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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF THE DISSOLVING EFFECT OF RC SOLVE, EUCALYPTUS OIL AND G-SOL ON AH PLUS ROOT CANAL SEALER – AN INVITRO STUDY

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Abstract

Context: Use of root canal solvents has increased the success rate of endodontic retreatment and it has made the procedure faster and simpler.

Aims: During retreatment, a solvent facilitates the removal of obturation material and root canal sealer by softening it, so as to obtain a root canal free of debris and microorganisms. Hence an invitro study was done to evaluate and compare the dissolving effect of RC Solve, Eucalyptus oil and G-sol on AH Plus Root Canal Sealer.

Methods and Material: Thirty standardized stainless-steel rings filled with AH Plus sealer manipulated according to manufacturer's instructions were prepared and placed ten minutes for complete setting in an incubator at 37°C for 48 hours and weighed to obtain the initial weight. The samples were divided into three equal groups of 10 each and immersed in RC Solve, Eucalyptus oil and G-sol for 10 minutes and dried in an incubator at 37°C for 24 hours and weighed again for final weight. The amount of sealer lost was determined by calculating the difference between initial and final weight.

Results: The dissolving effect of AH Plus sealer on all three solvents showed a marked amount of weight loss ($p<0.05$). The best dissolving capability on AH Plus sealer was exhibited by Eucalyptus oil followed by RC Solve and least for G-Sol. The result of the ANOVA with a p-value of 0.004 indicated a significant difference of weight change of AH Plus sealer after immersion into RC Solve, Eucalyptus Oil and G-Sol.

Conclusions: Based on the findings of this study, it was concluded that Eucalyptus oil has a slightly better solvent effect.

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Introduction:-

The main purpose of nonsurgical endodontic retreatment is an attempt to restore healthy periapical tissues due to reinfection of an obturated root canal system because of apical or coronal leakage or after incompetent treatment (Stabholz A et al., 1988). During retreatment, a solvent can facilitate the removal of obturation material (i.e., gutta percha) by softening it. However, it is important to remove the root canal sealer to obtain a root canal free of debris and microorganisms which may be the primary cause of endodontic failure (Torabinejad., 1990).

The utility of organic solvents has been expected to reduce the resistance of obturating materials in the canal so that their removal will be simple along with instrumentation (YadavHK et al., 2016). Organic solvents have been used for a long period of time as the principal method of gutta-percha removal and are most effective chemical substances to dissolve the endodontic filling material (Martos J et al., 2006).

There are many solvents that are commonly used. Some studies have shown that chloroform has best dissolving effect when compared to other solvents such as eucalyptol, halothane or xylol, but the potential carcinogenic nature of chloroform is the reason why the U.S Food and Drug Administration has prohibited it (Schäfer E et a., 2002). Xylene though not a potential carcinogen, however it is very toxic to the tissues. So, in this study three organic solvents which is non-toxic to tissues has been used.

RC Solve liquid is a derivative of orange oil, that is indicated for dissolving gutta-percha and root canal sealers (BediHarsheen et al., 2018). Eucalyptus oil is extracted from the leaves of Eucalyptus globulus; a plant from the family Myrtaceae native to Australia and it is cultivated worldwide (Magalhães BS et al., 2007). G-sol is a D-limonene based gutta percha solvent for removal of gutta percha and root canal sealants. To date, no study has been done with G-sol solvent.

AH Plus root canal sealer is the one of the commonly used sealer presently, hence we have used this sealer in our study. It has low solubility, small degree of expansion, adhesion to dentin, and very good sealing ability. Due to these excellent properties AH Plus is considered as the "Gold Standard" (Ali Kangarlou et al., 2016).

This study uses organic solvents for effective cleaning and disinfection. This is done with an objective of cleaning canal walls and apical ramifications from sealers. The aim of this study is to evaluate and compare the dissolving effect of RC Solve (Prime Dental, India), Eucalyptus oil (Ashwin Chemicals and Pharmaceuticals) and G-sol (MAARC, India)on AH Plus Root Canal Sealer (Dentsply, USA).

Subjects and Methods:-

Epoxy resin-based AH Plus root canal sealer (Dentsply, USA) was used in this study. Standardized stainless-steel rings with a diameter of 8 mm and height of 2 mm was used in this study. The stainless-steel rings were placed over a microscopic glass slide and the sealer cement was mixed according to the manufacturer's instructions and was placed inside the rings. To make the surface flat a microscopic glass slide was pressed on the upper surface of the ring (Fig 1). The rings were labelled as 'Ring 1' to 'Ring 30'.

Ten minutes after mixing, the samples were placed inside an incubator (Cultura, Ivoclar vivadent) with a temperature of 37°C for 48 hours for complete setting of the material. (Fig 2) After 48 hours, the microscopic glass slides were removed and excess material surrounding the stainless-steel rings was removed and cleaned using a scalpel blade.

The weight of the samples was measured in grams (up to four decimal places) using a digital weighing scale before immersing the sample into the solvent to obtain the initial weight(w1)(Fig 3). The samples were weighed for 3 times and the mean value was calculated.

Thirty samples of rings with AH Plus sealer were prepared and then it was divided into three equal groups.

In Group I, the sealer sample was immersed in 10 ml of RC Solve (Prime Dental, India) for a 10 minutes immersion period. The same procedure was done in Group II, where Eucalyptus oil (Ashwin Chemicals and Pharmaceuticals) was used and in Group III, G-sol (MAARC, India) was used. Each sample was kept in separate glass vials. (Fig 4)

After 10 minutes, the samples were taken out from the glass vial using tweezers, and the samples was washed using 100 mL of distilled water and then dried using an absorbent paper. Then the samples were allowed to dry by placing it again in the incubator at 37°C for 24 hours.

The sample was weighed again using the same weighing scale for the final weight(w2). The samples were again weighed for 3 times and the mean value was calculated.

The difference between the initial and final weight (w1-w2) was calculated to determine the total amount of sealer lost from each sample.

All data was entered into a Microsoft Office Excel (version 2016) in a spreadsheet which was prepared and validated for the data form. The change in sealer weight before immersion and after immersion within each group was analysed using paired t-test. The weight loss of sealers after immersion was compared between the three solvents using One-Way Analysis of Variance (ANOVA) followed by post-hoc pairwise comparisons using Tukey-Kramer test method. All testing was done using two-sided tests at alpha 0.05 (95% confidence level). Thus, the criteria for rejecting the null hypothesis was 'p' value of <0.05.

Results:-

The dissolving effect of AH Plus sealer on all three solvents showed a significant amount of weight loss ($p<0.05$). Dissolution means and standard deviations recorded for AH Plus sealer immersed in different solvents are summarized in Table 1.

The best dissolving capability on AH Plus was exhibited by Eucalyptus oil followed by RC Solve and least for G-Sol. The result of the ANOVA with a p-value of 0.004 indicates a significant difference of weight change of AH Plus sealer after immersion into RC Solve, Eucalyptus Oil and G-Sol. (Graph 1)

Discussion:-

The success of any root canal treatment is mostly determined by having a good coronal and apical seal that with the help of endodontic sealers. Thus, endodontic sealers are used to fill the space between dentinal walls and the obturating core interface. Apart from that, sealer is important in establishing a fluid tight or hermetic seal throughout the canal including apical foramen and canal irregularities (Zheoul HM et al., 2013).

The American Association of Endodontists has published guidelines that may help the clinician with clinical decision making of whether nonsurgical or surgical endodontic treatment should be undertaken (American Association of Endodontists, 2004). However, the choice of which option to undertake will be determined by the clinician's experience, knowledge, patient considerations, and the preoperative diagnosis. The choice of nonsurgical retreatment versus apical surgery becomes the focus of the decision in most instances. Outcomes assessment studies provide some help in making this decision. The reported healing rates of nonsurgical retreatment range between 74% and 98%, (Friedman S et al., 2004) but with apical surgery alone, only 59% heal completely (Orstavik D et al., 2008). In general, nonsurgical retreatment can be the preferred choice, since it seems to provide the most benefit with the lowest risk.

The removal of root canal obturating materials by only mechanical means during nonsurgical endodontic retreatment can result in root perforation, canal straightening, or change the original canal outline. The decrease in the resistance of obturating materials inside the canal can be brought about by the use of solvents. This enables easier retrieval of the obturating materials along with instrumentation (Martos J et al., 2006).

Some of the solvents used for dissolution are as follows: Chloroform, Xylene, Halothane, Eucalyptol oil, Orangewood oil, Turpentine oil, Pandine needle oil etc. Although chloroform is recognized as one of the most effective solvents, it is classified as a group 2B carcinogen (International Agency for Research on Cancer, 1987). This led the scientists to develop alternative solutions. Xylene is chlorinated hydrocarbon commonly considered as gutta percha solvent. Xylene causes gastrointestinal distress, irritation of mucous membranes and eyes, chemical pneumonitis, toxic hepatitis when ingested, cytotoxic reaction when extruded periapically, haemorrhages in air spaces when inhaled. Hence, the use of essential oils in endodontics is growing because it is safe, biocompatible, and noncarcinogenic.

RC Solve which is a derivative of orange oil does not irritate the soft tissues or periapical areas. It also provides pleasant orange fragrance and has a slow rate of evaporation(BediHarsheen et al., 2018). Eucalyptus oil is extracted from the leaves of Eucalyptus globulus. The major constituent ofEucalyptus oil is 1,8-cineole. It exhibits anti-inflammatory and antibacterial properties(Magalhães BS et al., 2007). G-sol is a D-limonene based solvent. Based on natural substances, d-limonene is found in the peels of citrus fruits and refined from orange oil and does not cause irritation to the oral mucosa and periapical tissues.

The results of the present study indicate that AH Plus sealer was soluble to some degree in all three solvents. Eucalyptus oil followed by RC Solve was the more effective solvent on AH Plus sealer followed by G-sol (Table 1). No standardized specification has been mentioned for the measurement of root canal sealer solubility in organic solvents. Hence this study uses similar methods that have been used in previous studies(Yadav HK et al., 2016; Martos J et al., 2006).It has been reported by many studies that the removal of well-compacted obturating materials with or without solvents using instrumentation takes mean time of 1.5–10.8 min (Whitworth JM et al., 2000) therefore time period of 10 min was chosen in this study. In this study, the stainless-steel rings were used instead of extracted tooth because it would be difficult to obtain a standardized root canal length and diameter. Furthermore, the stainless-steel rings are stable and they are not affected by the dissolving effect of the solvents. These factors make the relative weight changes absolute (Azah Binti Zainal Abidin et al., 2016).The sealer sample was used only once to enhance the accuracy of the measurements this helped in eliminating the issue of undesirable weight loss which arisesdue to repeated drying and immersion. All samples were washed with distilled water after the specified immersion period to remove the decomposed loosen debris(BediHarsheen et al., 2018).

The result in our study is similar to other previous studies(Yadav HK et al., 2016; Martos J et al., 2011).In those studies, Eucalyptus oil and orange oil has similar dissolving ability. In this study G-sol shows less solubility when compared to other two solvents but this contradicts the result by Uemura et al in which difference in the solubility of d-limonene and eucalyptus oil is not significant (Uemura M et al., 1997). Ring et al. (2009) found that orange oil and chloroform had similar results against AH Plus and RealSeal (Ring J et a., 2009). Bodrumlu et al. reported that eucalyptus oil or chloroform dissolved Epiphany and AH Plus to the same extent (Bodrumlu E et a., 2008). Magalhães et al. stated that the best dissolving effect was shown by xylol whereas eucalyptol, chloroform and orange oil showed similar dissolving effect (Magalhães BS et al., 2007).All this indicates that both eucalyptol and orange oil could be suitable as solvents for softening or dissolving the endodontic sealers. The solubility of AH Plus sealer can be explained by a SEM analysis done by Ferreira et al to clarify the action of the solvents. The surface topographic changes caused by chloroform and MEK affected mainly the organic component of the AH Plus sealer, either through its dissolution or structural changes, confirmed by XRD analysis (Ferreira I et al., 2017).

Some of the drawbacks of the present study are the extrapolation of the immersion model to clinical scenario because in the invitro model there is a full surface contact of sealer with the solvent whereas in the clinical situation, the sealer is attached to the root canals walls and only partially exposed to the effect of the solvents and we did not consider the clinically imposed parameters such as temperature, access, canal system anatomy, volume of exchange, dilution or displacement by irrigants or biological fluids regarding the action of solvents on root canal sealers. Therefore, the result cannot be directly extrapolated to clinical scenarios. Till now an ideal solvent has not been found. Therefore, the search for more effective and biocompatible universal solvent needs to continue.

RC SOLVE	**0.0229 ± 0.0083**
EUCALYPTUS OIL	**0.0259 ± 0.0082**
G-SOL	**0.0094 ± 0.0070**

Table 1:- Mean value in percentage with standard deviation (±) of weight loss for AH Plus sealer in three different organic solvents

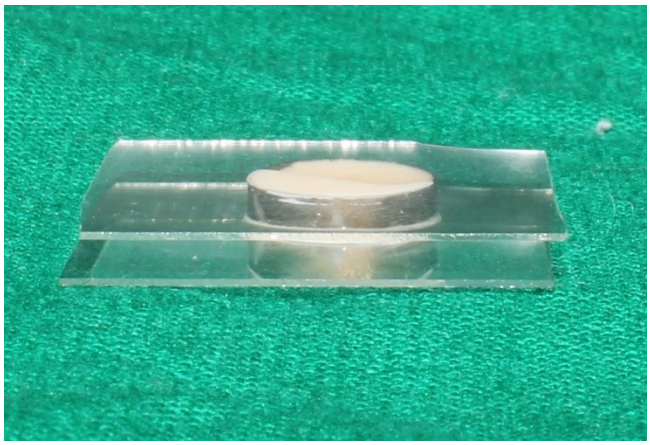


Figure-1:- Prepared Sealer Sample.

Figure-2:-Sealer samples in incubator.

Figure 3:- Measurement of sealer sample in a digital weighing scale.

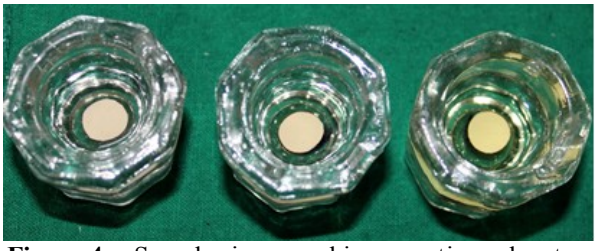
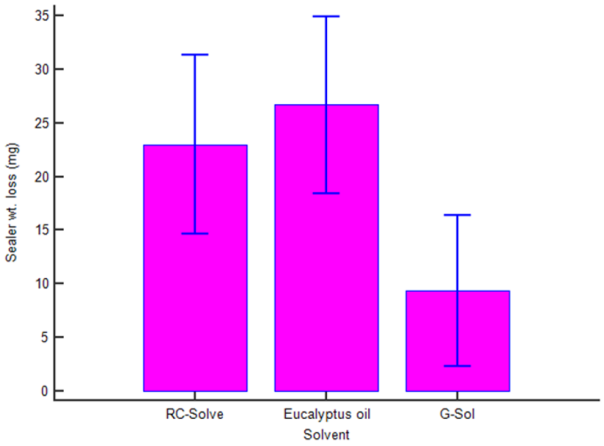


Figure 4: - Samples immersed in respective solvents.



F-ratio	6.836
Significance level	P = 0.004

Graph 1:- Dissolution of AH Plus sealer in different organic solvents.

Conclusion:-

Within the limitations of this study, the following can be concluded:

1. No significant difference was seen in the solvent behaviour of RC Solve and Eucalyptusoil.
2. Eucalyptus oil presented a slightly superior solvent effect.
3. Insignificant sealer dissolution was observed when G-Sol was used

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