Tikrit Journal for Dental Sciences 12(2) (2024) 265-271
https://doi.org/10.25130/tjds.12.2.2

Tikrit Journal for Dental Sciences
https://tjds.tu.edu.iq
ISSN:2073-1213

Assessment of Apical Microleakage of Three Based Endodontic Sealers

Saif Saad Kamil [(1)] *
[(1)] Department of Operative, College of dentistry, Tikrit University, Tikrit, Iraq

Keywords:
apical microleakage, dye penetration method, root canal sealers

Article Info.:

Article History:
Received: 2/9/2023
Received in revised form: 1/11/2023.
Accepted: 5/11/2023
Final Proofreading: 5/11/2023
Available Online: 1/12/2024

Citation: **Kamil SS. Assessment of Apical Microleakage of Three based Endodontic sealers. Tikrit Journal for Dental Sciences 2024; 12(2): 265-271.**
https://doi.org/10.25130/tjds.12.2.2

***Corresponding Author:**
Email:
saif1990@tu.edu.iq

(1) Department of Operative, College of dentistry, Tikrit University, Tikrit, Iraq

Abstract

Aim of the study: to examine the apical microleakage of three distinct endodontic sealers: One-fil, Sealapex and EssenSeal utilizing a dye penetration technique. **Materials and methods**: Thirty single-canal mandibular premolars were extracted from human for orthodontic purposes. The teeth were cleaned and the appropriate working length was measured. It was instrumented, and it was irrigated. The samples were separated into three categories according to the type of sealer that were obturated by it. These endodontic sealers are: One-fil (bioceramic sealer), Sealapex (calcium hydroxide sealer) and EssenSeal (zinc oxide eugenol sealer). Following the manufacturer's guidelines, the sealer was manipulated and applied. F3 (protaper system) gutta-percha was used to obturate all of the specimens. Obturated samples were sectioned, the apical microleakage was examined using the dye penetration technique, and microleakage was calculated with Kinovea software. The data was analyzed using a one-way ANOVA and post-hoc Tucky test. **Results:** The statistical analysis of the endodontic sealers in this study shows a statistical difference between the three types of root canal sealers ($P < 0.05$).

Conclusions: This study found that the apical seal of a One-fil sealer was the most effective, followed by a Sealapex and then a EssenSeal sealer.

Introduction:

Endodontics has developed into a sophisticated field that may maintain grossly carious or diseased teeth and keep them in the patient's mouth where they belong by disinfecting the canals thoroughly and forming a three-dimensional seal [(1)]. The canal must be sealed and occluded in all three dimensions in order to get successful endodontic treatment for the long term [(2)]. Microleakage inside root canal system is used to evaluate the quality of an apical seal [(3)]. Microleakage and consequent

treatment failures may be avoided using recent products of obturation materials and procedures that allow for more sealer and gutta-percha penetration into canal complexity [4].Therefore, an endodontic sealer plays a major role in the sealing quality of a root canal filling[5]. Moreover, it showed the type of endodontic sealers during filling root canals contributes greatly to endodontic therapy's effectiveness. To avoid microbial re-contamination after root canal filling and to alleviate periapical irritation, the sealers must have certain physical, chemical, and biological properties[6]. The most common root canal sealers include zinc oxide eugenol, calcium hydroxide, bioceramic, glass ionomer and resin. The chemical components of these sealants have led to their classification into several subsets. The sealers used in this study are One-fil, Sealapex and EssenSeal. The One-fil is a calcium silicate based bioceramic root canal sealer. Sealapex is the original non-eugenol, calcium hydroxide polymeric root canal sealant. EssenSeal is a new generation zinc oxide eugenol sealer featuring tea tree essential oil. The most popular procedure for assessing apical microleakage for root canal sealer in vitro is the dye penetration method in which the tooth is submerged in a dying solution and the degree of dye penetration is quantitatively measured[7,8]. The null hypothesis will test there is no significant difference in the apical microleakage of various sealers: One-fil, Sealapex and EssenSeal.

Materials and Methods

Sample Collection

Thirty single-rooted mandibular premolars were chosen for this investigation, all of the teeth had just been extracted for orthodontic purposes. The radiographs were used to ensure that the teeth met the selection criteria, which included having a completely developed apex, a single canal, a canal that was not calcified, no evidence of internal resorption and a lack of caries or previous root canal therapy [9].

Sample Preparation and Distribution

Plaque, calculus and other debris are removed from the tooth's surface, and then the teeth are submerged in a 2.5% NaOCl solution for 2 hours for disinfection purposes [10]. Then, the digital vernia with the diamond disc bur was used to standardize the length of all teeth to be 15 millimeters from the apex. High-speed bur was used to make access opening and a water spray cooled the area. The canals' apical patency was then verified by inserting a K-file of (size 10) 1 mm below their apices. Working length (WL) was measured at less than 1 mm from the apical foramina[11] .

All samples were placed in blocks composed of silicone impression material to get more standardization during the process of preparing and filling root canals. Then following the manufacturer's instructions, teeth were prepared using a pro taper rotary system with a low speed handpiece coupled to an electric engine at a constant speed of 250 RPM and torque of 2.5 Ncm up to size F3. Each canal's irrigation solution consisted of 5 milliliters (2 minutes) of 2% sodium hypochlorite. After the cleaning process was finished, The canals were washed for a minute with 5 mL of 17% ethylenediamine tetra-acetic acid. Finally, any remaining irrigating solution was removed by rinsing the canal with distilled water (5 ml) for 2 minutes[12].After that, a paper point size (F3) was used to dry the canal.

Application of Sealers

According to the sealer used, the stored roots were randomly divided into three groups (n=10/group). Group 1: One-fil (bioceramic sealer) Group 2: Sealapex (calcium hydroxide sealer) Group 3: EssenSeal (zinc oxide eugenol sealer). All sealers were applied as specified by the manufacturer’s instructions. Obturation with F3 gutta-percha was performed on all samples. The samples were taken out of the blocks of silicone impression material and put in an incubator at 37 degrees Celsius and 100% humidity for 30 days while wrapped in gauze moistened with distilled water to mimic the clinical environment as closely as possible[13]. The

composition of examined endodontic sealers are listed in Table(1).

Measurement and Evaluation of apical microleakage

After collecting the samples from an incubator , they were dried and put away for a day. To prevent the methylene blue dye from entering into the root canal system, all samples were covered with three coats of nail varnish for each group, except at the apical 2 mm[14]. The root samples were submerged in a sterile plastic container containing in 2% methylene blue dye for 72 hours. Then the root samples were cleaned for an hour in running water and dried[15].

Each root was sectioned longitudinally by created grooves in buccal and lingual directions along the canal without penetration of the gutta-percha, using two-sided diamond disc with copious water irrigation. Micrographs of sample sections were taken using a stereomicroscope, and then saved to a computer in JPEG format for further analysis and storage Fig. (1).

The Kinovea software was calibrated by measuring the dye-penetrated surface using a plastic ruler with a millimeter scale that was put next to each root sample and the ruler that appeared in each photograph Fig. (2) [16].

The length of the linear stained region at the interface of the root canal wall and the filling material was measured in millimeters on both sides of each root half using the Kinovea software [17].

Results:

The mean and standard deviation of dye penetration with minimum and maximum values were calculated for each group of sealers as shown in Table (2)

The group related to a One-fil had the lowest mean for penetration of the dye, followed by those related to a Sealapex. In addition, those who used a EssenSeal had the highest levels of dye penetration. To test if any statistical difference exists in the mean sealing ability among sealers. ANOVA was performed in Table (3). The outcome-showed a statistical difference (P-value ≤ 0.05) among groups obturated with different sealers. It was marked from ANOVA test that there is a statistical difference among the sealers group. But, to know where the differences existed the post-hoc Tucky test was done Table (4). Post-hoc Tucky test showed statistically different between One-fil and Sealapex. Moreover, it showed difference statically between EssenSeal with other types of sealers (One-fil and Sealapex).

Discussion:

The effectiveness of endodontic therapy relies on many factors, one of which is the three-dimensional sealing of the root canal, which serves a crucial function in avoiding reinfection of the canal and maintaining the health of periapical tissues. The main components of root canal filling materials are semisolid gutta-percha cones, and appropriate root canal sealers. The endodontic sealer plays a major role in achieving this purpose[18] Therefore, three root canal sealers were tested for their apical microleakage in this study. In this study, the One-fil had the best apical seal among the tested sealers. This bioceramic sealer has moisture adaptation, enhanced heavy penetration within the dental tubule to establish a tag, formation of hydroxyapatite that promotes a chemical link with the root canal dentin, limited expansion and no shrinkage, and minimum film thickness [19]. The result of this study agreed with prior study by Mahendra *et al* which concluded that the apical sealing of the bioceramic-based sealer has greater than the apical sealing of the zinc oxide eugenol sealer [20].

Also, the result of this study consistent with the findings of many prior studies. Al-Kadhi *et al*. [21] found that the apical seal in bioceramic endodontic sealer was significantly higher than the other sealers (resin based and silicon based sealers). Ballullaya *et al*.[22] found that bioceramic sealers had superior sealing ability to resin-based sealer when they used the dye penetration technique, Thus the results of this study are consistent with theirs.

The result of this study also contradicted those of Trivedi *et al*. [23] and Jafari et al. [24], who reported that resin-based sealer was more effective at apical sealing than

MTA Fillapex. Possible causes for the inconsistent findings in researches include variations in the sealers used and the methods for measuring microleakage.

The results of this study showed lower dye penetration in groups filled with Sealapex than the groups filled with EssenSeal. This is because Sealapex (calcium hydroxide sealer) contains calcium hydroxide which released calcium and hydroxyl ions over time that may elevate the pH and thus interfering with the osteoclastic activity and promoting an alkalinization in the adjacent tissues and promoting healing[25].

This study shows that EssenSeal provides a more apical leakage than other types of sealers.

These results were consistent with the findings by Barnett et al [26] who found the zinc oxide eugenol sealer had more coronal leakage than the other endodontic sealers. Moreover, Chailertvanitkul *et al* [27] found that teeth that were filled by lateral condensation technique with zinc oxide eugenol sealer showed toatl bacterial microleakage within ninety days. This result may be because the zinc oxide eugenol sealers take a long time to set, have poor solubility, and shrink significantly once dry [28].

Conclusion:

Apical seal ability was highest for One-fil, lowest for EssenSeal and intermediate for Sealapex.

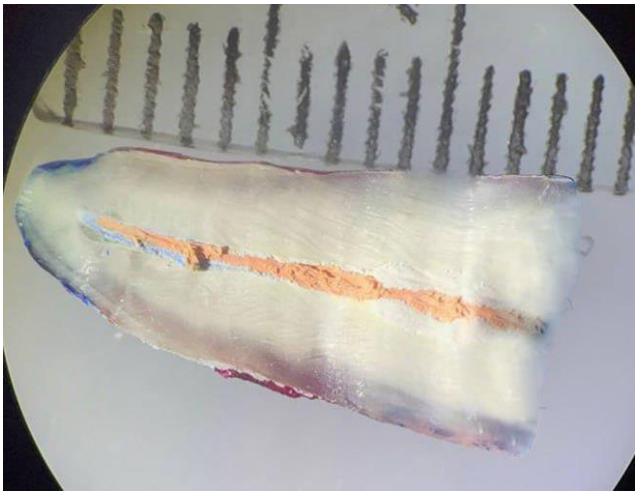

Figure (1): The sectioned sample under- magnification.

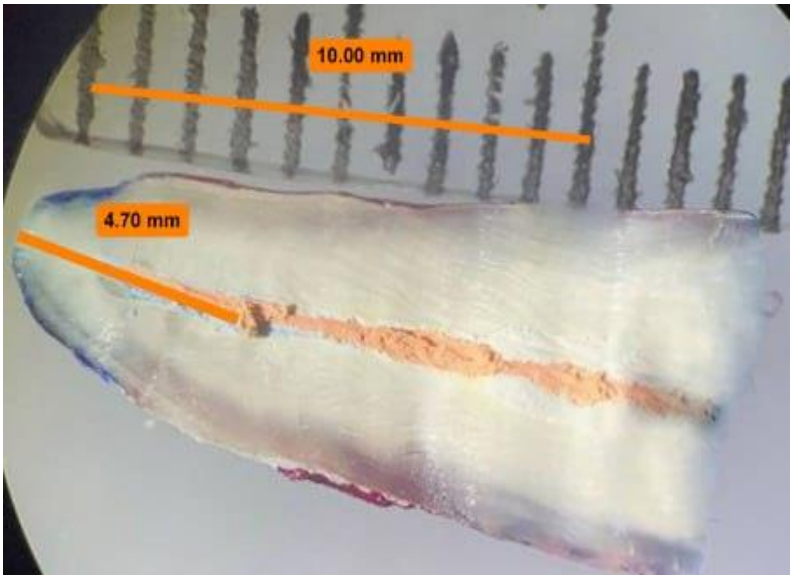

Figure (2): Measurement of dye infiltrated surface by using the Kinovea program.

Table (1): The composition of examined endodontic sealers

Material	Composition
One-fil (MEDICLUS, South Korea)	Zirconium oxide, Calcium alumina silicate, Hydrophilic polymer
Sealapex (Sybron-Kerr, Romulus, MI, USA)	Base: N-ethyl toluene solfanamide resin, fumed silica, zinc oxide, calcium oxide. Catalyst: Isobutyl salicylate resin, fumed silica, bismuth trioxide, titanium dioxide pigment
EssenSeal (PD, Switzerland).	tea tree essential oil (Melaleuca) Powder thymol iodide ,Polyoxymethylene , Acetate ,Excipient ad ,Liquiod eugenol

Table (2): The mean and standard deviation of dye penetration with minimum and maximum values

VAR00001								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
EssenSeal	10	5.2900	.58820	.18600	4.8692	5.7108	4.48	6.27
Sealapex	10	3.5290	.62160	.19657	3.0843	3.9737	2.22	4.12
One-fil	10	1.4790	.45369	.14347	1.1545	1.8035	1.01	2.13
Total	30	3.4327	1.67334	.30551	2.8078	4.0575	1.01	6.27

Table (3): ANOVA test for dye penetration among different types of sealer

One Way ANOVA					
VAR00001					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	72.758	2	36.379	116.326	.000
Within Groups	8.444	27	.313		
Total	81.202	29			

Table (4): Post-hoc Tucky test for dye penetration among different types of sealer

Dependent Variable: VAR00001 **Post-hoc Tucky test**						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
EssenSeal	Sealapex	1.76100*	.25009	.000	1.1409	2.3811
	One-fil	3.81100*	.25009	.000	3.1909	4.4311
Sealapex	EssenSeal	-1.76100*	.25009	.000	-2.3811	-1.1409
	One-fil	2.05000*	.25009	.000	1.4299	2.6701
One-fil	EssenSeal	-3.81100*	.25009	.000	-4.4311	-3.1909
	Sealapex	-2.05000*	.25009	.000	-2.6701	-1.4299
*. The mean difference is significant at the 0.05 level.						

References

1.Lone MM, Khan FR. Evaluation of micro leakage of root canals filled with different obturation techniques: An in vitro study. Journal of Ayub Medical College, Abbottabad. 2018;30(1):35

2.Cobankara FK, Orucoglu H, Sengun A, Belli S. The quantitative evaluation of apical sealing of four endodontic sealers. Journal of endodontics. 2006 Jan 1;32(1):66-8.

3.Lone MM, Khan FR, Lone MA. Evaluation of microleakage in single-rooted teeth obturated with thermoplasticized gutta-percha using various endodontic sealers: an in-vitro study. Journal of the College of Physicians and Surgeons Pakistan. 2018;28(5):339.

4. Atom J, Moolchandani K. To study and compare the apical sealing ability and fracture resistance to root canal dentine with Endosequencebioceramic, MTA and AH plus sealers–an ex-vivo study. Int. J. Dent. Med. Sci. Res. 2018;2:21-6.

5.Sfeir G, Zogheib C, Patel S, Giraud T, Nagendrababu V, Bukiet F. Calcium silicate-based root canal sealers: A narrative review and clinical perspectives. Materials. 2021 Jul 15;14(14):3965.

6.Bouillaguet S, Wataha JC, Lockwood PE, Galgano C, Golay A, Krejci I. Cytotoxicity and sealing properties of four classes of endodontic sealers evaluated by succinic dehydrogenase activity and confocal laser scanning microscopy. European journal of oral sciences. 2004 Apr;112(2):182-7.

7.Lone MM, Khan FR. Evaluation of micro leakage of root canals filled with different obturation techniques: An in vitro study. Journal of Ayub Medical College, Abbottabad. 2018;30(1):35.

8.Muliyar S, Shameem KA, Thankachan RP, Francis PG, Jayapalan CS, Hafiz KA. Microleakage in endodontics. Journal of international oral health: JIOH. 2014 Nov;6(6):99.

9.Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral surgery, Oral medicine, Oral pathology. 1971 Aug 1;32(2):271-5.

10.Pešić D, Melih I, Kolak V, Nikitović A, Jakovljević A. Evaluation of apically extruded debris during removal of gutta-percha and Resilon™ using different instrumentation techniques. Vojnosanitetski pregled. 2018;75(1).

11.Jena A, Shashirekha G, Barai S, Mahaprasad A. Comparison of Apically Extruded Debris after Retreatment Procedure with ProTaper and Endostar Retreatment File Systems. Journal of Clinical & Diagnostic Research. 2018 Jul 1;12(7).
12. Topçuoğlu HS, Demirbuga S, Topçuoğlu G. Evaluation of apically extruded debris during the removal of canal filling material using three different Ni-Ti systems and hand files in teeth with simulated apical root resorption. International Endodontic Journal. 2020 Mar;53(3):403-9.
13.Yilmaz F, Sönmez G, Kamburoğlu K, Koc C, Ocak ME, Celik HH. Accuracy of CBCT images in the volumetric assessment of residual root canal filling material: Effect of voxel size. Nigerian journal of clinical practice. 2019 Aug 1;22(8):1091-8.
14.El-Sayed MA, El-Mahdy RH. In-Vitro Comparative Study Of Diadent Bioaggregate And Other Retrofilling Materials: Dye Penetration And Antibacterial Activity. Dental Journal. 2012 Apr;58(1105):1115.
15.Gupta PK, Garg G, Kalita C, Saikia A, Srinivasa TS, Satish G. Evaluation of sealing ability of Biodentine as retrograde filling material by using two different manipulation methods: an in vitro study. Journal of international oral health: JIOH. 2015 Jul;7(7):111.
16.Puig-Diví A, Escalona-Marfil C, Padullés-Riu JM, Busquets A, Padullés-Chando X, Marcos-Ruiz D. Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. PloS one. 2019 Jun 5;14(6):e0216448.
17.Winik R, Araki ÂT, Negrão JA, Bello-Silva MS, Lage-Marques JL. Sealer penetration and marginal permeability after apicoectomy varying retrocavity preparation and retrofilling material. Brazilian Dental Journal. 2006;17:323-7.
18.Zogheib C, Naaman A, Sigurdsson A, Medioni E, Bourbouze G, Arbab-Chirani R. Comparative micro-computed tomographic evaluation of two carrier-based obturation systems. Clinical oral investigations. 2013 Nov;17:1879-83.
19.Kala M, Torvi SJ. An in vitro comparision of apical leakage in immediate versus delayed post space preparation using EndoREZ and RoekoSeal root canal sealers. Journal of the International Clinical Dental Research Organization. 2015 Jan 1;7(1).
20. . Mahendra DA, Nindita Y, Wibowo GW, Fortuna G. Comparison of apical sealing ability between bioceramic and zinc oxide eugenol-based sealer during root canal treatment, in vitro. Majalah Kedokteran Gigi Indonesia. 2022;7(2):95.
21. Al-Kadhi A, Al-Ani ZB, Al-Eanizi J. Comparison of apical microleakage of four contemporary endodontic sealers by dye penetration method. IMJ. 2019 Jun 1;26:237-40.
22.Ballullaya SV, Vinay V, Thumu J, Devalla S, Bollu IP, Balla S. Stereomicroscopic dye leakage measurement of six different root canal sealers. Journal of clinical and diagnostic research: JCDR. 2017 Jun;11(6):ZC65.
23.Trivedi S, Chhabra S, Bansal A, Kukreja N, Mishra N, Trivedi A, Gill P, Kulkarni D. Evaluation of sealing ability of three root canal sealers: An in vitro study. J Contemp Dent Pract. 2020 Mar 1;21(3):291-5.
24.Jafari F, Sobhani E, Samadi-Kafil H, Pirzadeh A, Jafari S. In vitro evaluation of the sealing ability of three newly developed root canal sealers: A bacterial microleakage study. Journal of clinical and experimental dentistry. 2016 Dec;8(5):e561.
25. Gomes-Filho JE, Bernabé PFE, Nery MJ, Otoboni-Filho JA, Dezan-Júnior E, Costa MMTM, et al. Reaction of rat connective tissue to a new calcium hydroxide-based sealer. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;106:71–76.
26.Barnett F, Trope M, Rooney J, Tronstad L. In vivo sealing ability of calcium hydroxide-containing root canal sealers. Dental Traumatology. 1989 Feb;5(1):23-6.
27.Chailertvanitkul P, Saunders WP, Mackenzie D. An assessment of microbial coronal leakage in teeth root filled with gutta-percha and three different sealers. International Endodontic Journal. 1996 Nov;29(6):387-92.
28.Allan NA, Walton RE, Schaffer M. Setting times for endodontic sealers under clinical usage and in vitro conditions. Journal of Endodontics. 2001 Jun 1;27(6):421-3.