ORIGINAL ARTICLE

A Comparative Evaluation of Two Commonly Used GP Solvents on Different Epoxy Resin-based Sealers: An *In Vitro* Study

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Abstract

Aim: This study evaluates epoxy resin-based sealers after their final set, immersed in Endosolve-R or xylene for 1–2 minutes, for its easy removal mechanically after softening.

Materials and methods: Sixty Teflon molds were grouped with 20 samples in each of the three commercially available sealers, i.e., AH 26, AH Plus, and Adseal. The sealers were put in the specific molds after their manipulation as per the instructions given in the literature by the manufacturer. They were allowed to harden for 2 weeks at 37°C in 100% humidity. Two subgroups, A-Xylene and B-Endosolv-R, of 10 samples each, were formed from 20 set specimens based on solvents to which they were immersed for 1 and 2 minutes, respectively. The data obtained was subjected to the Mauchly's test one-way ANOVA and two-way ANOVA for analysis.

Results: It was proved that for all the sealers immersed in solvents, there was a significant reduction in the mean Vickers hardness as the time increases. There was a significant difference in the initial hardness between the mentioned sealers with AH plus showing the highest followed by AH 26 and Adseal showing the lowest. AH Plus and Adseal sealers were softened by xylene after 2 minutes of their initial microhardness ($p < 0.001$); least effect was seen on AH 26. After 2 minutes, Endosolv-R softened initial microhardness of all the three sealers ($p < 0.001$).

Conclusion: It was concluded that Endosolv-R was more effective in softening the epoxy-based resin sealer than xylene, after 2 minutes of exposure.

Keywords: Endodontic solvents, Microhardness, Resin-based sealers.

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Introduction

The success rate of root canal treatment ranges from 86 to 93% and the most common cause of its failure is the microbial infections of the root canal system.[1] Root canal-treated teeth can be retreated either by orthograde or retrograde retreatment. There are various reasons of endodontic failure such as left-out canals, inappropriate cleaning, under/overobturation, inefficient hermetic seal, and bacterial microflora in the root canal.[2] When resin-based sealers are used, retreatment and removal of the gutta percha (GP) is not easy. Therefore, different solvents can be used along with the mechanical method to avoid complications like altering of the original canal shape, canal straightening, or perforations.[3–5] This study was designed to evaluate two GP solvents on three commercially procured epoxy resin-based sealers.

Materials and Methods

Root Canal Sealers Used: Epoxy Resin Based

- AH 26 (group I)
- AH Plus (group II)
- Adseal (group III)

Solvents Used

- Xylene (subgroup A)
- Endosolv-R (subgroup B)

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Specimen Preparation

Sixty disks of Teflon measuring 12 × 2 mm in diameter and height with a well of 1.5 × 6.0 mm in depth and diameter were fabricated. The molds were divided into three groups of 20 samples each. The sealers were put in the specific molds after their manipulation as per the instructions given in the literature by the manufacturer. They were allowed to harden for 14 days at 37°C in 100% humidity. Two subgroups, A (Xylene) and B (Endosolv-R) of 10 samples each, were

formed from 20 set specimens based on solvents to which they were immersed in, for 1 and 2 minutes, respectively.

Measuring the Softening of the Sealer Surface

The Mitutoyo microhardness testing machine with an indenter was used to calculate the Vickers microhardness (HV) of all the specimens. The specimens were then subjected for 10 seconds to a load of 10 g at three different, predetermined points by the indenter and were measured under the microscope with 100 times magnification. The mean was calculated for the samples.

Specimens were immersed in the mentioned solvents for 60 seconds. They were air-dried after retrieval from the solvent and the microhardness was reassessed. Each specimen was again immersed in corresponding solvents for another 1 minute.

A total of 10 specimens from every group were assessed for microhardness after 1 and 2 minutes in solvent immersion. Data were collected and tabulated to obtain mean and standard deviation.

The two-way analysis of variance (ANOVA) was performed to assess the mean hardness across the groups. Data were also subjected to one-way ANOVA, followed by pairwise comparison using the Tuckey's *post hoc* analysis.

Results

With time, hardness reduced considerably for all the sealers and solvents. Tables 1 and 2 show mean and standard deviation of Vickers microhardness of root canal sealers immersed in the solvents for 1 and 2 minutes.

Highest reduction in the mean hardness (HV) was seen in the AH Plus sealer as compared to the other two. It was more evident for Endosolv-R in case of AH Plus. Among the three groups, subgroups A and B showed considerable difference in the mean hardness after 1 and 2 minutes but the result was constant after 1 minute in subgroup B. After 2 minutes, the mean hardness (HV) of group I was considerably different than groups II and III, while the means of groups II and III showed no variation.

After 60 seconds, Endosolv-R was most favorable in dissolving Adseal then AH 26 and AH plus as compared to xylene that was most favorable in dissolving AH Plus then Adseal and minimum in AH 26. After 2 minutes, Endosolv-R was most favorable in dissolving AH plus followed by Adseal and AH 26 as compared to xylene that was most effective against AH Plus (79.1%) followed by Adseal (65.1%) and least effective against AH 26 (7.6%).

Table 1: Mean and standard deviation of Vickers microhardness after exposure to subgroup A (xylene) of all three sealers

Time	*Group I*	*Group II*	*Group III*
Initial hardness	145.71 ± 7.83	155.31 ± 5.83	120.54 ± 8.33
Hardness after 1 minute	134.21 ± 8.0	20.80 ± 1.52	41.75 ± 5.63
Hardness after 2 minutes	130.04 ± 8.20	17.20 ± 0.54	31.52 ± 4.99

Table 2: Mean and standard deviation of Vickers microhardness after exposure to subgroup B (Endosolv-R) of all the three sealers

Time	*Group I*	*Group II*	*Group III*
Initial hardness	137.61 ± 7.67	156.92 ± 6.89	120.90 ± 5.65
Hardness after 1 minute	50.33 ± 3.84	61.24 ± 5.87	33.53 ± 4.81
Hardness after 2 minutes	15.69 ± 1.67	7.23 ± 0.43	9.80 ± 1.20

Discussion

In any retreatment case, complete removal of the sealer and the gutta percha is very crucial, in order to facilitate entry for the antimicrobial agent, disinfectant, and medicament in the canal and further, to ensure its success.[6,7]

Whenever resin-based sealers are used, retreatment and removal of the gutta percha becomes difficult. Therefore, different solvents can be used along with the mechanical method, to avoid complications like altering of the original canal shape, canal straightening, or perforations.

Xylene, chloroform, Pandine needle oil, eucalyptol oil, turpentine oil, etc., are commonly used solvents in the nonsurgical retreatment cases for easy removal of root canal fillings.

About 60–70% of the gutta percha can be easily removed within 2–3 minutes but some firmly adhered remnants of the sealer and the gutta percha that remained attached to the canal dentin walls are difficult to remove; therefore, along with solvents various mechanical methods have been well documented like using files, gates glidden, heated pluggers, ultrasonic, etc., for complete removal of root canal fillings.[5,8,9] Also "wicking action" by solvents as suggested by Ruddle is most effective in removal of the gutta percha in cases of retreatment.[10]

In this study, resin-based sealers have been used as they firmly adhere to dentin walls and are difficult to remove as compared to nonresin-based sealers.[11] Various authors have suggested that these resin-based sealers are biocompatible, radiopaque, and firmly adhere to both gutta percha and dentinal walls; therefore, they are difficult to remove in retreatment cases.[12–14]

The study compared three sealers after being immersed in two different solvents (Endosolv-R and xylene) for 1 and 2 minutes. It was found that Endosolv-R was the most effective softener for all the three sealers in less time.[15]

Due to hydrophobic property of Endosolv-R and xylene, they have the capacity to break through the 3D lattice structure of epoxy resin-based sealers formed after the chemical reaction.[15] A combined use of Endosolv-R along with rotary files for removal of the gutta percha from apical third in less time has been well reported by various authors.[6,16] Evident reduction in microhardness of the enamel and the dentin along with reduction in the binding force of resin-based endodontic sealers with use of xylene have also been noted.[17,18]

The U.S. Food and Drug Administration has barred chloroform for its carcinogenicity and cytotoxicity.[17,19] An endodontic solvent like orange oil is more popular because of its safe and biocompatible nature, even though few authors have suggested orange oil to be less effective than chloroform and xylene.[20] Xylene is mainly composed of chlorinated hydrocarbon that has the capability to dissolve the gutta percha and the sealer; when used along with the mechanical methods, it can facilitate easy removal of filling materials.[16] Whereas, Endosolv-R that contains formamide (66.5 g) and phenyl ethylic alcohol (33.5 g) is more effective for removal of the resin-based sealer.[21]

The Occupational Safety and Health Administration stated the adverse effect of xylene, which includes hypersensitivity of the mucous membrane and the eye, when ingested causes gastrointestinal discomfort, when inhaled causes air spaces hemorrhages, chemical pneumonitis, if extruded periapically

causes cytotoxic reaction.[22] Chutich et al. have recommended that the quantity of xylene that leaches out of the apical foramen is way less than the permissible dose.[23] Biological acceptability of Endosolv-R is questionable as it is known to have fetotoxic properties.[24]

Conclusion

It was concluded that Endosolv-R was more effective for softening the epoxy-based resin sealer than xylene, after 2 minutes of exposure. Further studies are required with long-term trials and varying parameters simulating the clinical conditions.

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