Original Research Article

Evaluation of microleakage associated with four different endodontic sealers

ABSTRACT

Introduction: The main goal of the root canal obturation is to provide a three dimensional seal, thereby preventing the microleakage and reinfection of the canal, and preserving the health of the periapical tissues. It has been seen that the sealer used during root canal therapy has a direct link with the longevity of the treatment and occurrence of post-operative pain.

Objective: The aim of present study was to evaluate microleakage in extracted teeth of four different endodontic sealers (AH Plus, Sealapex, MTA Fillapex and Ceraseal) using dye penetration method.

Materials and Method: In this study, 84 extracted teeth were endodontically treated with four different sealers alongwith 2 control groups (n=14) and microleakage was checked in apical sections using dye penetration method under stereomicroscope.

Results: The maximum dye penetration was seen in Sealapex whereas least microleakage was shown by Ceraseal endodontic sealer.

Conclusion: Maximum microleakage was seen with calcium hydroxide based (Sealapex) while least microleakage was observed in bioceramic based (Ceraseal) sealer group.

Keywords: Microleakage; Dye penetration; Bioceramic sealer, Resin sealer, Calcium hydroxide sealer.

INTRODUCTION

In endodontics, microleakage is described as clinically imperceptible movement of microorganisms, ions, fluids and molecules between the root canal dentinal walls and obturation material or in spaces within the obturation material. This leakage is a

major factor influencing the long-term success of endodontic therapy as it causes many severe biological effects leading to failure of root canal treatment[1].

Ballullaya SV et al. (2017)[2] compared the microleakage in six root canal sealers and found that microleakage was maximum in ZOE sealer and minimum in Endosequence BC sealer due to their chemical bond with dentin. Also, **Remy V et al. (2017)**[3] compared the marginal adaptation and sealing ability of AH Plus, Endofill and MTA Fillapex sealer and observed that AH Plus has better marginal adaptation compared to other sealers used.

Jasrotia A et al. (2021)[4] compared the sealing ability of three different endodontic sealers using dye penetration method under stereomicroscope and they found that dye penetration was least for Ceraseal and Epiphany sealer and highest for AH Plus suggesting that Ceraseal bioceramic sealer and epiphany sealed the root canal better.

There are various methods to evaluate the microleakage such as bacterial penetration, fluid transport, dye penetration or clarification but dye penetration is the most commonly used as it is relatively easy and faster.

Since the apical seal, from irritants and bacteria, is an important determinant in the success of endodontic therapy, therefore, more research needs to be done on the sealing ability of the newly introduced sealers. The purpose of the present study was to evaluate microleakage in extracted teeth using dye penetration, of different endodontic sealers (AH Plus, Sealapex, MTA Fillapex and Ceraseal).

MATERIAL AND METHODS

Freshly extracted teeth were obtained from Department of Oral and Maxillofacial Surgery, Sri Guru Ram Das Institute of Dental Sciences and Research, Sri Amritsar, to check the apical sealing ability of four different root canal sealers (AH Plus, Sealapex, MTA Fillapex and Ceraseal) using stereomicroscope.

SAMPLE SIZE CALCULATION

The sample size was calculated by using the following formula as suggested by Charan and Biswas (2013)[5]

n=2*Z1-α/2 2 X SD2 /d2

Z1-α/2=Power of the study

SD: Assumed standard deviation of the study variable

d: Mean value n=2*1.96*1.96*(0.15*0.15) / (0.157*0.157) = 7 in each group

Taking into consideration the various factors, the sample size for the study was increased to 14 in each group. The results were presented in frequencies, percentage and mean±SD. The Chi-square test was used to compare categorical variables. The Unpaired t-test/One way analysis of variance (ANOVA) test had been used to compare continuous variables. The p-value <0.05 was considered significant.

The eighty four extracted teeth then were divided into the following groups:

GROUP-1(n=14):- AH Plus sealer (Dentsply, Konstanz, Germany)

GROUP-2(n=14):- Sealapex (Sybron Endo, USA)

GROUP-3(n=14):- MTA Fillapex (Angelus, Londrina-Parana, Brazil)

GROUP-4(n=14):- Ceraseal (Meta Biomed Co., Cheongju, Korea)

GROUP-5(n=14):- Negative control group (access opening and biomechanical preparation was done but no obturation was done)

GROUP-6(n=14):- Positive control group (unprepared sound teeth in which the apical part was also coated with nail varnish)

INCLUSION CRITERIA:

1. Single rooted teeth with single root canal configuration.

2. Permanent teeth with complete root development.

3. Teeth free of cracks and restorations.

EXCLUSION CRITERIA:

1. Previously root canal treated teeth

2. Teeth with evidence of resorption, craze lines, severe curvatures

3. Calcified canals

4. Teeth with root fracture

Procedure:

The extracted teeth were cleaned of organic debris and hard deposits were removed by an ultrasonic scaler. Teeth were washed with distilled water to remove any soft tissue debris and stored in 10% formalin until used.

Endodontic Preparation:

The teeth were decoronated at CEJ using a diamond disc mounted in a straight handpiece with micromotor. After sectioning, 10 No. K-file (Dentsply Maillefer) was inserted into the canal until the tip of instrument was first visible at apical foramen and then working length was established by 15 No. K file (Dentsply Maillefer). The canals were prepared using rotary instrumentation (neo endo system) via crown down technique in the sequential order of 17/4%, 20/4%, 25/4%, 20/6% and 25/6%. After each instrument, canals were copiously irrigated using 30-gauge needle (Orikam Healthcare Pvt. Ltd., India) with 5.25% sodium hypochlorite solution (Parcan, Septodont Healthcare India Pvt. Ltd., India) and then 17% ethylenediamine tetra acetic acid gel (Endo-L, Maarc Dental, Maharashtra, India) by coating it over the endodontic file. Normal saline was used as the final irrigant.

Obturation Technique:

After thorough cleaning and shaping, canals were dried using paper points and obturated with Cold Lateral Condensation Technique. The master gutta percha cone were selected according to the last file used at the working length and its apical portion adjusted till its tug back was achieved. The apical half of primary gutta percha cone and the root canal walls were coated with sealers. Spreader was inserted alongside the primary cone one mm short of working length to compact the apical part of canal. This process was repeated with secondary gutta percha cones until the entire canal filled with a well condensed gutta percha.

Microleakage Evaluation:

The prepared samples were stored in a sealed container at 37^{o}C, 100% air humidity for 72 hours. Samples were coated with nail varnish except for apical 2-3 mm. The

layer of varnish was allowed to dry and then immersed in dye for 72 hours, in different specimen containers. Samples were rinsed with running water and nail varnish was scrapped off with a surgical blade. All specimens were longitudinally sectioned in bucco-lingual direction using a diamond disc and straight hand-piece and the depth of dye penetration was analysed in millimetres. Evaluation of microleakage was done, using dye penetration method (2% methylene blue) under stereomicroscope at 30X magnification (Motic, Hong-Kong).The data calculated was sent for statistical analysis.

RESULTS

TABLE-1: Mean and Standard Deviation (SD) of different groups for microleakage after dye penetration

Group	N	Mean	SD
Group-I (AH Plus)	14	0.893	1.43015
Group-II (Sealapex)	14	3.136	1.50721
Group-III (MTA Fillapex)	14	1.864	1.4026
Group-IV (Ceraseal)	14	0.828	1.0794
Group-V (Negative Control)	14	10.8071	2.1120
Group-VI (Positive Control)	14	0.000	0.000
Total	84	2.9213	2.0327

TABLE-2: Statistical comparative analysis of mean dye penetration among various groups

Comparison	Mean Difference	p-value
Group I vs II	**2.243**	**0.001***
Group I vs III	**1.021**	**0.881**
Group I vs IV	**0.064**	**1.000**
Group I vs V	**9.914**	**<0.001****
Group I vs VI	**0.893**	**1.000**
Group II vs III	**1.221**	**0.386**
Group II vs IV	**2.307**	**0.001***
Group II vs V	**7.671**	**<0.001****
Group II vs VI	**3.136**	**<0.001****
Group III vs IV	**1.085**	**0.673**
Group III vs V	**8.938**	**<0.001****
Group III vs VI	**1.914**	**0.009***
Group IV vs V	**9.978**	**<0.001****
Group IV vs VI	**0.828**	**1.000**
Group V vs VI	**10.807**	**<0.001****

TABLE-2 depicts the statistical comparative analysis of mean dye penetration among various groups for evaluation of microleakage. The highly significant difference was seen between various groups with Group-V resulting in highest mean penetration in Group-V and significant difference was also seen in Group-II and Group-IV & between Group-I and Group-II

DISCUSSION

Root canal therapy not only aims to eradicate periapical inflammation and pathologies, but also to prevent the post-operative pain and its recurrence**. Muliyar S (2014)**[1] reported that about 60% of endodontic failures are due to inadequate filling of root canal space which further causes microleakage and hence failure.

Therefore, leakage tests are important in evaluating the excellence of the root canal treatment. In current study, microleakage evaluation has been done to check the sealing ability of endodontic sealers used. There are different methods to detect

microleakage such as dye penetration methods, electrical methods, fluid filtration technique, radioisotope tracing, glucose filtration, Scanning Electron Microscopy (SEM) and Confocal Scanning Microscopy (CFSM) are used [6].

The most commonly employed is the passive dye penetration method which is based on the linear measurement of the dye penetration the basic concept behind which is that it uses passive diffusion and capillary action in order to penetrate through any spaces between the canal walls and filling material[6]. Also, it is very sensitive, convenient, easy to use and dyes used are readily available. Dyes that can be used are Eosin, Methylene blue (MB), Black India 109 ink, Procion brilliant blue, etc[2].

Of all, the Methylene Blue (MB) is widely used dye and the concentrations of MB used are 0.25, 1 and 2%. The particle size of this dye is 0.1- 2 µm, corresponding best with the sizes of a number of endodontic pathogens. It appears to be suitable for application in dye leakage studies[7]. In present study, 2% Methylene Blue was used as it was most commonly used concentration. This stain is a standard material because it is simple, economical, and the same size as organic products such as butyric acid.

Most critical area of the prepared root canal is the apical 2-3 mm. This area has irregular and variable dentinal structure such as areas of resorption, presence of cementum like tissue that contour the apical root canal wall, atubular dentin and occasional pulp stones. Also, the number of dentinal tubules present and their size reduces in the apical area. Another important consideration is the reduced effectiveness of smear layer removal techniques and irrigants in the apical region. Hence, in the present study, dye penetration from apical one-third of root was checked among the tested groups[8].

AH Plus performed better than Sealapex with less depth of dye penetration (0.893mm) than the latter (3.136mm) and statistically significant difference (p-value=0.001). This could be due to low solubility, dimensional stability and adhesive nature of the sealer that provide sufficient seal and adequate sealing ability than that of Sealapex group[9].

In comparison to the specimens of MTA Fillapex, specimens of AH Plus showed less mean microleakage 0.893mm & 1.864mm respectively (TABLE-1). However, statistically insignificant difference (p-value=0.881) was found between the two

groups (TABLE-2). This could be due to the reason that both the sealers have increased adhesiveness and adaptation to the canal walls that resulted in insignificant difference between the two[10].

Also, in the current study, Ceraseal, a calcium silicate bioceramic sealer, performed slightly better (0.828mm) than AH Plus (0.893mm) with least mean microleakage values among the sealers used (TABLE-1). However, statistically insignificant difference (p-value=1.00) was found between the two groups as shown in TABLE-2. It can be concluded that this insignificant difference could be due to the similar water sorption and solubility of both the sealers that seemed to correlate with their sealing performance. So, it can be mentioned that both the sealers are comparable to each in terms of microleakage as both of them has minute particle size and can flow readily into the dentinal tubules[11].

Sealapex showed highest mean dye penetration (3.136mm) for microleakage and lowest (0.828mm) in Group-IV (TABLE-1). Statistically significant difference (p-value=0.034) was also seen among the two groups (TABLE-2). It was deduced that bioceramic sealer (Ceraseal) due to their small particle size and early formation of hard calcific barrier showed less microleakage than calcium hydroxide based sealer (Sealapex) [12].

Another conclusion can be drawn from results of the present study was that MTA Fillapex showed less mean dye penetration (1.864mm) depth than Sealapex (3.136mm) (TABLE-1) but statistically insignificant difference (p-value>0.386) was found between the two groups (TABLE-2).This could probably be due to the ability of both the sealers to produce hard tissue formation by releasing calcium ions which further favoured the sealability[13].

Mean value of microleakage was higher (1.864mm) for MTA Fillapex than that of Ceraseal group (0.828mm) as depicted in TABLE-1, however, the difference was statistically insignificant (p-value=1.00). This could be due to their comparable viscosity and flow to penetrate the canal irregularities alongwith their property to form hard tissue that resulted insignificant difference between the two groups in terms of their sealing ability[14].

LIMITATIONS OF THE STUDY

1. There were chances that operator bias could be seen in regard to sealer placement.
2. All the clinical conditions like presence of moisture, change of temperature, presence of variable masticatory forces etc. could not be simulated in an in-vitro study.

CONCLUSION

With reference to microleakage among sealers used in the study, Sealapex showed maximum (3.136) and Ceraseal (0.828) the least mean dye penetration depicting highest and lowest microleakage respectively. However, statistically significant difference was seen only between Sealapex & AH Plus and Sealapex & Ceraseal whereas no significant difference was found between the other groups. It was concluded that the apical sealing ability of AH Plus was almost similar to MTA Fillapex sealer, Ceraseal has the best and Sealapex the worst sealing ability.

REFERENCES

1) Muliyar, S, Shameem, KA, Thankachan, RP, Francis, PG, Jayapalan, C.S. and Hafiz, KA 2014, 'Microleakage in endodontics', Journal of International Oral Health, vol.6, no.6, pp.99-104.
2) Ballullaya, SV, Vinay, V, Thumu, J, Devalla, S, Bollu, IP and Balla, S 2017, 'Stereomicroscopic dye leakage measurement of six different root canal sealers', Journal of Clinical and Diagnostic Research, vol.11, no.6, pp.ZC65-68.
3) Remy, V, Krishnan, V, Job, TV, Ravisankar, MS, Raj, CR and John, S 2017, 'Assessment of Marginal Adaptation and Sealing Ability of Root Canal Sealers: An in vitro Study', The Journal of Contemporary Dental Practice, vol.18, no.12, pp.1130-34.
4) Jasrotia, A, Bhagat, K and Sharma, N 2021, 'Comparative evaluation of sealing ability of bioceramic sealer, AH plus and epiphany sealer: an in vitro study', Journal Advanced Medical Dental Sciences and Research, vol.9, no.4, pp.121-24.

5) Charan, J and Biswas, T 2013, ‘How to calculate sample size for different study designs in medical research?’, Indian Journal of Psychological Medicine, vol.35, no.2, pp.121-26.

6) Raghuvanshi, R, Dubey, M.S.S.D.C. and Pushkar, AP 2018, ‘A Comparative Evaluation of the Apical Microleakage in Root Canals Sealed with Bioceramic, Resin Based and Glass Ionomer Root Canal Sealers: An Ex-Vivo Study’, Journal of Research and Advancement in Dentistry, vol.8, no.3, pp.46-55.

7) Al-Kadhi, A.M.A.A, Al-Ani, Z.B.M.A. and Al-Eanizi, J.A.J 2019, ‘Comparison of apical microleakage of four contemporary endodontic sealers by dye penetration method’, International Medicine Journal, vol.26, pp.237-40.

8) Gutmann, J.L. and Fan, B 2016, Cohen's Pathways of the Pulp, Elsevier publications, St. Louis.

9) Lone, MM, Khan, FR and Lone, M.A 2018, ‘Evaluation of microleakage in single-rooted teeth obturated with thermoplasticized gutta-percha 127 using various endodontic sealers: an in-vitro study’, Journal of the College of Physicians and Surgeons Pakistan, vol.28, no.5, pp.339-42.

10) Meidyawati, R and Suprastiwi, E 2017, ‘Comparison sealing ability of MTA sealer and resin epoxy sealer’, Journal of International Dental and Medical Research, vol.10, no.1, pp.134-38.

11) Hasnain, M, Bansal, P and Nikhil, V 2017, ‘An in vitro comparative analysis of sealing ability of bioceramic-based, methacrylate-based, and epoxy resin-based sealers’, Endodontology, vol.29, no.2, pp.146-50.

12) Lin, G.S.S., Ghani, N.R.N.A., Noorani, TY and KAMARUDİN, A 2020, ‘Apical sealing ability of different endodontic sealers using glucose penetration test: a standardized methodological approach’, Cumhuriyet Dental Journal, vol.23, no.2, pp.79-87.

13) Jain V, Chawdhary P, Kaushik M, Roshni R, Mehra N 2017, ‘Qualitative and quantitative analysis of apical microleakage of different endodontic sealers’, International Journal of Advanced Research, vol.7, no.6, pp.476-81.

14) Zhou, HM, Shen, Y, Zheng, W, Li, LI, Zheng, YF and Haapasalo, M 2013, ‘Physical properties of 5 root canal sealers’, Journal of Endodontics, vol.39, no.10, pp.1281-86.