MDJ

The effect of dowel space preparation on the apical seal of Resilon & Gutta-percha obturation materials. (An in vitro comparative study)

Dr.Saleh M. F. Al-Kasaki B.D.S
Prof. Dr. Abdul Karim J. Al-Azzawi, B.D.S., M.Sc.

Abstract

Aim: The aim of this in vitro study was to compare the effect of immediate versus delayed dowel space preparation using peeso reamers on the apical seal of roots filled by Gutta-percha with two types of resin based-sealers (AH26 and AH Plus) and by Epiphany obturation system.

Methodology: Sixty freshly extracted human teeth with single and straight canals were used in this study. The roots were instrumented using the step-back technique, instrumentation was accomplished by using the Gates-Glidden drills with copious irrigation of 2.5% sodium hypochlorite and 17% solution of aqueous EDTA to remove smear layer. The roots were randomly divided into 3 main groups according to the type of obturation materials using lateral condensation technique (20 teeth for each group):

Group A: Gutta-percha + AH26 root canal sealer.

Group B: Gutta-percha + AH Plus sealer.

Group C: Resilon+ Epiphany sealer+ prime. (Epiphany obturation system)

Then each group divided into two subgroups according to the time of dowel space preparation either immediately after obturation or after one week. The external surfaces of all roots were coated by two layers of sticky wax except for the apical 2 mm and were then submerged in 2% methylene blue dye for 3 days at 37ºC. After that, all roots were longitudinally sectioned for linear measurement of dye penetration through the apical foramen using a stereomicroscope. The data obtained were analyzed statistically using ANOVA and Student t-tests.

Results: Significantly less apical leakage in roots filled by gutta-percha with AH Plus than those filled by gutta-percha with AH26 and those filled by Epiphany obturation system for delayed dowel space preparation ($P < 0.05$) and there was a significantly less apical leakage in roots filled by Epiphany obturation system that prepared immediately after obturation than those received delayed preparation ($P < 0.05$).

Conclusion: All the groups had apical leakage what ever the type of obturation material or time of dowel space preparation.

Keywords: Resilon, Gutta-percha, Dowel space preparation

Introduction

Endodontically treated teeth that are broken down are usually restored by means of a post and core. The preparation of the root canal space for a post involve removal of the root canal filling material to a level that will maximize resistance and retention form for the post, and at the same time, maintain the integrity of the apical seal. [(1)] Various methods or techniques have been described in the literature for the removal of gutta-percha filling material these include: Thermal removal using hot plugger, mechanical removal using rotary instruments (peeso reamers or Gates-Glidden drills) and chemo mechanical removal using solvent agents and K-files, but most often the easiest and most efficient method is with rotary instruments. [(2,3)] A review of the literature indicates that a great deal of controversy exists about the quality of the apical seal as it relates to the time of dowel space preparation.

Many filling materials have been used in root canal therapy in an attempt to achieve success. The most commonly material recommended for obturation is gutta-percha combined with a sealer. Gutta-percha is considered an impermeable core material; therefore, leakage through an obturated root canal is expected to take place at the interfaces between sealers and dentin or sealer and gutta-percha, or through voids within the sealer. [(4)] Improvements in adhesive technology have fostered attempts to reduce apical and coronal leakage by bonding to root canal walls. Total-etch adhesives have been tested with resin cements as alternative root filling materials. The results showed that dentin adhesives significantly reduced apical leakage. [(5)] Self-etching primers have also been used for bonding to root canal dentin. As epoxy resin sealers do not copolymerize with metharcrylate resin-based adhesives [(6)], so a methacrylate resin sealer was developed with a self-etching primer that resulted in improvements in the apical seal and adhesion to root dentin. [(7,8)] Recently, a new thermoplastic, filled polymer (Resilon; Resilon Research LLC, Madison, CT), has been introduced that has the potential to challenge the use of gutta-percha as a root filling material. Resilon Research has licensed this new technology to Pentron under the name Epiphany. The sealing ability of Resilon system may be attributed to the so-called (mono-block) that is created by the adhesion of the Resilon cone to the Resilon sealer, which adheres and penetrates into the dentin walls and tubules of the root canal system. [(9,10)]

Materials and Methods

Sample selection and preparation:

Sixty freshly extracted human teeth with single and straight root canals were used in this study. These teeth were extracted for various reasons, and none had received endodontic therapy before extraction. the Criteria for selection included the following: the existence of straight and single root canal, completely formed apex, a patent foramen located at the center of the root apex, the first file that binds to the working length was either 20 or 25 after pulp extirpation, and roots without cracks or fracture. The crown of each tooth was sectioned perpendicular to the long axis of the tooth at the cemento-enamel junction using a diamond disk with straight hand piece under constant cooling with distilled water. The length of roots ranged between (13- 15) mm. After

access opening and pulpal removal with barbed broaches, the patency of each canal was established by passing size # 15 K-file through the apical foramen and the working length was determined by subtracting 1 mm from the length at which the tip of size # 15 K-file just appeared at the apical foramen.

Root canal preparation:

A step back preparation technique was used to prepare the root canals using K-files with circumferential filing action. The canals were enlarged to size 50 at the working length, flaring began after completion of apical preparation by stepping back to three sizes after the master apical file till size #70 with a 1 mm reduction in the working length with each larger file. Recapitulation to full working length with master apical file after each flaring file with 2.5 % NaOCL irrigation. To flare the coronal and middle third of the canal a size 3 Gates-Glidden drill in a contra-angle handpiece was inserted at 4 mm short of the working length and activated with up and down motion, and then followed by size 4 and 5. After instrumentation, a size 15 K-file was passed through the apical foramen to remove dentinal debris. A total of 15 ml of 2.5% sodium hypochlorite (NaOCL) was used for irrigation between instrumentation and before using the next larger size and 5ml of 17% EDTA rinses were used during and after instrumentation for 1 minute to remove smear layer followed by 5 ml of deionized water according to the manufacturer instruction of Epiphany obturation system.

Root canal obturation:

Preparation of the acrylic socket simulator [11,12] only to facilitate the grasping and control of the experimental samples during the obturation procedure. The canal obturation of all roots was performed with lateral condensation technique. At this stage 60 roots were randomly divided into 3 experimental groups (20 teeth for each group):

Group A: Gutta-percha + AH26 root canal sealer.

Group B: Gutta-percha + AH Plus sealer.

Group C: Epiphany obturation system

Each root was dried with paper points, gutta-percha or Resilon 0.02 taper master cones must fit to the full working length with a good tugback. The root canal sealers (AH26 & AH Plus) were mixed on a clean, dry glass slab with cement spatula, the mixture should have a homogenous consistency and carried to the canal in small amounts on a master apical file using a pumping action with simultaneous rotary movement in a counter clockwise direction, and then the tip of the master cone was dipped into the sealer and placed into its correct working length within canal. For Epiphany obturation system, the self-etch primer was placed into the root canal to the working length with paper point size # 50, also a brush provided by the manufacturer was used to bring the self etch primer into the coronal third of the canal. Dry paper points were then used to wick out the excess primer from the canal, followed by placement of Epiphany sealer by generously coating the Resilon master cone size 50 according to the manufacturer's instruction. An endodontic size 50 stainless steel handled spreader, which would reach within 2 mm of the working length, was used to compact the master gutta-percha or Resilon cone size 50 laterally and to create a space for subsequent

accessory cone. Medium fine accessory cone tip dipped in the sealer and inserted into the space left by the spreader. This point was followed by more spreading and more accessory cones until the spreader could not enter more than 2-3 mm into the canal orifice. The excess gutta-percha or Resilon was seared off with a hot instrument and vertical condensation of warm gutta-percha or Resilon with endodontic plugger. The coronal 3 mm of each root was sealed with glass ionomer cement as a temporary restoration according to the manufacturer of the Epiphany system. Each tooth was radiographed in a two different directions to evaluate the density of the filling materials.

Dowel space preparation:

At this stage each group divided into two subgroups, 10 teeth for each subgroup: In subgroups (A1, B1, C1), the roots received dowel space preparation immediately after obturation using peeso reamers starting with largest size No.3 that would fit the canal at 7 mm short of the working length then No.2 used until 5 mm of the apical filling material remained in the canal. [(1)] They were then sealed with glass ionomer cement and stored in 100% humidity condition at 37ºC in an incubator for one week to ensure complete setting of the sealer. (Immediate dowel space preparation). While Subgroups (A2, B2, C2): After one week storage in 100% humidity condition at 37ºC in an incubator, the obturated roots received dowel space preparation using peeso reamers in the same manner of immediate preparation. (Delayed dowel space preparation). **(Fig.1)**

Leakage study:

The external surfaces of all roots were coated by two layers of sticky wax except for the apical 2 mm and were submerged in 2% methylene blue dye for 72 hours at 37ºC. At the end of this period, the teeth were removed from the dye and washed and the sticky waxes were scrapped from the root surface. Using a diamond disk with straight hand piece, two grooves were made longitudinally on the opposite side of the tooth surface without penetrating into the pulp space, and then separation was done by using a chisel. Finally the filling materials were removed from the canals of the sectioned samples. The samples were examined for the degree of dye penetration using a stereomicroscope at x40 magnification with calibrated scale ocular and grid to establish the degree of dye penetration in millimeters. Linear dye penetration was measured from the apical end of the root canal preparation to the maximum coronal extent of dye penetration. The deepest score of dye penetration from both splitted halves of each root was recorded. Two measurements were taken from each tooth in two different times by two evaluators; one of them had no knowledge about the experimental groups.

One-Way Analysis of Variance (ANOVA) test was performed to determine if there was a significant difference among the experimental subgroups, then student t-test was used to evaluate the significance of difference between each pair of subgroups, significant difference was considered as $P<0.05$, while highly significant difference was considered as $P<0.0001$.

Results

The summary of the mean values, standard deviation (S.D.) and standard error (S.E.) with the minimum (Min.) and the maximum (Max.) values of linear dye penetration in millimeters

for the subgroups that received immediate and delayed dowel space preparation are presented in Table(1). While mean leakage for these subgroups are presented in Fig. 1.

The statistical analysis of the data was performed with a one-way ANOVA to test the differences between the means of leakage among the three subgroups (A1, B1, and C1) that received immediate dowel space preparation using peeso reamers. The result indicated that none of the means are significantly different from the others ($P>0.05$). While one-way ANOVA test among the three subgroups (A2, B2, and C2) that received delayed dowel space preparation indicated that at least one of the means leakage is significantly different from the others ($P<0.05$). Then Student t-test was used to evaluate the significance of difference between each pair of subgroups and between the two subgroups of the same group according to the time of dowel space preparation are presented in Table (2).

The results of above table showed no significant differences ($P>0.05$) between each pair of subgroups (A1, B1, and C1) that received immediate dowel space preparation and between roots filled by gutta-percha with AH26 (subgroup A2) and roots filled by Epiphany obturation system (subgroup C2) for delayed dowel space preparation. While Significant differences ($P<0.05$) were found between subgroup B2 (gutta-percha with AH Plus) and subgroup A2 (gutta-percha with AH26) and with subgroup C2 (Epiphany obturation system) for delayed preparation and there was a significantly less apical leakage ($P<0.05$) in roots filled by Epiphany obturation system that prepared immediately after obturation (subgroup C1) than those received delayed preparation (subgroup C2).

Discussion

One operator instrumented, obturated, and prepared the dowel space in all teeth to decrease variability between the experimental groups. Flared technique produced the necessary coronal funnel to allow the endodontic spreader and irrigant needle placed as far as possible into the preparation and facilitate the lateral condensation of the gutta-percha by allowing deeper penetration of the endodontic spreader within 1 to 2 mm of the apical extent of the master cone in order to achieve good apical seal. This is true for Resilon obturation material that performs, and handles like gutta-percha. [2,9,13]

Many manufacturers and researchers continue to use apical dye leakage studies to develop and justify new techniques, instruments, and materials for clinical use.[14] The leakage marker used in this study was methylene blue because it offers several advantages: It is highly soluble in water, it has a low molecular weight, and penetrates more deeply along root canal filling. [15,16]

All obturation materials used in this study showed apical leakage to a certain extent. Subgroup A2 that received delayed preparation after one week showed higher dye penetration than subgroup B2 and the difference was statistically significant ($P<0.05$), This difference may be related to the long setting time of AH 26 sealer (24 to 36 hours) which allows sufficient time for the development of adhesion to dentin, but the shrinkage stresses might fracture the still weak unseat sealer cohesively according to De Gee et al in 1994 [17], they found that after an initial volumetric expansion, some shrinkage occurred in AH26 root canal sealer with time. However both AH Plus and AH 26 root canal sealers have comparable sealing ability that can be

observed in many of leakage studies [18-21] and no studies have been done to compare the effect of dowel space preparation using both AH Plus and AH26 sealer. So this observed difference may be due to their different chemical composition and physical properties (adhesiveness, dimensional stability, film thickness, solubility, and setting times).

The results of the present study showed that there were no significant differences in the quality of the apical seal between roots that prepared immediately after obturation (Subgroup A1 & B1) and those prepared after one week (Subgroup A2 & B2) respectively when gutta-percha and epoxy resin based-sealer used. These findings are in agreement with the results of (Karapanou et al, 1996) [22], (Abramovitz et al, 2000) [23], and (Prado et al, 2006) [24] they showed no significant difference between immediate versus delayed dowel space preparation. But came in contrast with the results of (Solano et al, 2005) [25] they showed a significantly less leakage when post spaces prepared immediately after obturation, however the delayed preparation subgroups (A2 & B2) in this study showed higher means of dye leakage.

Subgroup C2 showed the highest means of dye leakage than the other subgroups of delayed dowel space preparation and the difference was statistically significant with subgroup B2, but the difference was not significant with subgroup A2, also when using Epiphany obturation system, there was significantly less leakage when the dowel space was prepared at the time of obturation compared to dowel space prepared one week after obturation, these differences may be due to the weak link in Resilon-filled root canals that resided predominantly along the sealer-dentin interface which resulted in earlier debonding from dentinal walls and gaps formation which facilitate apical dislodgement during dowel space preparation especially when rotary instruments used. These gaps were probably created by rapid polymerization contraction of the methacrylate resin-based sealer (Epiphany sealer) during setting. [26] However the Resilon/Epiphany system is a relatively new material that was developed to replace gutta-percha and root canal sealer [8] and obviously it needs more research to determine if it is an adequate obturation material or it is appropriate material that should replace gutta-percha, and to better understand the mechanical and thermal properties of Resilon/Epiphany system which may also help in explaining why delayed dowel space preparation produced more leakage than those prepared immediately.

References

1- Kwan E.H., Harrington G.W.: The effect of immediate post preparation on apical seal. J Endo 1981, 7(7), 325-29.
2- Ingle J.I.: Endodontics. 5th ed. Hamilton BC Decker Inc., 2002, Chp.10 (p. 527, 529), Chp.11 (p. 644).
3- Schwartz R.S., Robbins J.W.: Post placement and restoration of endodontically treated teeth: A literature review. J Endo 2004, 30(5), 289- 301.
4- Cobankara F.K., Adanir N., Belli S.: Evaluation of the influence of smear layer on the apical and coronal sealing ability of two sealers. J Endo 2004, 30(6), 406-9.
5- Mannocci F., Ferrari M.: Apical seal of roots obturated with laterally condensed gutta-percha, epoxy resin cement, and dentin bonding agent. J Endo 1998, 24(1), 41-4.
6- Britto L.R., Borer R.E., Vertucci F.J., Haddix J.E., Gordan V.V.: Comparison of the apical seal obtained by a dual-cure resin based cement or an epoxy resin sealer with or without the use of an acidic primer. J Endo 2002, 28(10), 721-23.
7- Gogos G., Economides N., Stavrianos C., Kolokouris I., Kokorikos I.: Adhesion of a new methacrylate resin-based sealer to

human dentin. J Endo 2004, 30(4), 238-40.
8- Shipper G., Trope M.: In vitro microbial leakage of endodontically treated teeth using new and standard obturation techniques. J Endo 2004, 30(3), 154-58.
9- Shipper G., Ørstavik D., Teixeira F.B., Trope M.: An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). J Endo 2004, 30(5), 342-47.
10- Teixeira F.B., Teixeira E.C.N., Thompson J.Y., Trope M.: Fracture Resistance of endodontically treated roots using a new type of resin filling material. J Am Dent Assoc 2004, 135(5), 646-52.
11- Pitts D.L., Matheny H.E., Nicholls J.I.: An in vitro study of spreader loads required to cause vertical root fracture during lateral condensation. J Endo 1983, 9(12), 544-50.
12- Dulaimi S.F., Wali Al-Hashimi M.K.: A comparison of spreader penetration depth and load required during lateral condensation in teeth prepared using various root canal preparation techniques. Int Endo J 2005, 38(8), 510-515
13- Trope M., and Barnett F.: Resilon: A novel material to replace gutta-percha. Contemporary Endo 2004, 1(2), 16-19.
14- Oliver C.M., Abbott P.V.: Correlation between clinical success and apical dye penetration. Int Endo J 2001, 34(8), 637-44.
15- Matloff I.R, Jensen J.R, Singer L., Tabibi A.: A comparison of methods used in root canal sealability studies. Oral Surg Oral Med Oral Pathol 1982, 53(2), 203-8.
16- Ahlberg K.M., Assavanop P., Tay W.M.: A comparison of the apical dye penetration patterns shown by Methylene blue and India ink in root-filled teeth. Int Endo J 1995, 28(1), 30-34.
17- De Gee A.J., Wu M.K., Wesselink P.R.: Sealing properties of Ketac-Endo glass ionomer cement and AH26 root canal sealers. Int Endo J 1994, 27(5), 239-44.
18- Miletic I., Anic I., Pezelj-Ribaric S., Jukic S.: Leakage of five root canal sealers. Int Endo J 1999, 32(5), 415-18.
19- Siqueira J.F., Rocas I.N., Valois C.R.: Apical sealing ability of five endodontic sealers. Aust Endo J 2001, 27(1), 33-35.
20- Miletic I., Ribaric S.P., Karlovic Z., Jukic S.: Apical leakage of five root canal sealers after one year of storage. J Endo 2002, 28(6), 431-32.
21- Schäfer E., Olthoff G.: Effect of three different sealers on the sealing ability of both Thermafil obturators and cold laterally compacted gutta-percha. J Endo 2002, 28(9), 638-42.
22- Karapanou V., Vera J., Cabrera P., White R.R.: Effect of immediate and delayed post preparation on apical dye leakage using two different sealers. J Endod 1996, 22(11), 583-85.
23- Abramovitz I., Tagger M., Tamse A., Metzger Z.: The effect of immediate Vs delayed post space preparation on the apical seal of a root canal filling: A study in an increased-sensitivity pressure-driven system. J Endo 2000, 26(8), 435-39.
24- Prado C.J., Estrela C., Panzeri H., Biffi J.C.: Permeability of remaining endodontic obturation after post preparation. Gen Dent 2006, 54(1), 41-43.
25- Solano F., Hartwll G., Appelstein C.: Comparison of apical leakage between immediate versus delayed post space preparation using AH Plus sealer. J Endo 2005, 31(10), 752-54.
26- Tay F.R., Loushine R.J., Weller R.N., Kimbrough W.F., Pashley D.H.: Ultrastuctural evalution of the apical seal in roots filled with a Polycaprolactone-based root canal filling material. J Endo 2005, 31(7), 514-19.

Table (1): Statistical summary

Groups		***Mean***	***±S.D.***	***S.E.***	***Min.***	***Max.***
Group A	A1	2.09	±1.116	0.353	0.7	3.6
	A2	2.78	±0.708	0.224	1.3	3.6
Group B	B1	1.79	±1.118	0.354	0.5	3.8
	B2	1.92	±0.745	0.236	0.9	3.2
Group C	C1	2.02	±0.940	0.297	0.7	3.3
	C2	2.98	±1.056	0.334	1.7	4.8

Comparison Groups	t-test	P-value	Statistical Sig.
A1&B1	0.60	0.56	N.S.
A1&C1	0.15	0.88	N.S.
B1&C1	0.50	0.62	N.S.
A2&B2	2.65	0.017	S.
A2&C2	0.50	0.63	N.S.
B2&C2	2.59	0.020	S.
A1&A2	1.65	0.12	N.S.
B1&B2	0.31	0.76	N.S.
C1&C2	2.15	0.047	S.

Table (2) Student t-test results

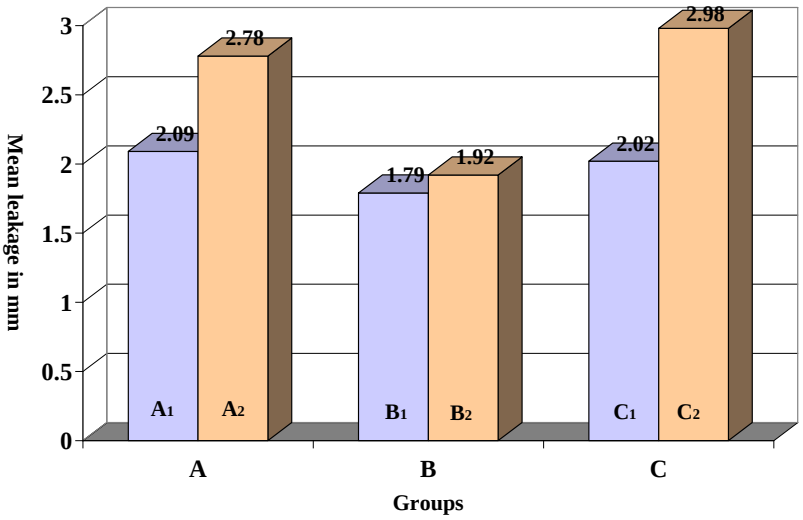

Fig. 1. Bar chart graph to compare the mean leakage for the three experimental groups concerning the time of dowel space preparation.