



Comparison of Apical Transportation During Retreatment Using 3 Different Root Canal Sealers an in-Vitro Study

KEYWORDS

apical transportation, retreatment, sealers

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ABSTRACT

AIM: Comparison of the incidence of apical transportation during retreatment using 3 different intra-canal sealers.

METHODOLOGY: 60 curved root canals were divided into three groups of 20 each, biomechanical preparation of the teeth was done with ProTaper rotary system and post instrumentation radiographs were taken. The teeth were obturated using ZOE sealer, AH plus and Sealapex sealers. Gutta percha was removed using ProTaper retreatment files, following which the final radiographs were taken. Post instrumentation and final radiographs were superimposed using Adobe Photoshop software. Kruskal Wallis test was used to compare the groups.

RESULT: The maximum apical transportation occurred in the AH Plus group at 353µm. The apical transportation for Sealapex group was at 212µm and the minimum occurred for ZOE at 157µm.

CONCLUSION: AH Plus demonstrated larger transportation compared to the other 2 sealers, which proved the increased bonding of AH-Plus sealer to the root dentin

INTRODUCTION

Over the last few decades endodontic treatment has reported a very high success rate of around 92%.¹ However it is unfortunate that a certain number of endodontically treated teeth have to be retreated.

Variety of reasons have been advocated for the failure of root canal treatment such as untreated canals, canals that are poorly cleaned and obturated, complications of instrumentation, over extensions of root filling materials and complicated canal anatomy.²

Primary goal of endodontic retreatment is to regain access to the apical area by complete removal of the root canal filling material and sealers. Variety of sealers have been used by endodontists ranging from zinc oxide eugenol sealers to resin based sealers. Sealers bond to root canal dentin either mechanically or chemically. Hence during retreatment removal of the sealer along with the obturating material is a must to reduce the number of microorganisms within the canal. The challenge lies in removing the resin based sealers which are more strongly bonded to the root canal dentin than the other variety of sealers.

Removal of the obturating material and sealer can be achieved by several methods such as hand files, ultrasonics, solvents, heat pluggers, lasers and nickel-titanium rotary instruments. Recently, Specialized rotary instruments for retreatment have been introduced which are designed specifically to remove obturating material from root canals such as ProTaper Universal retreatment instruments, Mtwo retreatment files and R-Endo retreatment files.

However a mishap known to occur during retreatment is Apical Transportation. This is an undesirable deviation from

the natural canal path.³

According to the Glossary of Endodontic Terms of the American Association of Endodontists, Apical Transportation is defined as "Removal of canal wall structure on the outside curve in the apical half of the canal due to the tendency of files to restore themselves to their original linear shape during canal preparation; may lead to ledge formation and possible perforation"⁴

There are various undesirable Apical preparation outcomes such as damage to the apical foramen, elbow formation, zip formation and perforation have been described as possible results of canal transportation.

Apical Transportation hampers the apical seal, which facilitates the invasion by microorganisms and failure of the treatment.

Hence the study analyzes the incidence of Apical Transportation during retreatment using three different sealers namely Zinc Oxide Eugenol, AH plus and Sealapex.

MATERIALS AND METHODS

Sixty extracted premolars with curvatures ranging from 20-40 degree calculated according to methodology of Schneider⁵ were used in the study. The teeth were sectioned to maintain a standardised length of 16mm.

The length of the canal was established by placing a #10 file in each root canal until it was seen emerging through the apical foramen. Working length was then determined by subtracting 1mm from the total length. Subsequently the canals were instrumented to the working length by a K-file #25 (Dentsply,OK,USA), followed by ProTaper rotary

system (Dentsply Maillefer) till file size F2.

The teeth were mounted on individual square pieces of high consistency condensation silicon on a fixed platform to allow successive radiographs to be taken with the reproducible angulations.

Post instrument radiographs with the corresponding file inserted into the canal to the working length were taken

The instrumented teeth were then divided into 3 groups of 20 each.

Group A:Teeth were obturated with gutta percha 25,0.06 size cone using ZOE as the sealer.

Group B:Teeth were obturated with gutta percha 25,0.06 size cone using resin based AH plus sealer.

Group C:Teeth were obturated with gutta percha 25,0.06 size cone using Ca(OH) based Sealapex sealer.

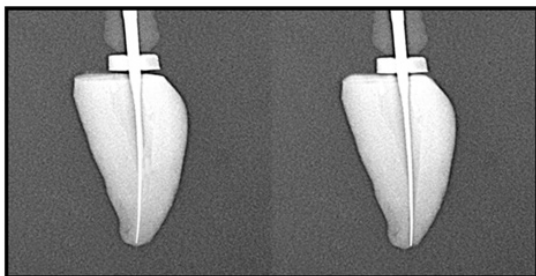
Removal of Gutta-percha and sealer was done using Pro-taper retreatment files (Dentsply Maillefer) and irrigated with Saline and 2.5% sodium hypochlorite.

Final radiograph with the corresponding file inserted into the root canal to the working length were taken under the same condition as the post instrument radiograph.

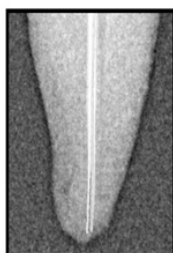
Post instrumentation and final radiographs of each specimen were superimposed according to the peripheral shape of the tooth using Adobe Photoshop software to check for transportation.

Transportation was measured when there was a divergence between the superimposed files in the apical 2mm. Data was then subjected for statistical analysis using Kruskal Wallis test.

Group A: With ZOE as sealer

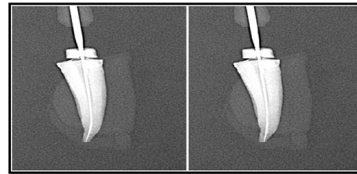


After Instrumentation After Retreatment



Super Imposition of Images

Group B: With Sealapex as sealer

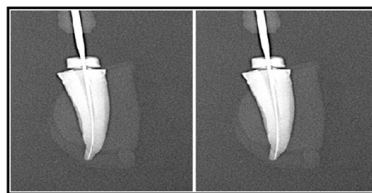


After Instrumentation After Retreatment

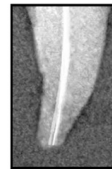


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Group C: With AH plus as sealer



After Instrumentation After Retreatment



Super Imposition of Images

RESULTS

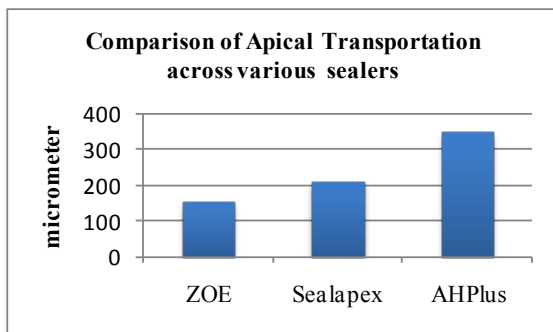
The results showed maximum apical transportation occurred in the AH Plus group at 353µm with SD of ±6.272. The apical transportation for Sealapex group was at 212µm with SD of ±7.364 and the minimum occurred for ZOE at 157µm with SD of ±7.902 (p<0.001).

The comparison between post-instrumentation and radiographs taken after retreatment showed apical transportation in all the groups. However greater apical transportation was seen in teeth which were obturated with AH-Plus as the sealer at 353µm with SD of ±6.272 compared to the teeth which were obturated using Sealapex and Zinc-oxide Eugenol sealers.

Sealers	N	Mean(SD)	Kruskal Wallistest	
			Chi square value(df)	p-value
ZOE	10	157.00(7.902)	25.986(2)	<0.001 *
Sealapex	10	212.00(7.364)		
AHPlus	10	353.00(6.272)		

*P<0.001 statistically significant

Table 1: Comparison of Apical Transportation across various sealers (measured in micrometer units)



Graph 1: Graphical representation of Apical Transportation across various sealers (in μm units)

DISCUSSION

Patients increasingly expect to retain their natural dentition and are often reluctant to have teeth extracted because of improved awareness. Additionally due to improvement in Endodontic Techniques long term success is now achievable.

For a successful endodontic therapy 3-D obturation of the root canal with a fluid tight seal is considered an important factor. The obturated root canal should seal the canal both apically and coronally to prevent the ingress of microorganism to the apex or vice versa. The use of gutta-percha cones with sealer cement is traditionally considered to be the most reliable method. Sealers based on zinc oxide-eugenol, calcium hydroxide (Sealapex), epoxy resins (AH Plus) were included in the present study.

Sealapex is a calcium hydroxide based sealer. It has been observed in some studies that, calcium hydroxide sealers showed a significant volumetric expansion during setting because of water absorption, which increases its solubility and its adhesion may be decreased.

ZOE-based sealers have represented the gold standard in endodontics for a number of years because of their long history of successful usage. However due to non-adherence to tooth structure, a microspace can exist between Zinc oxide based sealer and tooth preventing the establishment of a hermetic seal. Hence, several new resin cement sealants have been developed to be used instead of ZOE, thereby improving the root canal seal and imparting it more strength as compared to the conventional materials.

AH Plus a epoxy resin-based sealer has better penetration into the micro-irregularities, therefore has greater adhesion to root dentin.⁶

Over the last few decades endodontic treatment has reported very high success rates varying between 86% to 98%.⁷ However it is unfortunate that a smaller percentage of endodontically treated teeth have to be retreated. There are many causes for the failure of initial endodontic therapy that have been described in the endodontic literature, which include biological failings (infection), cysts, root fracture, incorrect diagnosis and primary treatment, foreign body reactions, healing with scar, neuropathic problems and economic constraints.⁸

Procedure for Retreatment consists of Diagnosis, Isolation, removal of coronal restoration, Post removal and Guttapercha removal. Once the tooth filling material is removed,

files are used to reshape the root canals, which are then cleaned, disinfected and filled with guttapercha.

Specialized rotary instruments have now been designed for retreatment such as ProTaper Universal retreatment instruments, Mtwo retreatment files and R-Endo retreatment files. ProTaper Universal retreatment instruments have been used in the present study. ProTaper Universal Retreatment Files are designed to be used in sequence to remove obturating materials. The three, easily identified files comes in 3 sizes D1, D2, D3 and are designed for the different needs of unfilling the coronal third, the mid-third and the apical third- before the canal reshaping. A working tip on the D1 file facilitates initial penetration.⁹

A study was done by Valentina et al to evaluate the efficiency of the ProTaper retreatment files, K-files and ProFile 0.06 with respect to removal of obturating materials. Sample group of 42 anteriors were used as part of the study. The teeth were prepared using nickel-titanium rotary instruments and obturated with gutta-percha cones along with sealer. These were then divided into 3 random groups. Solvent along with ProTaper retreatment files, K-file and ProFile 0.06 were used to remove the filling materials. Longitudinal sectioning of the roots were done. Finally the images of the root surface were captured in appropriate digital format. The ProTaper retreatment files showed better efficiency in removing obturating materials compared to ProFile rotary instruments and hand instruments. The teeth which were treated with ProTaper retreatment files showed cleaner root canal walls when compared to ProFile Rotary and K-file hand instruments.¹⁰

A mishap known to occur during retreatment is Apical Transportation. It occurs mainly due to the deviation of the instruments from the natural canal curvature. Apical transportation is an undesirable occurrence sometimes observed in the mechanical preparation of root canals that present pronounced curvature. It occurs mainly due to the straightening of the files to its original shape during the biomechanical preparation of the canals. Apical transportation hinders the complete cleaning of the entire root canal space, which results in failure of the proper disinfection of the canals, and hence can compromise the outcome of the endodontic therapy.

An in vitro study was done by **Fernando Goldberg** et al comparing the incidence of apical transportation after placement and removal of Ca(OH) on 20 mandibular molars and central incisors. No transportation was seen in straight canals, whereas in curved canals 9 out of the 20 canals showed apical transportation¹¹

Hence this study analyzed the incidence of Apical Transportation during retreatment in curved canals using three different sealers namely Zinc Oxide Eugenol, AH plus and Sealapex. The results of this study, demonstrated higher amount of apical transportation with AH plus compared to Zinc Oxide Eugenol and Sealapex. The maximum apical transportation occurred in the AHPlus group at 353 μm with a SD of ± 6.272 . This could be attributed to the fact that AH plus has better bonding with dentin and lesser solubility compared to Zinc Oxide Eugenol and Sealapex. It penetrates into the micro-irregularities of the dentinal tubules which increases the mechanical interlocking between the sealer and the root dentin. This fact together with the cohesion of the sealer molecules increases the resistance to removal from root dentin which can be translated as greater adhesion.¹²

A study done by Bodrumlu et al to evaluate the efficacy of 3 techniques namely System B device, Gates Glidden drill and a Gates Glidden drill plus chloroform in removing laterally compacted gutta-percha/AH Plus and Resilon/Epiphany from curved and straight canals during retreatment. Specimens obturated with gutta-percha/AH Plus showed comparatively more remnants of obturating material than specimens filled with Resilon/Epiphany for both curved and straight canals ($p < 0.05$) across all the removal techniques. The results obtained were similar to those obtained in our study where the resin based sealers showed greater adhesion to the dentinal walls and hence greater transportation when removed during retreatment.

Under the limitations of this study we could conclude that AH plus demonstrates greater resistance to removal from canal walls due to better adhesion to dentin and could lead to apical transportation during retreatment.

CONCLUSIONS

In the present quantitative study AH Plus demonstrated larger apical transportation compared to Zinc Oxide Eugenol and Sealapex.

This can be attributed to fact that AH plus has better bonding with dentin and lesser solubility compared to Zinc Oxide Eugenol and Sealapex..

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