersed in 3% NaOCl, 17% EDTA and triphala for each experimental period was carried out. **Statistical analysis:** - Statistical analysis was performed using Statistical package for local sciences. (SPSS) version 21 for windows. Data normality was checked by using Shapiro – Wilk test. Overall intergroup comparison among three groups was done using Chi square test followed by Tukey's post hoc test for pairwise intergroup comparison between each groups. **Results:** - Group A3 vs C3 (NaOCl 1hr vs Triphala 1hr) showed highly significant difference, Group A2 vs B2 (NaOCl 45 min vs EDTA 45 min), A3 vs B3 (NaOCl 1 hr vs EDTA 1hr), A2 vs C2 (NaOCl 45 min vs Triphala 45) showed significant difference. **Conclusion:** - In the present study time periods (20min, 45min and 1hr) were approximately similar to the single visit endodontic treatment in which triphala group shows less surface corrosion than other two irrigating solution. Due to the antibacterial property and less corrosive effect on files Triphala may be an alternative to the other two irrigating solutions.

KEYWORDS

Neo endo-s rotary files, 3% NaOCl, 17% EDTA and triphala

INTRODUCTION: -

The primary goal of root canal treatment is to improve disinfection of the root canal system to prevent or eliminate apical periodontitis. Disinfection of root canal is achieved through chemo-mechanical instrumentation, which includes mechanical debridement of the root canal walls by using endodontic files and chemical irrigation by different irrigating solution.[1] In 1988, Walia et al proposed the use of a nickel-titanium (NiTi) alloy called nitinol for the manufacturing of endodontic instruments characterized by excellent mechanical properties such as superelasticity and shape memory. The endodontic treatment had great benefits from the development of NiTi rotary instruments because of their increased taper that allows an easier and more efficient root canal preparation.[2] Proponents of NiTi rotary file instrumentation generally recommend the use of files with a greater taper than conventional stainless steel hand files as well as preparations that include the full working length of the canal.[3] The approximately equiatomic Ni–Ti alloy used in the manufacture of rotary endodontic instruments exhibits two special characteristics: the shape memory effect (SME) and superelasticity (SE), in which the metal, deformed in an apparently permanent way, recovers its original shape when heated – SME, or after the stress removal– SE. Both effects in Ni–Ti alloys are related to the transformation of austenite, to martensite.

This phase transformation is known as thermoelastic, which can be induced by cooling or by the application of stress. When the metal is heated it regains its original shape (SME) or the stress is released (SE), the reverse transformation, martensite to austenite, takes place. [4] Surface corrosion could influence mechanical properties of rotary Ni-Ti files and lead to undesirable fracture during root canal instrumentation. [5] The release of nickel ions caused by corrosion in endodontic instruments extruded to the periradicular region causes unwanted reactions and corresponds to the corrosion rate. Nickel cannot be metabolized in the body and it is known as a haematotoxic, immunotoxic, neurotoxic, genotoxic, reproductive toxic, pulmonary toxic, nephrotoxic, hepatotoxic, and carcinogenic agent. [6]So files with least corrosion susceptibility are desirable.

Neo endo S rotary file is designed to have a special S-shaped cross-section. This allows the least radial wall contact which relocates to reduced stress on the file. In addition, the excellent upward debris forecasting ensures that the debris isn't pushed apically or packed into the apical third. Further, proprietary heat treatment make sure that the file remains highly flexible and resistant to fracture. The file has cross-section of the alphabet. The cutting efficiency is increased by the two-blade cutting surface. Proprietary heat treated NiTi wire with high fracture resistance. [7]

NaOCl is corrosive to metals. The corrosion patterns, involve selective removal of nickel from the surface which can create micropitting (Sarkar et al. 1983). It is supposed that these microstructural defects leads to formation of cracks, areas of stress collection and weakening the structure of the instrument (Oshida et al. 1992). The effect of NaOCl on the corrosion of NiTi instruments has been studied (Busslinger et al. 1998, Haikel et al. 1998, Stokes et al. 1999); despite minor signs of corrosion being detected. [8]

Nygaard — Ostby introduced ethylene diamine tetraacetic acid (EDTA) to the field of endodontics, in 1957, and recommended the use of 15% EDTA solution with a pH of 7.3. Since then, EDTA has been used as the most common chelating solution, which reacts with calcium ions in dentin and form soluble chelates.[9]

Triphala (*tri* _ three, *phala* _ fruits) is a mixture of fruits of three plants: *Terminalia chebula*, *Terminalia bellerica* and *Phyllanthus emblica* or *Emblica officinalis* in powdered form in equal proportions (1:1:1). [10] Triphala is effective on the treatment of headaches, constipation and hepatic disorders. Studies has shown that it can be used in endodontics as root canal irrigant. In comparison to commonly used root canal irrigants, it is safe and is composed of compounds with proper physiologic effects in addition to its anti-oxidative and anti-inflammatory properties. Benefits of triphala are easy access, low cost, long-term substantivity, less toxicity and absence of microbial resistance. [11] Triphala has shown the most significant antibacterial efficacy against the *Enterococcus fecalis* biofilm. [9] The aim of this study was to evaluate and compare the corrosion susceptibility of a Ni-Ti endodontic instruments immersed in 3% NaOCl, 17% EDTA and Triphala solution by scanning electron microscopy (SEM).

MATERIALS AND METHOD:-

- A total of 90 files (21mm, 25/ 6%) from neoendo-s rotory file

system were selected. Samples were divided into 3 groups (30 in each group)

- There were three main groups of solutions A, B and C, NaOCl, EDTA and Triphala respectively which were further divided into 3 subgroups on the basis of time periods 20 min, 45 min and 1hr.
- 90 Flat-top 2.0-mL polypropylene microtubes (Fisher Scientific, Hampton, NH, USA) were filled with 1.0 mL of 3% NaOCl, 17% EDTA and Triphala solution.
- Triphala powder was dissolved in 10% dimethylsulfoxide to prepare an irrigation solution at a concentration of 5 mg/ml.
- Each file was placed in an individual tube and approximately 18mm of the file, including the flute and shaft, was immersed in the irrigating solutions. The lid of the tube was left open.
- The handle of the file was left unexposed. All microtubes was placed in an incubator at 37 ˚C during the experimental times to simulate the temperature at which 3%NaOCl, 17% EDTA and Triphala solution is found in the root canals in a clinical situation.
- File immersion was terminated at three time points, namely 20 min, 45 min and 1h. (Fig 1,2,3) Examining the files at each time point, files were taken out of each microtube and prepared for further analysis.
- After being immersed in 3% NaOCl, 17% EDTA and Triphala solution for each experimental period, each file was taken out of the microtube, and rinsed in distilled water twice, and allowed to air-dry at room temperature overnight.
- All files from each group were then examined using SEM.

Fig 1 20 min (A1), 45 min(A2), 1hr (A3)

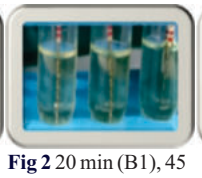


Fig 2 20 min (B1), 45 min(B2), 1hr (B3)

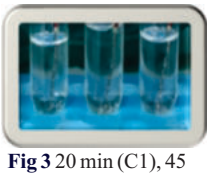


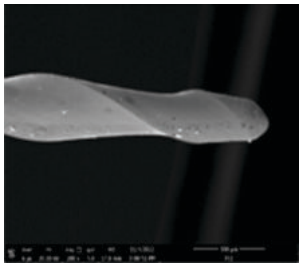
Fig 3 20 min (C1), 45 min (C2), 1hr (C3)

RESULT:-

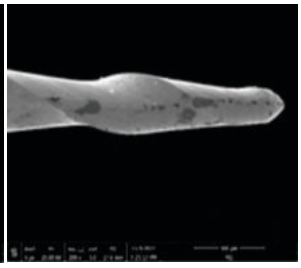
The results of the SEM analysis showed that group A2 and B2 (NaOCl 45 min vs EDTA 45 min), group A3 and B3 (NaOCl 1 hr vs EDTA 1hr) and A2 and C2 (NaOCl 45 vs Triphala 45 min) are showing significant difference in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation while group A3 and C3 (NaOCl 1hr vs Triphala 1hr) showed highly significant difference among the groups. [Table 3]. Descriptive statistics of effect of 3% NaOCl, 17% EDTA and triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation. [Table 1]

Overall intergroup comparative statistics of effect of 3% NaOCl, 17% EDTA and Triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation. [Table 2].

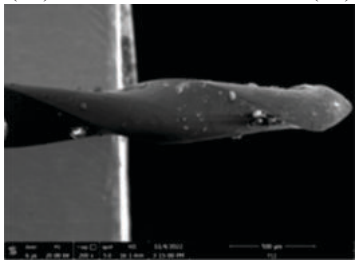
The all subgroups of group B and C showed no significant difference among them.



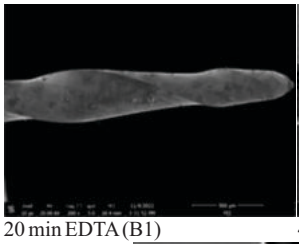
20 min NaOCl (A1)



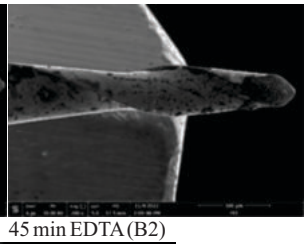
45 min NaOCl (A2)



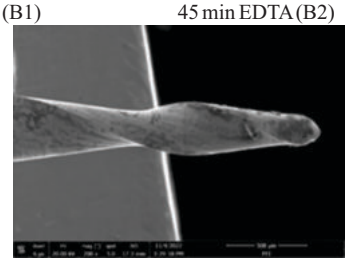
1 hr NaOCl (A3)



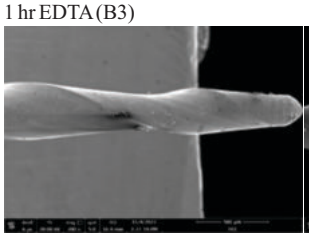
20 min EDTA (B1)



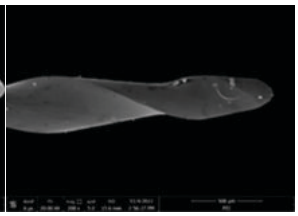
45 min EDTA (B2)



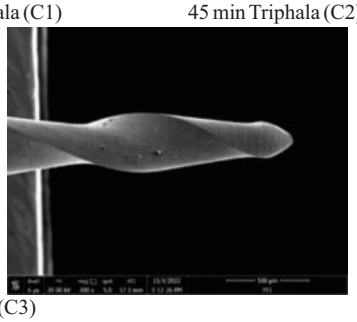
1 hr EDTA (B3)



20 min Triphala (C1)



45 min Triphala (C2)



1 hr Triphala (C3)

Table 1: Descriptive statistics of effect of 3% NaOCl, 17% EDTA and triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation.

% precipitate	20 min n (%)	45 min n (%)	1 hour n (%)
Group A (3%NaOCl)	4/10 (40%) (A1)	7/10 (70%) (A2)	9/10 (90%) (A3)
Group B (17% EDTA)	2/10 (20%) (B1)	4/10 (40%) (B2)	5/10 (50%) (B3)
Group C (Triphala)	2/10 (20%) (C1)	4/10 (40%) (C2)	4/10 (40%) (C3)

Table 2: Overall intergroup comparative statistics of effect of 3% NaOCl, 17% EDTA and Triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation

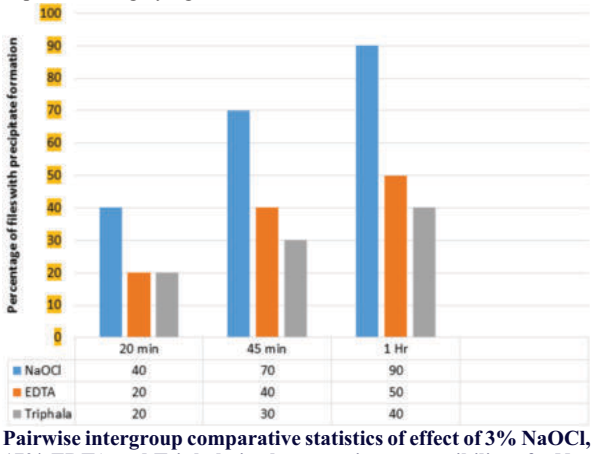
% precipitate	20 min n (%)	45 min n (%)	1 hour n (%)
Group A (3%NaOCl)	4/10 (40%) (A1)	7/10 (70%) (A2)	9/10 (90%) (A3)
Group B (17% EDTA)	2/10 (20%) (B1)	4/10 (40%) (B2)	5/10 (50%) (B3)
Group C (Triphala)	2/10 (20%) (C1)	3/10 (30%) (C2)	4/10 (40%) (C3)
Chi square test	Chi = 2.19	Chi = 8.19	Chi =14.97
p value, Significance	p =0.371 (NS)	p = 0.03*	p<0.001**

p>0.05 – not significant
*p<0.05 – significant
**p<0.001 – highly significant

Table 3: Pairwise intergroup comparative statistics of effect of 3% NaOCl, 17% EDTA and Triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation

% precipitate	20 min n (%)	45 min n (%)	1 hour n (%)
Group A (3%NaOCl)	4/10 (40%) (A1)	7/10 (70%) (A2)	9/10 (90%) (A3)
Group B (17% EDTA)	2/10 (20%) (B1)	4/10 (40%) (B2)	5/10 (50%) (B3)
Group C (Triphala)	2/10 (20%) (C1)	3/10 (30%) (C2)	4/10 (40%) (C3)
Group A (3%NaOCl) vs Group B (17% EDTA)	p =0.168 (1)	p =0.006* (2)	p =0.001* (3)
Group A (3%NaOCl) vs Group C (Triphala)	p =0.168 (1)	p =0.002* (2)	p<0.001** (3)
Group B (17% EDTA) vs Group C (Triphala)	p =1.000 (1)	p =0.487 (2)	p =0.372 (3)

p>0.05 – not significant
*p<0.05 – significant
**p<0.001 – highly significant



Pairwise intergroup comparative statistics of effect of 3% NaOCl, 17% EDTA and Triphala in the corrosion susceptibility of a Neo endo S rotary file in terms of percentage of files with precipitate formation.

DISCUSSION: -

NiTi alloy has been found to be prone to corrosion in certain media. The primary type of corrosion is pitting corrosion that is a localized attack occurring on passive metals in chlorine-containing media. Corrosion of endodontic instruments can occur during chemo mechanical preparation, chemical disinfection or sterilization as a result of the action of chemical substances. [12] The NiTi used for manufacturing the endodontic files was not an equiatomic alloy (i.e. Ti, 46 atomic %; Ni, 54 atomic %) in the martensitic phase, with a homogeneous structure. [13] Busslinger et al.(1998) found measurable release of titanium when light speed NiTi files were immersed in NaOCl solution for 30 and 60 min, but were not sure of the clinical implication. Haikel et al (1998) found no significant effect on NiTi files after they were subjected to NaOCl treatment for 12 to 48 hrs. [14] The lowest corrosion rate of stainless-steel files was observed in17% EDTA solution. EDTA forms complexes with metal ions (Fe, Ni, Cr, Co, etc.) at pH values <4. EDTA's ability to protect and passivate instruments is due to its ability to complex with iron to form an inhibiting barrier to oxidation and corrosion (Reinhard et al. 1992, Skoog et al.1992).[15]Bonaccorso et al. (2008) confirmed that long-term EDTA contact did not alter the surface structure of files.[16]

Triphala showed more potency on E. faecalis biofilm. This may be attributed to its formulation, which contains three different medicinal plants in equal proportions. In such formulations, different compounds may be of help in enhancing the potency of the active compounds resulting in an additive or synergistic positive effect. [17] A Study conducted by Pramod Siva Prasad et al (2014) on to use Atomic Force Microscope and Energy Dispersive X-ray Spectroscopy to evaluate the effect of 5% NaOCl, 17% EDTA and triphala on ProTaper and iRaCe rotary Ni-Ti instruments. In this study it has shown that Sodium hypochlorite and EDTA immersed iRaCe files have shown a significantly higher surface roughness values when compared to the Triphala immersed iRaCe files. The fact that triphala is a less reactive hydrocarbon compound when compared to other study irrigants could be a reason for this difference.[9]

There are many studies on triphala which showed that triphala was more effective on E. faecalis cultures, indicating stronger antibacterial activity. It was very successful and nearly as effective in removing the smear layer. When compared to 5% NaOCl and 17% EDTA, Triphala showed reduced degradation in the microhardness of root dentin in a study by Vaishnavi Elika et al. When triphala was employed as an irrigant, Mahsa et al. found that there was no drastic reduction in microhardness of root canal dentin. The citric acid in triphala fruits, which acts as a mild chelating agent, could be the most likely cause of this effect. [18] There are very few studies on the effect of surface roughness of triphala solutions on rotory instruments. Therefore from this study we can conclude that Triphala can be a better option for endodontic irrigation. As it has shown less corrosion effect and also it has a good antimicrobial properties.

CONCLUSION:-

However, all immersion periods (20 min,45 min,1hr), which more closely approximate clinical conditions during one single root canal therapy, seem to show less surface corrosion across EDTA and Triphala experimental groups than NaOCl.

Due to the less corrosive effect and good antibacterial activity triphala may be considered as better irrigating solution for endodontic treatment.

REFERENCES:

1. Lin JH, Karabucak B, Lee SM. Effect of sodium hypochlorite on conventional and heat-treated nickel-titanium endodontic rotary instruments–an in vitro study. Journal of dental sciences. 2021 Mar 1;16(2):738-43.
2. Plotino G, Costanzo A, Grande NM, Petrovic R, Testarelli L, Gambarini G. Experimental evaluation on the influence of autoclave sterilization on the cyclic fatigue of new nickel-titanium rotary instruments. Journal of endodontics. 2012 Feb 1;38(2):222-5.
3. Hilfer PB, Bergeron BE, Mayerchak MJ, Roberts HW, Jeansonne BG. Multiple autoclave cycle effects on cyclic fatigue of nickel-titanium rotary files produced by new manufacturing methods. Journal of endodontics. 2011 Jan 1;37(1):72-4.
4. Viana AC, Gonzalez BM, Buono VT, Bahia MG. Influence of sterilization on mechanical properties and fatigue resistance of nickel–titanium rotary endodontic instruments. International Endodontic Journal. 2006 Sep;39(9):709-15.
5. Valois CR, Silva LP, Azevedo RB. Multiple autoclave cycles affect the surface of rotary nickel-titanium files: an atomic force microscopy study. Journal of Endodontics. 2008 Jul 1;34(7):859-62.
6. Oktavia E, Abidin T, Dennis D. Effect of sodium hypochlorite, EDTA, and chitosan solution on corrosion and quantity of extruded nickel ions using two rotary instruments (in vitro). J Dent. 2019 Jun 1;10(3):207-13.
7. Tomer AK, Cecilia LL, Mushtaq H, Tyagi A, Singh S, Sabharwal G. EVALUATE AND COMPARE THE CYCLIC FRACTURE RESISTANCES OF THREE DIFFERENT NI-TI ENDODONTIC FILE SYSTEM-AN INVITRO STUDY. transportation.;1:2.
8. Berutti E, Angelini E, Rigolone M, Migliaretti G, Pasqualini D. Influence of sodium hypochlorite on fracture properties and corrosion of ProTaper Rotary instruments. International endodontic journal. 2006 Sep;39(9):693-9.
9. Prasad PS, Sam JE, Kumar A. The effect of 5% sodium hypochlorite, 17% EDTA and triphala on two different rotary Ni-Ti instruments: An AFM and EDS analysis. Journal of conservative dentistry: JCD. 2014 Sep;17(5):462.
10. Jagetia GC, Malagi KJ, Shrinath Baliga M, Venkatesh P, Veruva RR. Triphala, an ayurvedic rasayana drug, protects mice against radiation-induced lethality by free-radical scavenging. Journal of Alternative & Complementary Medicine. 2004 Dec 1;10(6):971-8.
11. Shakouie S, Eskandarinezhad M, Gasemi N, Milani AS, Samiei M, Golizadeh S. An in vitro comparison of the antibacterial efficacy of triphala with different concentrations of sodium hypochlorite. Iranian endodontic journal. 2014;9(4):287.
12. Fayyad DM, Mahran AH. Atomic force microscopic evaluation of nanostructure alterations of rotary N i T i instruments after immersion in irrigating solutions. International endodontic journal. 2014 Jun;47(6):567-73.
13. Haïkel Y, Serfaty R, Wilson P, Speisser JM, Allemann C. Mechanical properties of nickel-titanium endodontic instruments and the effect of sodium hypochlorite treatment. Journal of Endodontics. 1998 Nov 1;24(11):731-5.
14. O'hoy PY, Messer HH, Palamara JE. The effect of cleaning procedures on fracture properties and corrosion of NiTi files. International endodontic journal. 2003 Nov;36(11):724-32.
15. Akman AA, Zaimoglu L, Bilgic S. Corrosion rates of stainless-steel files in different irrigating solutions. International endodontic journal. 2002 Aug 1;35(8):655-9.
16. Ametrano G, D'Antò V, Di Caprio MP, Simeone M, Rengo S, Spagnuolo G. Effects of sodium hypochlorite and ethylenediaminetetraacetic acid on rotary nickel–titanium instruments evaluated using atomic force microscopy. International endodontic journal. 2011 Mar;44(3):203-9.
17. Prabhakar J, Senthilkumar M, Priya MS, Mahalakshmi K, Sehgal PK, Sukumaran VG. Evaluation of antimicrobial efficacy of herbal alternatives (Triphala and green tea polyphenols), MTAD, and 5% sodium hypochlorite against Enterococcus faecalis biofilm formed on tooth substrate: an in vitro study. Journal of endodontics. 2010 Jan 1;36(1):83-6.
18. Sebastian SM, Christabel SL, Claribel SM, Mukundan PE. Triphala in Endodontics-A Review. Triphala in Endodontics-A Review. 2022.