Comparison of Microleakage in Root Canals Obturation Using Zinc Oxide-Eugenol and Epoxy Resin Based Sealer

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Abstract. This study aims to determine the differences in microleakage of root canal obturation using two different sealers, zinc oxide-eugenol based sealer and epoxy resin based sealer. The subject of the research was using 32 mandibular premolars. The subjects were randomly divided into 2 groups each consisting of 16 teeth. The group I was root canal obturation with zinc oxide-eugenol based sealer and group II was root canal obturation with epoxy resin based sealer, respectively. The entire root surface coated with two coats of nail polish except the apical 1 mm and soaked with 2% methylene blue solution for 1 week at 37°C. Penetration of the color of methylene blue solution is an indicator of an apical leakage. The results showed that root canal obturation with epoxy resin based sealer has lower apical leakage than root canal obturation zinc oxide-eugenol sealer ($p<0.05$).

Keywords: apical leakage, root canal sealants, root canal obturation

1. Introduction

Root canal treatment without obturation or with improper obturation is termed as incomplete root canal treatment. Ingle and colleagues radiographically studied endodontic success and failure; they indicated that 58% of treatment failures were due to incomplete obturation [1]. The three dimensional (3D) obturation is the primary objective of root canal therapy, the purpose of obturation in turn is to seal all "portals of exit". Obturation impedes any sort communication between periapex, periodontal space and root canal, thus entombing the micro- organisms and preventing re-infection by spread of microbial toxins [2] .

The prevention of recontamination and spreading of bacteria and their products into periapical tissues is done by root canal obturation with different types of gutta-percha and in addition root canal sealers. The function of root canal sealers is to block the pathway of bacteria and to prevent micro-leakage, Root canal sealers should prevent recontamination by sealing the lateral and the main canal and to prevent colonization of bacteria, in addition penetration to dentinal tubules is very important feature, root canal sealers should fill the space which created between the gutta-percha and the root canal wall. Today there are seven types of root canal sealers which are using in practice and can be classified according to their chemical composition such as mineral trioxide aggregate (M.T.A) based sealer, zinc oxide eugenol based sealer, epoxy based sealers silicone-based sealer, bioceramic based sealer, calcium hydroxide based sealer and glass ionomer based sealer. [3]

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The present study was undertaken to compare and evaluate the apical sealing ability of frequently used epoxy resin based sealer with the old zinc oxide eugenol sealer[4],[5]. The null hypothesis tested was that there are differences in the apical sealing ability between the sealers groups tested.

Tissue fluid leakage from the apex is the biggest cause of failure of root canal treatment because it can supply nutrients to the remaining bacteria in the root canal. The filler material is expected to have a low microleakage rate to produce a good filling density to support the success root canal treatment [6],[7]. In general, obturation techniques using gutta-percha can be classified into various kinds [8],[9].

Leakage into the root canal system can occur in four ways, namely through the apical foramen, which is between the obturation material and the root canal wall, through the apical foramen by diffusing into the obturation material, from the outside of the tooth through the open cementum and the root canal accessories, and through the cavity access from the corona. Evaluation of the apical leakage in root canal obturation can be done by several methods, including by penetration test of the dye solution, radioisotope technique, electrochemical technique, bacterial penetration test and scanning microscopic electron analysis, fluid filtration technique and dye penetration method. The apical leakage evaluation that is widely used is the penetration test of the dye solution. This method is widely used because it is fast, easy to do, low cost and does not require modern equipment [10]. The most commonly used substances are methylene blue dyes. Leakage measurements can be done by splitting the roots longitudinally, transversal cut, decalcification, and transparency on the roots [6].

2. Materials and Methods

The design used in this research was an experimental laboratory. The study was conducted at the Department of Operative Dentistry of UPDM FKG (B), in April 2018. Samples were chosen randomly with the same treatment. Samples of mandibular premolar teeth were divided into 2 types of root canal sealer, namely root canal filling the group with epoxy resin based sealer and zinc oxide eugenol sealer. root canal filling group with Each group was consisting of 16 samples. The obturation technique was using a thermoplastic technique obturation.

The sample size was obtained based on Frederer's formula:

$$(t-1)(n-1) > 15$$
$$(2-1)(n-1) > 15$$
$$1(n-1) > 15$$
$$n > 16$$

t: Number of treatment groups
n: Number of samples

The research tools and materials used were: Lower premolar teeth with single root canals, rotary Protaper files, stainless steel K files No.10, 15, 20, lentulo needles, endodontic irrigation syringes and needles, 40 times magnification of light microscopes, Thermaprep plus oven, Endomotor, Access Bur Kit (Dentsply, Carborandum disc, Single cone gutta-percha (protaper), Paper point, Endomethasone Sealer, transparent nail paint, 2.5% NaOCl, EDTA gel, 70% and 96% alcohol, 1% methylene blue solution, 100% methyl salicylate solution, Glass Ionomer Cement (GIC) [9].

All teeth then were soaked with 0.9% NaCl for 1 week. The samples were divided randomly and divided into 2 study groups of 16 teeth, respectively: group I (with epoxy resin based sealer) and group II (with zinc oxide eugenol sealer). The root canal that had been prepared was then irrigated, dried with paper. Both research groups were coated with the chosen sealer. Both of the group were obturated with preheated Thermafil obturator using a Thermaprep plus oven for 30 seconds according to the manufacturer's instructions, after that, it was inserted into the root canal according to the length of work. After that, using a plugger which size was suitable for extra vertical condensation. Then the carrier was cut 2mm in the direction of the corona from the orifice with a Thermacut Bur. The remaining gutta-percha was removed using an excavator [11],[12].

After filling was complete, the density of the filling results of all samples was evaluated with a photo radiograph. The coronal section was given glass ionomer cement. Then the outer surface of the tooth root was covered with two layers of nail polish except at 1 mm from the end of the apex. The first layer was allowed to be dried at 37 ° C for 1 hour, then proceed with the application of the second layer with steps such as the first application [9].

After 1 day, all samples were soaked in 1% methylene blue solution for 7 days at 37°C. After the sample was removed from the 1% methylene blue solution, the sample was then washed under running water and the nail polish was cleaned. Then the next step was dehydration, which was soaking the sample in 70% and 96% alcohols, 24 hours each. Then the sample was immersed in a methyl salicylate solution at 37°C for 2 hours. Then the teeth were rinsed under running water until those were clean and then made a scratch on the teeth in the apex third in a longitudinal manner using a carborundum disc with the cutting machine. Next, the teeth were split following the direction of the scratches until they were split into two. Evaluation of root canal filling was done after all the specimens were cleaved based on the penetration of 1% methylene blue solution on the cavity wall of the premolar teeth from a score of 0 to 1[9].

The score was determined based on:
0: There was no microleakage
1: Microleakage occurred

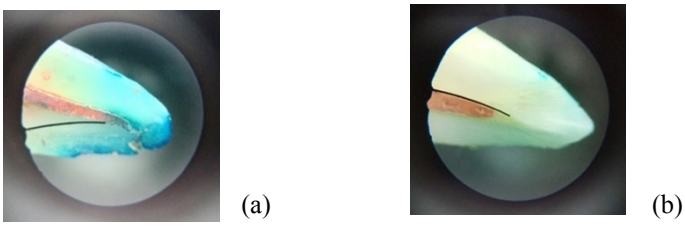
(a) (b)

Fig1. Criteria for microleakage scores in the group (a) Score 1 and (b) Score 0. Then from the data obtained for most microleakage scores

Data of dye penetration into the root canal were analyzed using the t-independent parametric statistical test to test the significant difference in all groups

3. Result

From the research that had been conducted on 32 dental samples (each group of 16 samples), the following data was obtained:

Table 1. Distribution of microleakage score in both groups

No	Group	Microleakage score		Total sample (n)
		0	1	
1	Epoxy resin based sealer	4	12	16
2	Zinc oxide eugenol sealer	0	16	16
	Total	4	28	32

In Table 1, in a total of 32 samples, there were 28 samples that experienced microleakage and 4 samples that did not experience microleakage. It could be seen that the root canal filling test group with zinc oxide eugenol sealer had 16 samples that had microleakage (score 1). Root canal filling test group with epoxy resin based sealer there were 12 samples which experienced microleakage (score 1) and 4 samples which did not experience microleakage (score 0).

Tabel 2. Mean Difference Microleakage Score with two different Sealer (N=32)
*p≤0.05,CI 95%, Independent T-test

Leakage Score	**Mean (SD)**	**P**
Epoxy Resin based sealer	0.75 (0.447)	0.041*
ZOE based sealer	1 (0.000)	

The results of this study in Table 1 and 2 had a total of 32 samples with 16 samples per group, the epoxy resin based sealer group had a lower leakage rate than the ZOE based sealer group. Based on the results of the Independent T-test statistical test obtained the value of 0,041 where Df = 1 ($p \leq 0.05$). This means that the proportion of microleakage on root canal filling in epoxy resin based sealer techniques was significantly different from the ZOE based sealer group. From the results of the study, it was found that the level of microleakage in root canal filling in the epoxy resin based sealer was lower than the Zinc Oxide eugenol based sealer group.

4. Discussion

This study was conducted in the third apex which is the hardest area to be cleaned, prepared and filled because it has a very complex anatomy that is the number of lateral root canals. The quality of root canal filling density is needed to prevent leakage because it will cause maintenance failure [9].

The root canal filling techniques that were compared in this study were a single gutta-percha thermoplastic using two different sealer. Obturation material was divided into two, namely the main obturation material and the root canal sealer. Gutta-percha is the main obturation material that is often used because it is biocompatible, plastic when heated, and easily removed both post-treatment for post placement and retreatment [13].

Various types of sealers are available, from Eugenol based, non-eugenol to most recent being Calcium silicate sealers. Each of them have their own inherent drawbacks, still the search for ideal sealer is on.

This study used an extracted mandibular first premolar to help the testing because it had single and straight roots, thus allowing uniformity of the sample. The number of samples was 32 teeth which contained 16 teeth per group according to Federer's formula. The root canal preparation limit was determined 1 mm from the apex because if limited to the foramen apex it would push debris to the apex more. Root canal preparation in this study was carried out with machine instruments, the irrigant used in this study was 2.5% NaOCl and EDTA gel. The use of NaOCl combined with EDTA aimed to effectively remove the smear layer. This was because NaOCl could only remove the organic component of the smear layer, and the one that could remove the inorganic component of the smear layer was EDTA. Smear screen could reduce the ability of sealer to penetrate into the dentinal tubules when obturating a root canal [13].

To evaluate the sealing ability of sealers, tracers like dyes, radioisotopes, bacteria and their products, such as endotoxins and other methodologies like fluid filtration and dye extraction method have been used [14]. One of the commonly applied methods to evaluate the sealing ability of different root filling materials and techniques is based on linear measurement of dye penetration. Dyes like Eosin, Methylene blue, Black India Ink, Procion brilliant blue, etc are used. Methylene blue dye was used in this study as its molecular size is similar to bacterial by- products such as butyric acid which can leak out of infected root canals to irritate periapical tissues, also it is easy to use, pH manipulation and availability add to it advantages [15],[16]. In our study the flow of methylene blue dye in the tooth through the apex, determined the result for the sealers evaluated. Methylene blue dye has the potential to enter the obturated canals through complex anatomies of apical third of the root canal or space between dentin-sealer-core material interfaces. The vertical and horizontal penetration of dye was measured in units by a stereomicroscope using micrometer eye-piece to achieve more accurate results.

Studies in past have evaluated the apical sealing ability of various sealers by different methods like antibacterial effectiveness, fluid filtration method and use of SEM, light microscope or digitally captured images for evaluation of sealer- dentin interface [17]. The present study was done to compare and evaluate the amount of apical leakage in root canal walls after obturation using two different root canal sealers, using dye penetration method.

Among various types of sealer used today AH plus has gained popularity due to its radiopacity, biocompatibility, ease to use and availability. AH Plus is an epoxy-bis-phenol resin based sealer that also contains adamantine and bonds to root canal [15]. It is a two-component paste/paste root canal sealer. Since it contains resin and has faster setting time AH Plus tends to shrink and cause early debonding from the root canal wall. AH plus has greater adhesion to root dentin than Zinc Oxide eugenol sealer, it can be likely due to the fact that, as an epoxy resin-based sealer, AH Plus has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin. Moreover, it has low solubility, small expansion while setting and bond to root dentin through adamantine [14], [15].

In the present study, Zinc Oxide Eugenol sealer showed the highest amount of microleakage compared with all groups. Method for analyzing microleakage was by the method of penetrating dyes with longitudinal cutting technique. The advantage of longitudinal cutting technique was that visualization of apex leakage at millimeter size [18]. The color substance used in this study was methylene blue. Torabinejad stated that root canal filling

materials did not allow to penetrate small particles such as dye molecules; this was more likely to prevent microleakage from bacteria. Therefore, this study used methylene blue because it had a light molecular weight and penetrated deeper along the root canal filling [19].

The results of the study in Table 2 showed that all samples in the zinc oxide eugenol based sealer group experienced microleakage. The sealer entered the dentinal tubules through a mechanical bond, while the sealer with the root canal wall that occurred was a chemical bond. The mechanical and chemical bonds that occurred between the gutta-percha and the sealer became unstable and strong due to poor adaptation and homogeneity [20][21].

Various ingredients and techniques had been developed to improve the obturation quality in the root canal. However, none of the techniques and materials could avoid microleakage. Pashley stated that microleakage was a serious clinical problem because most dental materials showed different levels of microleakage. The most important prerequisite for endodontics was debridement of the pulp chamber as a whole, the fluid-tight seal on the apical foramen and thorough root canal cleansing. Therefore, the microleakage test was a relevant way to evaluate root canal filling [22].

5. Conclusion

The highest microleakage occurred in the root canal group obturated with zinc oxide eugenol sealer. The lowest microleakage occurred in the root canal group with epoxy resin based sealer.

References

[1]. Ingle JI, Bakland LK, Baumgartner JC.: Ingle's Endodontics 6 th ed. Hamilton: BC Decker Inc; p. 1053-87 (2008)

[2]. Nair U, Ghattas S, Saber M, Natera M, Walker C, Pileggi R. : A comparative evaluation of the sealing ability of 2 root-end filling materials: An *in vitro* leakage study using Enterococcus faecalis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. Vol 112, pp.74-7 (2011)

[3]. Willershausen I, Callaway A, Briseño B, Willershausen B. In vitro analysis of the cytotoxicity and the antimicrobial effect of four endodontic sealers. Head Face Med.Vol 7, pp 15 (2011)

[4]. Kossev D, Stefanov V. Ceramics-based sealers as new alternative to currently used endodontic sealers. Roots . pp 42-8. (2009)

[5]. Ken K. A Review Of Bioceramic Technology In Endodontics. Roots. Vol 4, pp 6-12 (2012)

[6]. Schmalz G, *Root Canal Filling Materials*. In: Bergenholtz G, Bindslev PH, Reit C (Editor), Textbook of Endodontology. Victoria: Blackwell Publishing Company. pp 261-85(2003)

[7]. Saunders WP, *Apical and Coronal Leakage.* Dalam: Bergenholtz G, Bindslev PH, Reit C (Editor), Textbook of Endodontology. Victoria: Blackwell Publishing Company. pp 192-98 (2003)

[8]. Bergenholtz G, Preben HB, Claes R. *Textbook of Endodontology,* 2th ed. (2010)

[9]. Poedyaningrum F. Perbandingan Kebocoran Mikro Sepertiga Apeks Pada Pengisian Saluran Akar Dengan Semen Resin Epoksi dan MTA. Ilmu Konservasi Gigi, [Tesis]. Jakarta: Universitas Indonesia; (2013)

[10]. Ruli Y, Ema Y, Wignyo H. Perbedaan Kebocoran Apikal pada Obturasi Saluran Akar Menggunakan Tiga Siler Berbahan Dasar Resin. *J Ked Gi*; 4(2), pp 122-28 (2013)
[11]. Christine WI, Diatri NR, Wignyo H. Pengaruh Teknik Obturasi Saluran Akar Dengan Kondensasi Lateral, Warm Gutaperca Dan Carrier-Based Gutaperca Terhadap Kebocoran Apikal. *J Ked Gi*; Vol 2(3), pp 143-15(2011)
[12]. Cohen S. Burns R. *Pathways of the pulp.* 12th ed, St. Louis : Mosby. (2012)
[13]. Kurniawan. Perbandingan Adaptasi Tepi Sepertiga Apikal Apeks Antara Teknik Kompaksi Lateral Panas, Carrier-Based Gutaperca, Dan Downpack Backfill. Ilmu Konservasi Gigi, [Tesis]. Jakarta: Universitas Indonesia; (2014)
[14]. Veríssimo DM, V. do, Methodologies for assessment of apical and coronal leakage of endodontic filling materials: a critical review. *Journal of oral science*. 48, 93–98 (2006).
[15]. M. Tanomaru-Filho *et al.*, Evaluation of the thermoplasticity of gutta-percha and Resilon?? using the Obtura II System at different temperature settings. *International Endodontic Journal*. Vol 44, pp 764–768 (2011).
[16]. Tay FR, Loushine RJ, Weller RN, Kimbrough WF, Pashley DH, Mak YF, *et al*. Ultrastructural evaluation of the apical seal in roots filled with a polycaprolactone-based root canal filling material. J Endod. Vol 3 pp 514-9 (2005)
[17]. Figdor D. Apical periodontitis: A very prevalent problem. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. Vol 94, pp 651-2 (2002)
[18]. Cohen S. Burns R. *Pathways of the pulp.* 12th ed, St. Louis : Mosby. (2012)
[19]. Sadr S, Golmoradizadeh A, Raoof M, Tabanfar MJ. Microleakage of Single-Cone Gutaperca Obturation Technique in Combination with Different Types of Silers. *Iranian Endodontic Journal*. Vol 10(3): pp 199-203 (2015)
[20]. Neuhaus KW, Schick A, Lussi A. Apical Filling Characteristics of Carrier-Based Techniques vs. Single Cone Technique in Curved Root Canals. *Clin Oral Invest*. Vol 20: pp1631–7 (2016)
[21]. Edwin R, Mulyawati E, Ratih DN. The Difference of ZOE Based Siler and Resin Based Siler Used With Termoplastik Obturation Technique Continuous Wave of Condesation and Carrier-Based Gutta Percha on Apical Leakage After The Root Canal Treatment. *J Ked Gi*; 2(1), Januari 2011:43-9.
[22]. Inan U, Aydin C, Tunca YM, Basak F. In Vitro Evaluation of Matched-Taper Single-Cone Obturation with a Fluid Filtration Method. *JCDA*. Vol 75(2),pp123a-c. (2009)