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Comparative Evaluation of Effectiveness of Xylene and Acetate Containing Solvent in Dissolving Two Different Bioceramic Sealers: An In-Vitro Study

Running Title: Effectiveness of Xylene and Acetate Containing Solvent in Dissolving Bioceramic Sealer.

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KEYWORDS

Ceraseal, MTA fillapex, Xylene, Endosolv

ABSTRACT:

Introduction: Due to rising popularity of bioceramic sealers, there is an increasing demand for a solvent that is both efficient and safe for use in endodontic retreatment. However, there is limited information in the literature regarding the effectiveness of xylene and acetate-containing solvents in dissolving endodontic sealers.

Objectives: The study was aimed to evaluate and compare the effectiveness of xylene and acetate containing solvent in dissolving two different bioceramic sealers.

Methods: Standardized stainless steel molds were used to prepared the sixty samples (30 from each endodontic sealer). All samples were classified into Group I (CeraSeal) and Group II (MTA-Fillapex), with each group subsequently split into three subgroups according to immersion solution utilized. Ten samples from each group were immersed in a specific organic solvent for 2 minutes. Sample weight was recorded before and after immersion using a digital analytical scale.

Results: Amongst all groups, Group IIB (mta fillapex immersed in endosolv) shows the highest dissolution with (mean=0.065±0.0163) followed by Group IIA (mta fillapex immersed in xylen, mean=0,0426±0.024), Group IB (ceraseal immersed in endosolv, mean= 0.0074±0.009), Group IA (ceraseal immersed in xylene, mean=0.0038±0.009). Group IC (ceraseal immersed in distilled water, mean=0.0001±0.0001) and IIC (mta fillapex immersed in distilled water, mean=0.0002±0,0003) shows least dissolution with no significant difference between them.

Conclusions: Within the limitations of this study, an acetate-based solvent, demonstrated more effectiveness and they can use as an alternative to traditional solvents such as xylene.

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1.Introduction

Endodontic treatment success rates can range from 86% to 98%. However, apical periodontitis may continue or arise after treatment due to factors like coronal leakage, fracture, caries, which can facilitate reinfection by oral microorganisms and continued growth of bacteria in existing endodontic infections.[1] In nonsurgical retreatment approach, eliminating endodontic sealing material is essential to ensure thorough root canal cleaning and minimize microbial presence, promoting recovery and maintaining periapical health. While it's practically impossible to completely eliminate root canal obturating material. Endodontic solvents help in dissolving sealer and gutta-percha, depending on their effectiveness. However, there are some debate about their potential toxicity to periapical tissues. In cases of failure, non-surgical management is preferred whenever possible over more invasive procedures such as apical surgery or extraction, as non-surgical retreatment is less invasive and offers better long-term survival rates. To extract root canal filling material, different approaches are employed, such as hand files, rotary files, and ultrasonic instruments, either on their own or with the aid of heat or solvents. The choice of technique, whether used alone or in combination, depends on factors such as root canal configuration, morphology and type of root canal sealing material.[2]

Endodontic treatment includes the use of various sealers, including resin-based, zinc oxide eugenol, calcium hydroxide, mineral trioxide aggregate, and calcium silicate based sealers. Among them, epoxy resin-based sealers are widely preferred due to their numerous advantages. They are radiopaque, ensuring visibility in X-rays, exhibit excellent dimensional stability with low solubility, and offer superior adhesion to dentin compared to zinc oxide eugenol and calcium hydroxide sealers.

Zinc oxide eugenol-based and resin-based sealers have certain drawbacks, including their tendency to dissolve in body fluids and shrink after setting. To address these limitations, researchers have worked on developing new endodontic sealers, such as bioceramic-based sealers, which provide superior properties over traditional options.[3]

With growing use of bioceramic sealers, a reliable and safe solvent for endodontic retreatment is now more essential. The effectiveness of a solvent can be assessed by measuring the change in the sealer's mass before and after immersion.[4] There is limited information in literature about the effectiveness of xylene and acetate containing solvent in dissolving endodontic sealers, especially bioceramic sealers containing calcium silicate. This study was done to assess and compare the effectiveness of xylene and acetate containing solvent in dissolving different bioceramic sealers.

2.Objectives

1.To evaluate the dissolution of ceraseal after 2 min. immersion in xylene, acetate containing solvent and distilled water on analytical balance.

2.To compare the difference in dissolution of ceraseal after 2 min. immersion in xylene, acetate containing solvent and distilled water on analytical balance.

3.To evaluate the dissolution of mta fillapex after 2 min. immersion in xylene, acetate containing solvent and distilled water on analytical balance.

4.To compare the difference in dissolution of mta fillapex after 2 min. immersion in xylene, acetate containing solvent and distilled water on analytical balance.

5.To compare the difference in dissolution of ceraseal and mta fillapex after 2 min. immersion in xylene, acetate containing solvent and distilled water on analytical balance.

3.Methods

A total 60 samples, 30 from each endodontic sealer were prepared using standardized stainless steel molds (8 mm in diameter and 1.5 mm in thickness). Each sealer was mixed according to the manufacturer's guidelines. The freshly prepared material was carefully dispensed into the molds placed on a glass slab using a 2 ml syringe to minimize air entrapment. Cellophane strip was placed on mould and then microscope slide was pressed onto the upper surface to ensure a flat finish. All samples, along with the steel molds were placed in a chamber maintained at 80% relative humidity and 37°C and left undisturbed. After 48 hours, the specimens were taken out, and any excess material was carefully trimmed using a scalpel.

Groups were as follows

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Group I: CERASEAL Sealer

Ia) Immersed in xylene for 2min.

Ib) Immersed in endosolv for 2 min.

Ic) Immersed in distilled water for 2min.(control)

Group II: MTA FILLAPEX Sealer

IIa) Immersed in xylene for 2 min.

IIb) Immersed in endosolv for 2min.

IIIc) Immersed in distilled water for 2 min.(control)

Procedure:

The samples were weighed in grams three times using an analytical balance, and the average value was determined. At room temperature, all sealer sample were completely submerged in 20 ml of solvent within a glass beaker. After being immersed for 2 minutes, the extracted samples were rinsed with 100 mL of distilled water, gently dried with absorbent paper, and then oven-dried at 37°C ± 1°C for 24 hours before being stored in desiccators. Finally, samples were weighed three times, and average value was determined. Amount of sealer dissolved was calculated by measuring the difference between its initial and final weights.

Statistical analysis

Microsoft Excel 2007/2013 was used for data coding and entry, and SPSS software (version 21.0) was employed for descriptive and frequency analyses. The normality of the data was assessed using the Shapiro-Wilk normality test. For intergroup comparisons, a one-way Analysis of Variance (ANOVA) test was performed, followed by a post hoc test.

4.**Results**

According to Table 1 and Graph 1, intergroup comparison revealed that mta fillapex exhibited greater dissolution than ceraseal after immersion in xylene and endosolv with a highly significant difference between them. However, no significant difference was observed between the dissolution of mta fillapex and ceraseal after immersion in distilled water.

According to Table 2 and Graph 2, intragroup comparison indicated that both ceraseal and mta fillapex exhibited greater dissolution after immersion in endosolv compared to xylene, with a highly significant difference.

Additionally, both sealers showed greater dissolution in xylene compared to distilled water, with a highly significant difference. Furthermore, both ceraseal and mta fillapex exhibited greater dissolution in endosolv than in distilled water, also with a highly significant difference.

Table 1: Intergroup comparison between Group I(Ceraseal) and Group II(Mta fillapex) after immersion in different reagent in terms of mean weight loss

	Group I (Ceraseal) Mean (SD)	Group II (MTA) Mean (SD)	Unpaired t test	p value
Subgroup A (Xylene)	0.0038 (0.0009)	0.0426 (0.024)	t = -5.094	p< 0.001**
Subgroup B (Endosolv)	0.0074 (0.0009)	0.065 (0.0163)	t = -11.098	p< 0.001**
Subgroup C (Distilled water)	0.0001 (0.0001)	0.0002 (0.0003)	t = -0.449	p =0.659 (NS)

p>0.05 – no significant difference **p< 0.001 – highly significant

Table 2: Overall intragroup comparison in Group I(Ceraseal) and Group II (Mta fillapex) after immersion in different reagent in terms of mean weight loss

	Group I (Ceraseal) Mean (SD)	Group II (MTA) Mean (SD)
Subgroup A (Xylene)	0.0038 (0.0009)	0.0426 (0.024)
Subgroup B (Endosolv)	0.0074 (0.0009)	0.065 (0.0163)
Subgroup C (Distilled water)	0.0001 (0.0001)	0.0002 (0.0003)
One way Anova F test	F = 207.573	F = 38.301
P value, Significance	P< 0.001**	P< 0.001**

p>0.05 – no significant difference **p< 0.001 – highly significant

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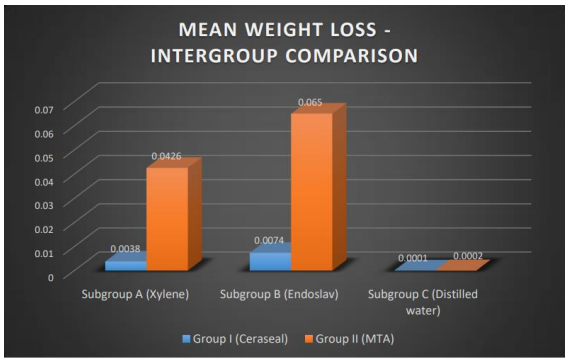
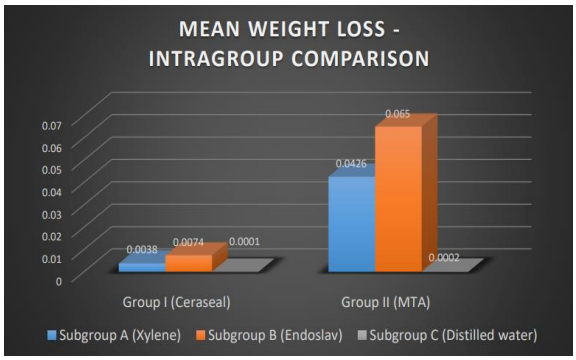
Graph:1 Intergroup comparison between Group I(Ceraseal) and Group II (Mta fillapex) after immersion in different solvent.



Graph:2 overall intragroup comparison in Group I(Ceraseal) and Group II(Mta fillapex) after immersion in different solvent.



Amongst all experimental groups, Group IIB (mta fillapex immersed in endosolv) shows the highest dissolution (Mean=0.065±0.0163) followed by Group IIA (mta fillapex immeresed in xylene,

Mean=0,0426±0.024), Group IB (ceraseal immersed in endosolv, Mean= 0.0074±0.009), Group IA (ceraseal immersed in xylene, Mean=0.0038±0.009). Group IC (ceraseal immersed in distilled water, Mean=0.0001±0.0001) and IIC (mta fillapex immersed in distilled water, Mean=0.0002±0,0003) shows least dissolution with no significant difference between them.

5.**Discussion**

Ideal root canal sealers for endodontic treatment should provide a superior seal, resist dissolution in body fluids, adhere well to root canal walls, maintain dimensional stability, be biocompatible, and allow for easy removal when needed.[5,6] Various types of root canal sealers, including epoxy resin and calcium silicate, are used to achieve a hermetic seal in root canals.[7,3]

Endodontic retreatment has become preferred treatment option over periradicular surgery for managing failed root canal treatments. Complete removal of the previously placed obturating material is essential during retreatment to eliminate any residual necrotic tissue and microorganisam responsible for the initial treatment failure.[8] It is essential to acknowledge the intricate nature of root canal anatomy, which prevents endodontic instruments from fully debriding and eliminating all filling material.[9] Increasing instrument size and taper can maximize contact with the root canal walls, leading to more effective cleaning and shaping.[10] However, this method often results in excessive dentin removal, compromising the root strength and consequently increasing fracture susceptibility. Hence, utilizing a solvent that effectively dissolves sealers and gutta-percha would be extremely useful in endodontic retreatment. These solvents help facilitate the removal of obturation material from hard-to-reach areas where hand or rotary files may be less effective.[11]

Newly developed bioceramic based sealers have been launched in the market. Their primary advantage lies in their bioactive properties. When they react with water, they formed $Ca(OH)_2$, creating an alkaline environment which stimulates alkaline phosphatase expression. This, in turn, supports the development of highly mineralized tissue and offers an antimicrobial effect. Additionally, alkaline pH of these sealers can neutralize acidic environment caused by lactic acid released from osteoclasts, thereby preventing the dissolution of highly mineralized tooth structures.[12]

Designed for convenience, the newly developed bioceramic-based sealer CeraSeal (Meta Biomed Co., Cheongju, Korea) comes in a single premixed syringe. Its composition includes dicalcium silicate, tricalcium silicate, tricalcium aluminate, zirconium oxide, and a thickening agent. As claimed by its manufacturers, CeraSeal offers exceptional stability and superior sealing capabilities.[13] First-generation paste-type root canal sealer containing MTA is MTA-Fillapex (Angelus, Londrina, Brazil). Which is formulated with salicylate resin and other resinous components. When mixed,

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MTA-Fillapex forms a composition of salicylate resin, natural resin, diluting resin, calcium tungstate, bismuth oxide, nanoparticulate silica, pigments, and MTA, characterized by an alkaline pH, antibacterial properties, and favorable physical characteristics, making it an effective endodontic sealer.[13] Endosolv (Septodont) consists of Ethyl acetate, amyl acetate and thymol.[14] Xylene is a chlorinated hydrocarbon widely recognized as a solvent for gutta-percha. It can also soften or dissolve sealers, potentially facilitating their mechanical removal during endodontic retreatment.[15]

Hydrophobic organic solvents, such as xylene and endosolv, can penetrate the 3D lattice structure, causing it to swell and reducing its strength and hardness. This softening effect enhances the removal of sealers and gutta-percha by scrubbing action of endodontic files.[16]

According to results in the study, endosolv is more effective than xylene in dissolving bioceramic sealers. This could be because of tetrachloroethylene in its composition.[17] MTA fillapex shows more dissolution than the ceraseal this could be because of structural difference between these two sealers. MTA fillapex contains resin in its composition while ceraseal doesn't contain resinious component. Jain Mahendra et al. carried out a study to assess the dissolving potential of Endosolv, Canalsolv, Xylene, Carvene, and distilled water on MTA-based sealers, concluding that Endosolv exhibited the highest effectiveness in breaking down bioceramic sealers.[2] In our study, Group IIB (MTA fillapex immersed in endosolv) shows the highest dissolution followed by Group IIA (MTA fillapex immersed in xylene), Group IB (Ceraseal immersed in endosolv), Group IA (Ceraseal immersed in xylene). Group IC (Ceraseal immersed in distilled water) and IIC (MTA fillapex immersed in distilled water) shows least dissolution with no significant difference between them.

6.Conclusion

Within the limitations of this study, endosolv, an acetate-based solvent, demonstrated high effectiveness as an alternative to traditional solvents like xylene. The highest dissolution was observed in mta fillapex after immersion in endosolv, while the least dissolution was seen in both ceraseal and mta fillapex after immersion in distilled water.

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