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Comparison of Apical Microleakage of Four Contemporary Endodontic Sealers by Dye Penetration Method

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ABSTRACT

Objective: **The study aims to evaluate the sealing ability of total fill bioceramic, GuttaFlow®2, Epoxy (Acroseal) and Zinc Oxide Eugenol base sealer.**

Material and method: **40 single-rooted lower 1st premolar were selected and divided into 4 equal groups (n = 10). All groups were instrumented by one shape file technique and were obturated by matching gutta-percha with different sealers: Group1 Zinc Oxide Eugenol base (I-Endo), Group 2 Epoxy (Acroseal), Group 3 GuttaFlow®2 and Group 4 total fill BC. The groups were placed under 100% humidity condition for 48 hours. Then, they were submerged in 2% methylene blue dye for one week. Dried, sectioned longitudinally and adhere to the slide. Images were captured by a digital camera fixed in a stereomicroscope, and then the length of the dye penetration was calculated by the Photoshop program in the computer.**

Results: **The dye penetration and standard deviation of the groups were as follows: Group1 (2.55 mm/SD0.80), Group2 (2.89 mm/SD0.48), Group3 (2.29 mm/SD0.82) and Group4 (1.52 mm/SD0.85). There were significant differences between Group 4 and the other 3 groups, and no significant differences among them.**

Conclusion: **No sealer can completely prevent microleakage, but the bioceramic is superior in performance to the other three.**

KEY WORDS

dye penetration, apical micro leakage, total fill, acroseal, GuttaFlow®2, bio ceramic

INTRODUCTION

To ensure the success of endodontic treatment, a complete sealing of all portals of an endodontic system is essential to prevent bacteria, their toxin, and endotoxin interchange between the root canal and the periapical area[1-3)]. Many factors affect the microleakage in endodontic during the different phases of treatment: preparation, obturation, and post-endodontic restoration.

In obturation, many materials and techniques suggested approaching this goal. The sealer is a part of root canal filling, used to enhance sealing and to overcome the shortcoming of different obturation techniques[4)]. Many types of sealers developed for that purpose and tested in many methods and under variable conditions. The present study aimed to evaluate more recent sealers (bioceramic, epoxy resins, gutta flow) and compare them with zinc oxide eugenol type as a control.

Total Fill BC (FKG Dentaire SA, Switzerland); is one of the more recently introduced sealers. It is a mixture of many gradients" Zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, filler and thickening agents"[5)]. This product gives very suitable properties; it is biocompatible, antibacterial, Bioactive, insoluble, injectable, and premixed, ready to use material[6)].

Acroseal (Septodont, France); an improved epoxy base material introduced in Auto-mixed Syringe, containing calcium hydroxide builds endodontic obturation with a high pH that promotes periapical healing[7)]. It adheres to both dentin walls and inert gutta-percha. It is resistant to water solubility and low viscosity which increases adaptation[8)].

Gutta Flow2 (Coltène/Whaledent Ltd); described as a filing system that uses alone or with gutta-percha as complete obturation. It contains powder particle of gutta-percha less than 30 μ with polydimethylsiloxane. It is simple, flowable, non-soluble with slight expansion at setting and adhesion material[9)].

I-Endo (innovative dental products, Šlauliai, Lithuania); Zinc Oxide Eugenol base material. It is a traditional material usually used as a control in most studies in this field.

The aim of the present study was to compares the apical sealing ability of root canal obturation performed with shap one gutta-percha and four different sealers(I-Endo, Acroseal, GuttaFlow®2 and Total fill BC), using dye penetration method.

MATERIAL AND METHOD

Teeth selection and preparation

Forty lower 1st premolars selected from freshly extracted teeth for an orthodontic purpose. These teeth examined by x-ray to confirm the existence of a single straight canal[3)] and inspected for a complete apex formation without fracture under a stereomicroscope. The teeth were cleaned and stored in normal saline at room temperature.

The coronal part of the teeth were sectioned by microtome under cooling water, to achieve standard root length of 16 mm. Each canal was explored by inserting k-file size 10 (Dentsply, Maillefer, Switzerland) until the file tip visible from the apical foreman, determin-

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Table 1. min., max., mean and SD

	Mean	Std. Deviation	Minimum	Maximum
G1	2.56	0.80	1.23	4.10
G2	2.89	0.48	2.20	3.65
G3	2.29	0.82	0.93	3.45
G4	1.53	0.85	0.25	3.05
Total	2.32	0.88	0.25	4.10

Table 2. comparsion multiple groups and p value

LSD

(I) VAR00005		Mean Difference (I-J)	Std. Error	Sig.
Group 1	Group 2	-33.50000	33.58174	.325
	Group 3	26.20000	33.58174	.440
	Group 4	103.05000*	33.58174	.004
Group 2	Group 1	33.50000	33.58174	.325
	Group 3	59.70000	33.58174	.084
	Group 4	136.55000*	33.58174	.000
Group 3	Group 1	-26.20000	33.58174	.440
	Group 2	-59.70000	33.58174	.084
	Group 4	76.85000*	33.58174	.028
Group 4	Group 1	-103.05000-*	33.58174	.004
	Group 2	-136.55000-*	33.58174	.000
	Group 3	-76.85000-*	33.58174	.028

*. The mean difference is significant at the 0.05 level.

ing the working length by subtracting 1 mm from file length[3]. The canal enlarged by k-file size 15 (Dentsply, Maillefer, Switzerland) then Irrigated by 2 ml of 5.25% sodium hypochlorite (NaOCl). Complete instrumentation with one shape file (MICRO-MEGA®, France) attached to siroendo (Sirona Dental Systems GmbH, Germany) rotary machine programmed at 350 RPM - torque: 2.5 N.cm until reaching full working length (according to the manufacturer's instruction)[10]. A 10 K- file was reintroduced inside the canals till it passes the apical foreman by 1 mm, to establish apical patency and standardize the orifice size. Final irrigation with 2 ml of 17% EDTA for 1 min, 5 ml of 5.25% NaOCl for 5 min, then 2 ml distal water and dried by one shape paper point (MICRO-MEGA®, France). The one shape gutta-percha (MICRO-MEGA®, France) inserted into the prepared canal and checked to reach the working length.

Obturation

The prepared roots divided randomly into four groups. Group one with The Zinc-oxide Eugenol based sealer (I-ENDO, innovative dental products, Šiauliai, Lithuania) was used as a powder and liquid mixed on a large surface of the glass cement slab to obtain a homogeneous creamy consistency. Group two and Group three with Epoxy resin (Acroseal, Septodont, France), Roeko GuttaFlow®2, (Coltene/Whaledent, Inc, Cuyahoga Falls, OH), respectively; supplied in automix Preloaded double Syringe with mixing tip. Group four with total fill BC sealer (FKG Dentaire SA, Switzerland) supplied as Premixed syringe.

The sealer carriers were used to fill the root canal in all groups, till ensured by observing extrude from the apical orifice. The apical third of pre-prepared gutta-percha was loaded with sealer and insert slowly to working length. An excess of gutta-percha was cut off by a red-hot instrument and slightly condensed by the plugger. Coronal 1 mm of gutta-percha of each root was removed and sealed by Cavit G (3M ESPE, Germany).

All samples were first introduced into distill water container in an incubator at temperature 37℃ for 48 hours to ensure complete setting of the sealer. The samples were then coated with a double layer of nail varnish except the apical 2 mm and carried in a container of 2% methylene blue. They were then stored at an incubator temperature of 37℃ for one week. Finally, they were left to dry.

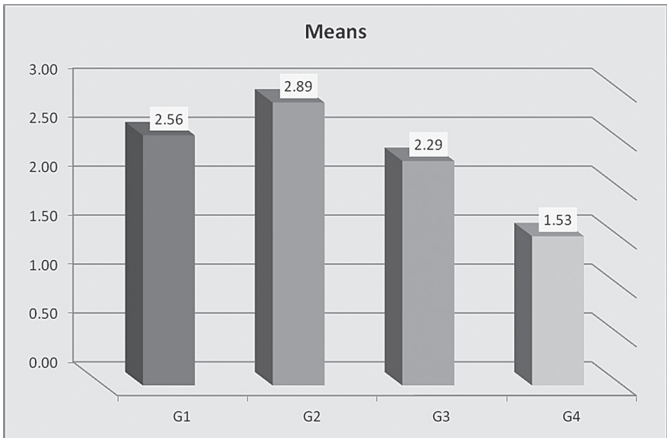

Figure 1. cluster colum for comparsion of the four groups

The root sample was sectioned into two vertical grooves buccally and lingually made with a diamond disc in the slow handpiece and then split by a chisel into two halves. Two halves of the same sample were adhered by the cyanoacrylate in the same slide. The final preparation for each slice involves removing the gutta-percha and a slightly gentle shaving by scalpel to clear the vision in the stereomicroscope.

A paper chart was placed under each slide in the stereomicroscope stage and a picture was captured by a fixed camera in the eye lens. Photoshop CS6 (Adobe.com 2012) was used to manage and measure the distance from the apex to the deepest point of dye penetration. The highest value of the two halves was chosen as a reading for each root.

RESULTS

All tested groups show microleakage from the apical foramen to different distance. Group 2 shows the highest mean value (2.89 mm/SD0.48) followed by Group 1(2.56 mm/SD0.80), Group 3 (2.29 mm/SD0.82) then Group 4 (1.53 mm/SD0.85) (Table 1& Figure 1)

A comparison was made between the four groups using a one-way ANOVA in SPSS version 23 to calculate "P-value". The result shows that the apical leakage in group 4 was significantly lower than the other three, while there were no significant differences between them. (Table 2)

DISCUSSION

It is well-known that the main sealer function is filled the remaining space between the primary endodontic obturation material and the prepared canal wall to complete sealing[11]. The sealing prevents the transmission of microorganism, toxin and their endotoxin between the root canal system and periapical area[12]. The area occupied by the sealer represents the weakest zone in the system due to setting changes and exposed to internal and external factors which may dissociate the material with time[13].

In recent endodontic instrument systems, many improvements demonstrated, such as increase tapering, variable pitch, and tip modification. in addition to that, matched gutta-percha was introduced as a simple alternative obturation method to the traditional[14]. It's well-established that the single-cone obturation is often less appreciated than the more complex 3D compaction techniques because increasing the sealer bulk results in more voids, shrinkage, and reduced seal quality[15,16]. These recent changes motivated us to use a new file instrument (shape one) and obturation with a single cone, to consider the demand in modern clinical practice. Increase in sealer layer thickness requires the used material with high quality in chemo-mechanical property and biological acceptability. At the same time, the use of shape one file leads to create a new well-known as "constant taper preparation" with a 0.06[17]. This preparation gives more reproducible shapes with less variable predict for the study[18].

Furthermore, the smear layer removal is still a controversial concept, but now it tends to be more accepting, for many factors such as it

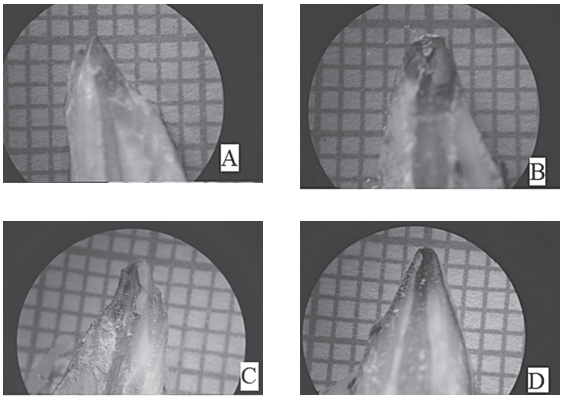

Figure 2. the images of stereomicroscope (A) total fill bioceramic, (B) Acroseal epoxy resin, (C) Zinc Oxide Eugenol based sealer I-ENDO, (D) GuttaFlow®2

interferes with an adaptation of obturation, provides a protected burrow for microorganisms and closes dentinal tubule preventing penetration of irrigation and sealer. In addition to that, it represents a weak, unstable layer. In this study, we use an irrigation protocol to ensure the elimination of this layer[19].

Many new obturation materials are introduced according to the demand for desirable properties to improve its performance. In this study, we use one classical material with an acceptable property (as a control) and three recently introduced sealers to assess their apical sealing efficacy.

Comparing the degree of apical microleakage resistance by various techniques, which one of them is the best still controversial. Each method views one aspect of the subject. As far as this study is concerned, we chose the dye penetration method by Methylene blue to evaluate the apical leakage. This stain is a standard material because it is simple, economical, and the same size as organic products such as butyric acid[20], although it doesn't allow to monitor the results of different experiment periods and observe the progress in microleakage.

In the current study, the total fill Bioceramic achieves the best value in resistance to dye leakage than other tested sealer (Figure 2A & Table 2) and more promising in future endodontic treatment. Other sealers show no significant difference among them. Bioceramic is the most excited sealer, fully filled the most requirement of the ideal one. It is adapted to moisture, promotes deep penetration into dental tubule to form a tag, the formation of hydroxyapatite enhance a chemical bond with the dentin, less film thickness, achieve a slight expansion rather than shrinkage[6], all these characteristics explain its sealing Priority.

This result consistent with many previous studies. Pawar *et al*. 2014 concluded that a superior bioceramic higher sealing than of epoxy and epiphany resins with continuous wave obturation using dye penetration[21]. Ballullaya et. al in 2017 estimate the microleakage of six sealers types include, Endosequence BC, AH Plus epoxy, resins, and zinc oxides Eugenol, findings suggest that Endosequence BC was the best and Zinc Oxide Eugenol the poorest[22].

In our results, the other three sealers are arranging respectively in accordance to their sealing ability as follows: Acroseal epoxy resin (Fig. 2B), Zinc Oxide Eugenol base sealer (Figure 2C) and Gutt flow (Figure 2D) with no significant difference among them. Several studies have revealed similar results. Malik *et al*. 2013, for example, showed that Acroseal has a higher sealing ability than ZOE[23]. This may be due to that the Acroseal epoxy resin sealer gives better adaptation to the canal wall and more tubular penetration than Zinc Oxide Eugenol as shown by Balguerie, E., *et al*. 2011[24]. Other types of resin-based sealer revealed similar results versus Zinc Oxide Eugenol[25-28].

The manufacturing company suggested using Gutta flow as root canal filling alone or in conjunction with a master gutta-percha but many studies give unsatisfied outcome when used alone. When used with gutta-percha it gives varying results, several studies have shown that it has the top sealing performance[29], others indicated GuttaFlow as the worse[30,31]. Many studies agree with our result, Manu Rana *et al* 2014 show almost equal leakage of gutta flow (mean = 0.35 mm) with Zinc Oxide Eugenol (mean = 0.36 mm)[32]. Vasiliadis L & coworker 2010, Patil *et al* 2016, find no significant difference between GuttaFlow and AH Plus[33,34]. Elias *et al* 2010 show no significant microleakage difference between epoxy resin (AH Plus) and gutta flow in both bacterial and dye penetration[35]. Johannes Ebert *et al* 2014 observed a similar result obtained by dye penetration[36]. Many researchers Explain the lack of superiority of this material to the other sealer because of insufficient wettability and flowability resulted from stiffer consistency and prominent surface tension forces of silicone which is part of its components[37,38].

CONCLUSION

Within the limits of this study, no one of tested sealer prevents microleakage completely, but bioceramic one promising and superior in performance than the other three types.

REFERENCES

1) Schilder, H., Filling root canals in three dimensions. Journal of endodontics, 2006. 32(4): p. 281-290.
2) Shabahang, S. and E. RESEARCH, State of the art and science of endodontics. The Journal of the American Dental Association, 2005. 136(1): p. 41-52.
3) Balasubramanian, S.K., *et al*., A comparative study of the quality of apical seal in Resilon/Epiphany SE following intra canal irrigation with 17% EDTA, 10% citric acid, and MTAD as final irrigants-a dye leakage study under vacuum. Journal of clinical and diagnostic research: JCDR, 2017. 11(2): p. ZC20.
4) Nagas, E., E. Altundasar, and A. Serper, The effect of master point taper on bond strength and apical sealing ability of different root canal sealers. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 2009. 107(1): p. e61-e64.
5) <201511_Totalfill_BC_Sealer_ifu_xx.pdf> instruction of manufacture.
6) Debelian, G. and M. Trope, The use of premixed bioceramic materials in endodontics. Giornale Italiano di Endodonzia, 2016. 30(2): p. 70-80..
7) Pinheiro, C.R., *et al*., In vitro antimicrobial activity of Acroseal, Polifil and Epiphany against Enterococcus faecalis. Brazilian dental journal, 2009. 20(2): p. 107-111.
8) Swaty Jhamb, V.N. and V. Singh, An in vitro study to determine the sealing ability of sealers with and without smear layer removal. Journal of conservative dentistry: JCD, 2009. 12(4): p. 150.
9) Bouillaguet, S., *et al*., Long-term sealing ability of pulp canal sealer, AH-Plus, GuttaFlow and epiphany. International Endodontic Journal, 2008. 41(3): p. 219-226.
10) One Shape® Complete canal shaping with only one single file in continuous rotation! [ ]; manufacture instruction]. Available from: http://www.js-davis.co.uk/uploads/brochures/brochureONESHAPE_EN_janv13.pdf.
11) D'souza, L.H.J., *et al*., Root Canal Sealers & its Role in Successful Endodontics-A Review. Annals of Dental Research, 2014. 2(2): p. 70-79.
12) Muliyar, S., *et al*., Microleakage in endodontics. Journal of international oral health: JIOH, 2014. 6(6): p. 99.
13) Li, G.-h., *et al*., Ability of new obturation materials to improve the seal of the root canal system: a review. Acta biomaterialia, 2014. 10(3): p. 1050-1063.
14) Samiei, M., *et al*., Sealing efficacy of single-cone obturation technique with MTA and CEM cement: an in vitro bacterial leakage study. Journal of dental research, dental clinics, dental prospects, 2014. 8(2): p. 77.
15) Monticelli, F., *et al*., Efficacy of two contemporary single-cone filling techniques in preventing bacterial leakage. Journal of Endodontics, 2007. 33(3): p. 310-313.
16) Robberecht, L., T. Colard, and A. Claisse-Crinquette, Qualitative evaluation of two endodontic obturation techniques: tapered single-cone method versus warm vertical condensation and injection system an in vitro study. Journal of oral science, 2012. 54(1): p. 99-104.
17) Koch, K. and D. Brave, The 0.06 tapered preparation." Secret technique" of endodontists. Dentistry today, 2002. 21(9): p. 68.
18) Yang, G., *et al*., Shaping ability of progressive versus constant taper instruments in curved root canals of extracted teeth. International endodontic journal, 2007. 40(9): p. 707-714.
19) Violich, D. and N. Chandler, The smear layer in endodontics-a review. International Endodontic Journal, 2010. 43(1): p. 2-15.
20) Camps, J. and D. Pashley, Reliability of the dye penetration studies. Journal of Endodontics, 2003. 29(9): p. 592-594.
21) Pawar, S.S., M.A. Pujar, and S.D. Makandar, Evaluation of the apical sealing ability of bioceramic sealer, AH plus & epiphany: An in vitro study. Journal of conservative dentistry: JCD, 2014. 17(6): p. 579.
22) Ballullaya, S.V., *et al*., Stereomicroscopic Dye Leakage Measurement of Six Different Root Canal Sealers. Journal of clinical and diagnostic research: JCDR, 2017. 11(6): p. ZC65.
23) Malik, G., *et al*., Comparative evaluation of intracanal sealing ability of mineral trioxide aggregate and glass ionomer cement: An in vitro study. Journal of conservative dentistry: JCD, 2013. 16(6): p. 540.
24) Balguerie, E., *et al*., Sealer penetration and adaptation in the dentinal tubules: a scan-

ning electron microscopic study. Journal of endodontics, 2011. 37(11): p. 1576-1579.
25) Dultra, F., *et al*., Evaluation of apical microleakage of teeth sealed with four different root canal sealers. Journal of Applied Oral Science, 2006. 14(5): p. 341-345.
26) Kumar, R.V. and C. Shruthi, Evaluation of the sealing ability of resin cement used as a root canal sealer: An in vitro study. Journal of conservative dentistry: JCD, 2012. 15(3): p. 274.
27) Mokhtari, H., *et al*., Evaluation of apical leakage in root canals obturated with three different sealers in presence or absence of smear layer. Iranian endodontic journal, 2015. 10(2): p. 131.
28) Ehsani, M., *et al*., Evaluation of apical micro-leakage of different endodontic sealers in the presence and absence of moisture. Journal of dental research, dental clinics, dental prospects, 2014. 8(3): p. 125.
29) Özok, A.R., *et al*., Sealing ability of a new polydimethylsiloxane-based root canal filling material. Journal of Endodontics, 2008. 34(2): p. 204-207.
30) De-Deus, G., *et al*., The sealing ability of GuttaFlow™ in oval-shaped canals: an ex vivo study using a polymicrobial leakage model. International endodontic journal, 2007. 40(10): p. 794-799.
31) Taranu, R., *et al*., Leakage analysis of three modern root filling materials after 90 days of storage. International Endodontic Journal, 2005. 38: p. 11-12.
32) Rana, M., *et al*., New Self Curing Root Canal Filling Material: Gutta flow 2. Journal of Advanced Medical and Dental Sciences Research| Vol, 2014. 2(4).
33) Vasiliadis, L., *et al*., Short-and long-term sealing ability of Gutta-flow and AH-Plus using an ex vivo fluid transport model. International endodontic journal, 2010. 43(5): p. 377-381.
34) Patil, P., *et al*., A comparison of apical sealing ability between GuttaFlow and AH plus: An in vitro study. Journal of International Society of Preventive & Community Dentistry, 2016. 6(4): p. 377.
35) Elias, I., *et al*., Apical sealing ability comparison between GuttaFlow and AH Plus: in vitro bacterial and dye leakage. J. Health Sci. Inst, 2010. 28(1).
36) Ebert, J., *et al*., Sealing ability of different versions of GuttaFlow2 in comparison to GuttaFlow and AH Plus. RSBO (Online), 2014. 11(3): p. 224-229.
37) Nakashima, K. and R. Terata, Effect of pH modified EDTA solution to the properties of dentin. Journal of endodontics, 2005. 31(1): p. 47-49.
38) Zhou, H.-m., *et al*., Physical properties of 5 root canal sealers. Journal of Endodontics, 2013. 39(10): p. 1281-1286.