Assessment of dissolving efficacy of various solvents on three different sealers

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Abstract:

Introduction: The dissolving capacity of root canal solvents for different sealers can vary depending on the specific solvent and sealer being used. Some solvents may be more effective at dissolving certain types of sealers than others, and different sealers may have different chemical compositions that make them more or less susceptible to dissolution.

Methodology: Three different sealers, Sealapex, AH plus and MTA fillapex were tested for the dissolving efficacy on Endosolv, neosolv and distilled water. All the root canal sealers were evaluated by two different activation namely ultrasonic and sonic agitation after 10 minutes immersion. 10 samples in each subgroup was tested. One way ANOVA was run to find significant differences between subgroups.

Results: Endosolv showed the greatest dissolution followed by neosolv. Sealapex had the highest weight loss in ultrasonic activation with a mean of 49.1733 $\pm$ .97508 and 37.6780 $\pm$.79747. This was then followed by AH plus and MTA fillapex. Overall ultrasonic was more effective than sonic activation.

Conclusion: This study can give clinicians advice on the best solvent to use for the effective dissolution of sealers upon ultrasonic and sonic activation.

Keywords: root canal, ultrasonic activation, solubility, immersion, sealers

Introduction:

The solubility evaluation of root canal sealing materials is an important aspect of endodontic treatment. Root canal sealing materials are used to fill the voids and gaps in the root canal system after the removal of infected pulp tissue. (1) The materials used for root canal sealing should be insoluble in tissue fluids and resistant to bacterial penetration. Various materials are used for root canal sealing, including zinc oxide-eugenol cement, glass ionomer cement, resin-based sealers, and calcium hydroxide-based sealers. The solubility of these materials can be evaluated using different methods. (2)

The removal of endodontic filling material is a requisite for endodontic retreatment using a non-surgical approach in order to accomplish maximum root canal cleansing and reduce microbial burden for healing and maintenance of periapical health. (3) In root canal treatment, a sealant is used to fill the empty space left after the removal of infected or damaged tissue from the root canal. The sealant acts as a barrier that prevents further infection and helps to restore the tooth's structural integrity. It is important for the sealant to be dissolved effectively because any residue left behind can interfere with the sealing process and compromise the success of the treatment. (4) Incomplete dissolution of the sealant may also cause irritation to the surrounding tissues and result in inflammation, pain, or even infection. Furthermore, effective dissolution of the sealant allows for proper visualization of the root canal space during follow-up appointments, which is necessary to monitor the healing process and ensure that no further treatment is needed. (5) Overall, proper dissolution of the sealant is crucial to the success of root canal treatment and the long-term health of the treated tooth. Endodontic solvents provide assistance in eliminating sealer and gutta percha based on their effectiveness of dissolving the material, although doubts do arise about their consequences as they may be hazardous to the periapical tissues.

A commonly used method for evaluating the solubility of root canal sealing materials is the weight loss method. In this method, the samples of the material are weighed before and after immersion in distilled water for a specified period. (6) The weight loss of the sample is then calculated and used to determine the solubility of the material. Other methods for evaluating the solubility of root canal sealing materials include the titration method and the scanning electron microscope (SEM) method. An ideal solvent must have an optimal balance between respectable degree of clinical safety, level of toxicity and tissue destruction, and chemical capacity for dissolving. (7) The current in vitro study aimed to determine the efficacy of three different root canal sealers (Sealapex, AHplus and MTA fillapex) dissolved in various solvents (Endosolv, Neosolv and Distilled water).

Materials and methods:

The invitro study assessed the dissolving capacity of three different solvents on 90 moulds filled with sealers. Sealpex, AH plus and MTA fillapex were the sealants tested in the study. The sealants were placed in stainless steel ring moulds measuring an internal radius of 8mm and height of 2mm filled with root canal sealants. These moulds were cleansed with acetone in an ultrasonic jet for 15 minutes and then weighed before use. The measured weight was recorded to nearest five decimal places.

A robust glass plate supported the moulds which was covered by cellophane layer. Sealers were mixed as per the manufacturer's instructions. The sealant was freshly mixed and flowed into the sample moulds, avoiding any entrapment of air. Following this, a glass plate covered with cellophane was pressed in a manner so as ensure that the plates remain in contact with the entire mould. This setup was placed in an incubator and settled for 24 hours. Any excess was trimmed using a sharp scalpel. Prior to immersion, the sealers were weighed thrice and the mean value was noted down. 90 samples were distributed into 30 samples for every sealer and further subdivided into subgroups of 10 based on the solvents at an immersion period of 10 minutes.

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 an intervals of 10 mins. Data analysis was done using Statistical package

Results:

The present study compared the dissolving capacity of 2 solvents and a negative control (distilled water) on three different sealants when activated separately with sonic and ultrasonic activation. When assessed between the sealants with ultrasonic activation, the highest dissolving capability was noted for sealapex sealants in endosolv at 49.1733 $\pm$ 0.97508 followed by nesolv at 42.4527 $\pm$ 0.54092. The mean readings of AH plus and MTA fillers for both endosolv and neosolv were around the same values. Distilled water ability to dissolve sealants were marginal as seen in Table 1.

When evaluated between the samples on sonic activation, a similar result to ultrasonic was noted for the solvent capability for sealants, but overall the values was much lesser than the former as seen in Table 2.

When independently checked between the type of activation, the greatest mean difference was noted in the sealapex dissolved in endosolv at 11.49530 followed by sealapex submerged in neosolv at 10.03267, both significant at p=0.000 as seen in Table 3. Overall inference of the study is;

Solvent – Endosolv > Neosolv > Distilled water

Sealant – Sealapex > AHplus > MTA fillapex

Table 1: Comparison of percentage weight loss between groups with Ultrasonic Agitation (U) in different solvents at 10 min

Solvent	Sealants	Mean	S.D	95% Confidence Interval	
				Lower bound	Upper bound
Endosolv	Sealapex	49.1733	.97508	45.6334	49.7133
	AH plus	34.1847	1.13044	33.5587	34.8107
	MTA fillapex	34.0847	1.17620	33.4333	34.7360

Neosolv	Sealapex	42.4527	.54092	42.1531	42.7522
	AH plus	33.3647	.90393	32.8641	33.8652
	MTA fillapex	32.9540	1.14874	32.3178	33.5902
Distilled water	Sealapex	.0209	.00779	.0166	.0252
	AH plus	.0961	.12738	.0256	.1667
	MTA fillapex	.2192	.15272	.1346	.3038
F statistic	8078.226				
P value	0.000*				

*=Significant; NS=Not significant

Table 2: Comparison of percentage weight loss between groups with Sonic Agitation (S) in different solvents at 10 min

Solvent	Sealants	Mean	S.D	95% Confidence Interval	
				Lower bound	Upper bound
Endosolv	Sealapex	37.6780	.79747	37.2364	38.1196
	AH plus	28.5700	.88789	28.0783	29.0617
	MTA fillapex	28.2467	.66924	27.8761	28.6173
Neosolv	Sealapex	32.4200	.43433	32.1795	32.6605
	AH plus	27.6633	.64478	27.3063	28.0204
	MTA fillapex	26.4833	.89576	25.9873	26.9794
Distilled water	Sealapex	.0243	.01430	.0164	.0323
	AH plus	.0347	.01151	.0283	.0410
	MTA fillapex	.0423	.01015	.0367	.0480
F statistic	9801.568				
P value	0.000*				

*=Significant; NS=Not significant

Table 3: Comparison of percentage weight loss between Ultrasonic and Sonic activation (S) among different solvents

Solvent	Sealants	Activation type	Mean	Std. Deviation	Mean difference	‘t’ statistic	P value
Endosolv	Sealapex	Ultrasonic	49.1733	.97508	11.49530	26.120	0.000*
		Sonic	37.6780	.79747			
	AH plus	Ultrasonic	34.1847	1.13044	5.61467	15.128	0.000*
		Sonic	28.5700	.88789			
	MTA fillapex	Ultrasonic	34.0847	1.17620	5.83800	16.708	0.000*
		Sonic	28.2467	.66924			
Neosolv	Sealapex	Ultrasonic	42.4527	.54092	10.03267	56.012	0.000*
		Sonic	32.4200	.43433			
	AH plus	Ultrasonic	33.3647	.90393	5.70133	19.887	0.000*
		Sonic	27.6633	.64478			

	MTA fillapex	Ultrasonic	32.9540	1.14874	6.47067	17.204	0.000*
		Sonic	26.4833	.89576			
Distilled water	Sealapex	Ultrasonic	.0209	.00779	-.00343	-.817	.421 (NS)
		Sonic	.0243	.01430			
	AH plus	Ultrasonic	.0961	.12738	.06147	1.861	.073 (NS)
		Sonic	.0347	.01151			
	MTA fillapex	Ultrasonic	.2192	.15272	.17687	4.476	0.084 (NS)
		Sonic	.0423	.01015			

*=Significant; NS=Not significant

Discussion:

A sealer needs to be removed effectively from the root canal during endodontic intervention. When assessed between the sealants with ultrasonic activation, the highest dissolving capability was noted for sealapex sealants in endosolv at 49.1733 ± 0.97508 followed by nesolv at 42.4527 ± 0.54092. Overall when compared ultrasonic activation showed the greatest weight loss for all the three sealers in both endonsolv and neosolv solution. The least solubility was noted in the distilled group, exhibiting no significant difference between ultrasonic and sonic activation. The greatest mean difference noted between sonic and ultrasonic was in the sealapex sealant group for both endosolv and neosolv at 11.49530 and 10.03267 respectively. The present study is the first of its kind, with no single literature available between dissolving capability of sealers with different solvents activated with ultrasonic and sonic agitation.

Sealapex as the root canal obturation material is recommended because it contains calcium oxide, which might cause the formation of hard tissue at the apex after root canal obturation. (8) Another sealer noted for its adequate flow, long-term dimensional stability, and expansive qualities is the epoxy resin-based AH Plus, which is regarded as the gold standard of root canal sealers. (9,10) MTA Fillapex is a root canal sealant made using synthetic Portland cement, which are nodular, dark grey materials.

None of the dissolving solution was able to completely remove the sealant from the root canals. Residual filling was found in all three dissolving agents, which is in concordance with the other studies. (11,12,13) Endosolv resulted in significantly greater sealant mater removal compared to neosolv. This could because of its hydrophobic property, which has the capacity to break the 3D lattice structure of sealers formed after the chemical reaction.(14)

The dissolving efficacy of different solvents activated by ultrasonic waves is generally higher than that activated by sonic waves due to the intensity and frequency of the waves. Ultrasonic waves have a higher frequency and intensity than sonic waves. Ultrasonic waves have a frequency of above 20 kHz, while sonic waves have a frequency of below 20 kHz. This higher frequency and intensity of ultrasonic waves creates a more powerful and consistent agitation of the solvent molecules, which leads to increased contact between the solvent and the solute. This, in turn, facilitates faster and more effective dissolution of the solute. Furthermore, ultrasonic waves produce microscopic bubbles called cavitation bubbles. These bubbles collapse violently near solid surfaces, producing shock waves that enhance the diffusion of solute particles into the solvent. The shock waves create high-pressure zones and high-temperature gradients that help break down the solute into smaller particles and improve the solvent's ability to dissolve it. In contrast, sonic waves produce larger bubbles that do not collapse as violently, resulting in less efficient agitation and diffusion of solute particles into the solvent. As a result, the dissolving efficacy of different solvents activated by ultrasonic waves is generally higher than that activated by sonic waves.(15)

Though this study can provide valuable insights to the dissolving efficacy of various solvents to sealers, it limits itself in its ability to replicate to the complexity of living organisms.

Conclusion:

The study results concluded that Endosolv was more effective as root canal sealer dissolvents than Neosolv after 10 minutes of exposure to both sonic and ultrasonic agitation. Ultrasonic activation resulted in greater dissolution than sonic. Further studies are required with long-term trials and varying parameters simulating the clinical conditions.

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