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Comparative evaluation of dissolving efficacy of different solvents on MTA based endodontic sealer with and without ultrasonic activation: An in vitro study

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Abstract: *Background aim:- The main purpose of this study was to compare and evaluate the dissolving efficacy of various endodontic solvents used in retreatment cases, on mta-based sealer at different immersion time interval associated with and without ultrasonic agitation of solvent.*

Material and methods:- The solubility of mta- fillapex sealer was evaluated in endosolv, canalsove, carvene, xylene and distilled water. About 200 samples of the sealer were prepared and divided into two groups in which one was with ultrasonic activation at two different time intervals of 2 min and 10 min and other was without ultrasonic activation at 2 min and 10 min.
The mean weight loss was calculated for sealer sample in each solvent with and without ultrasonic activation at all immersion periods and statistical analysis was done.

Results:- Unpaired t-test showed that in MTA at 2 min and 10 min, mean percentage weight loss with Ultrasonic Agitation was significantly higher than without Ultrasonic Agitation for Endosolv, Canalsolve, Carvene and Xylene. However, for distilled water there was no significant difference for mean percentage weight loss between with and without Ultrasonic Agitation.

Conclusion:- Endosolv can be considered as best solvent among these to dissolve mta-fillapex which will provide even better results when used in ultrasonic environment. Increased efficacy of solvents was noticed under UA as compared to static environment while dissolving sealers in solvent efficacy also improved when immersion time was increased from 2 min to 10 min . For mta-fillapex endosolv shown increased dissolution as immersion time was increased followed by Carvene, Xylene & Orange oil but not with distilled water.

1. INTRODUCTION:

In cases of endodontic retreatment with non surgical approach, the removal of endodontic filling material is necessary to achieve maximum root canal cleaning and reducing microbial load for recovery and maintenance of periapical health. Although it is practically not possible to completely remove the root canal filling material, endodontic solvents offer helps in removing sealer and gutta percha based on their efficacy of dissolution, but there are some controversies regarding their effects as they may be toxic to periapical tissues.(1)

In failed cases whenever possible, non surgical management is preferable as compared to other radical intervention such as apical surgery or extraction because the non surgical retreatment is less invasive with good long term survival rates. For retrieving root canal filling material, several techniques like hand files, rotary files and ultrasonic are used either alone or in combination with heat or solvents. The type of technique used whether alone or in combination with other techniques depends on root canal configuration, anatomy and the type of filling.(2)

Gutta percha is most common filling material used with different types of endodontic sealers, it can be easily removed during retreatment but various evidence based study have shown that filling materials residues especially sealers left on canal walls and their microscopic ramifications remain inaccessible or resist dissolution, therefore solvents have no significant role for their removal to enhance disinfection and attainable success of the retreatment procedure. (3)

chloroform and xylene are known to be most effective solvents but due to their toxic and carcinogenic effects, the attention of researchers is now moved towards search of alternative more biocompatible solvents other solvents available are refined orange oil, tetrachloroethylene and ethyl acetate. (4)There are varieties of commercially available

endodontic sealers with different compositions and physiochemical properties that may affect the efficacy of organic solvents use to dissolve them clinically. (5)

Studies were already done with many other sealers but in this study MTA based MTA fillapex is when used with ultrasonic agitation of the solvent or without it at different time gaps has not been studied much.(6,7) Therefore, the purpose of this study was to compare and assess the effectiveness of tetra chloroethylene, orange oil, endosolv, containing ethyl acetate and xylene and dissolving mta based sealer MTA fillapex when used with and with without ultrasonic activation of solvents.

2. METHOD:

Standardized Stainless Steel moulds measuring 8mm in diameter and 2mm height were used to prepare 200 samples MTA fillapex (Angelus) had been used and their compositions are shown in table 1. Each sealer was mixed as per the manufacturer instructions and the fresh mix was carefully poured into the sample moulds placed on a glass slab using a 2ml syringe to prevent air entrapment and the microscope slide covered with cellophane strip was then placed into the uppermost surface to produce a flat surface.

All these samples along with their moulds were then transferred to a chamber with 80% relative humidity at 37 degree Celsius temperature. They were left untouched for sealers to set upto 48hrs and thereafter removed from the chamber. The material protruding out in excess from the mould was removed with the help of scalpel.

The samples were weighed in grams upto 4 decimal places 3 times on a digital analytical balancing machine. The mean values were calculated after these readings. Samples of sealer (n=200) were then divided into 5 groups of 5 solvents (n=40) each. These were further subdivided into 2 groups one with ultrasonic agitation (n=20) and other with static solvent environment (n=20) and again divided into 2 subgroups based on time of immersion as 2min and 10 min(n=10) . All sealer samples were then completely immersed in 20ml of solvent stored in glass vials.

After the time specified for immersion was over, the samples were removed from the glass vial, rinsed with 100ml of tripled distilled water and then dried using absorbent paper. For drying, all these samples were kept in oven for 24hrs at 37 degree Celsius and then subjected to dehumidifies desiccator. After that the samples were again weighed 3 times upto 4 decimal places value and mean was calculated.

The difference between the original weight and that after dissolution was determined and the amount of sealer dissolved was calculated by mean percentage loss. Data was statistically analysed of percentage weight loss for root canal sealer in different solvents with 2 different environments static and ultrasonic at two different time intervals of 2 mins and 10 mins.

3. DISCUSSION:

For successful completion of non surgical endodontic retreatment removal of re filling materials should be accomplished as much as possible to uncover remnants of necrotic tissue or bacteria that may contribute for periapical inflammational subsequent failure. Mainly the root canal sealer and its ramifications pose difficulty in its removal so, an ideal root canal sealer should be easy to remove in procedure of retreatment for proper access of irrigants and medicaments.(7) If removal is attempted only mechanically it may lead to alteration in original canal morphology or perforation or straightened root canal. Hence solvents serve to decrease resistance inside canal while removal making it easier and synergistic with instruments used.

However solvents may have deleterious effects too as they may be toxic if penetrated beyond apex & can cause pericementitis.(8) And can be strong enough to soften. Enamel and dentin that may induce canal transportation.

Method used in this in vitro study is similar to as done in previous studies as particulars standards exists to check the solubility of root canal sealer in organic solvents. As per certain studies an average time of 1.5 to 8 min is needed for removal of very well compacted obturating material by aid of instruments with or without using solvents.

In the present study in order to precisely distinguish the dissolving properties of the sealer used with different solvents the standardised samples were immersed for the gap time of 2 min & 10 min.

Since repeated drying and immersion was carried out with samples therefore to exclude error of undesirable weight loss one samples of sealer was exposed to just one immersion period for precise readings. Distilled water was used thereafter wash the samples to remove the loosened & decomposed debris.

Although, various studies has already been done regarding solubility of sealers in different solvents.(9) The present study, the results were found to be interesting as the comparison of solvents was made to evaluate their effect on solubility profiles of sealers. More or less all the solvents showed some dissolution of the sealers. Endosolv was the most effective solvent that too with UA followed by xylene, canalsolv and orange oil with distilled water as the least effective. However the dissolving effect of all the solvents was gradual and in accordance to the immersion time of contact with the surface of sealer samples.(10)

It is important before selection of an organic solvent to access its clinical safety and belligerence towards tissue as well as its sealer dissolution competency so that it aids in success of retreatment instead of any harmful effects. Use of endosolve for removal of resin sealer was suggested by cohen durican & Chong. Solvents that were popularly used in the past to dissolve were- chloroform, haloethane Xylene and others were turpentine oil eculyptus oil, pine needle oil.(11)

When small underprepared and curved canal needs negotiation, solvents and small k type files are best suited. The sequential technique involves refilling the created picking into the dissolving GP while filling with a size 10, 15, 20 stainless steel files. This is continued until the terminals is negotiated after all the solvents should be discontinued. Sequentially, larger K type files are then inserted into the canal until all the GP mass is removed. In most cases combined use of different methods may be the most efficient and time saving method.

Two specific organic solvents were used (ethyl acetate as endosolv and TCE as canalsolv), which shows good dissolution properties along with additional advantages as they are less volatile (low vapour pressure), non carcinogenic, non mutagenic and with low toxicity, thus they are advisable to be used as safer alternatives as compared to chloroform. Magalhaes et al. stated that xylol was the best solvent, whereas choloroform, eucalyptus oil, orange oil presented a similar solvent profile.(12)

There are few studies about the influence of UA in solvents(13,14). In an attempt to simulate the effect of passive ultrasonic irrigation for activating irrigation solution, the samples were subjected in an ultrasonic bath to a frequency of 3ochz in order to mimic a clinical situation.

For samples of mta fillapex, mean percentage loss at 10 mins was significantly higher than at 2 mins with endosolv, canalsolve, carvene and xylene. However for distilled water no significant difference for mean percentage water loss between 2 mins and 10 mins intervals mtafillapex showed more dissolution with UA at 10 min than with UA at 2 min for Endosolve, canalsolve carvene & xylene but not much difference was seen with distilled water at 2 min and 10 min interval. Mta fillapex in static environment of different solvents showed higher dissolution with endosolve followed by carvene canalsolve and xylene at 10 mins as compared to 2 mins.

Distilled water shown least solubility of sealers as solvent without much significant difference at different immersion time intervals or with UA and without UA.

One of the major drawbacks of the present in-vitro study is the extrapolation of the immersion model to clinic because it allows for a full surface contact of sealer with the solvent. In the clinical situation, the sealer is attached to the root canals walls and only partially exposed to the effect of the solvents.

4. RESULT:

Table 1: Comparison of percentage weight loss between with and without Ultrasonic Agitation (UA) in different solvents at 2 min in MTA.

Solvent groups	Mean ± SD of percentage weight loss		Unpaired t-test
	With UA	Without UA	
Endosolv	41.23 ± 0.03	28.45 ± 0.04	t = 828.403, P = 0.000 (<0.001), VHS
Canalsolve	11.76 ± 0.05	1.85 ± 0.05	t = 445.746, P = 0.000 (<0.001), VHS
Carvene	10.98 ± 0.06	1.82 ± 0.04	t = 417.108, P = 0.000 (<0.001), VHS
Xylene	32.99 ± 0.04	28.07 ± 0.04	t = 281.023, P = 0.000 (<0.001), VHS
Distilled water	0.02 ± 0.01	0.01 ± 0.01	t = 0.866, P = 0.398 (>0.05), NS

*VHS = Very high significant difference, NS = No significant difference

Unpaired t-test showed that in MTA at 2 min, mean percentage weight loss with Ultrasonic Agitation was significantly higher than without Ultrasonic Agitation for Endosolv, Canalsolve, Carvene and Xylene. However, for distilled water there was no significant difference for mean percentage weight loss between with and without Ultrasonic Agitation.

Table 2: Comparison of percentage weight loss between with and without Ultrasonic Agitation (UA) in different solvents at 10 min in MTA.

Solvent groups	Mean ± SD of percentage weight loss		Unpaired t-test
	With UA	Without UA	
Endosolv	47.95 ± 0.05	32.89 ± 0.04	t = 760.241, P = 0.000 (<0.001), VHS
Canalsolve	20.00 ± 0.05	18.75 ± 0.03	t = 70.698, P = 0.000 (<0.001), VHS
Carvene	13.64 ± 0.04	8.59 ± 0.04	t = 300.488, P = 0.000 (<0.001), VHS
Xylene	35.58 ± 0.03	31.96 ± 0.03	t = 270.003, P = 0.000 (<0.001), VHS
Distilled water	0.02 ± 0.00	0.02 ± 0.01	t = 0.949, P = 0.355 (>0.05), NS

*VHS = Very high significant difference, NS = No significant difference

Unpaired t-test showed that in MTA at 10 min, mean percentage weight loss with Ultrasonic Agitation was significantly higher than without Ultrasonic Agitation for Endosolv, Canalsolve, Carvene and Xylene. However, for distilled water there was no significant difference for mean percentage weight loss between with and without Ultrasonic Agitation.

5. CONCLUSION :

Within the limitations of present study, endosolv (ethyl acetate) proved to be excellent alternative to traditional solvent like xylene. Other solvents like TCE, xylene & orange oil also performed well to dissolve MTA sealer. An overall increase in dissolving capacity was noticed on agitating the solvents ultrasonically except distilled water.

Within the limitations imposed by this in vitro investigation, the present study suggests that endosolv/xylene, orange oil & TCE can be used for dissolving sealer like mta fillapex during retreatment with various techniques. Endosolv can be considered as best solvent among these to dissolve mta-fillapex which will provide even better results when used in ultrasonic environment.

Increased efficacy of solvents was noticed under UA as compared to static environment while dissolving sealers in solvent efficacy also improved when immersion time was increased from 2 min to 10 min . For mta-fillapex endosolv shown increased dissolution as immersion time was increased followed by Carvene, Xylene & Orange oil but not with distilled water. In distilled water , insignificant sealer dissolution was observed. TCE, Xylene and Carvene showed no significant difference in their solvent behaviour.

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