An evaluation of apical microleakage in roots filled with thermoplastic synthetic polymer based root canal filling material (RealSeal 1 bonded obturation)

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ABSTRACT

Background: This study aimed to evaluate and compare the apical microleakage of roots canal filled with cold lateral condensation of gutta-percha, cold lateral condensation of Resilon, Thermafil and RealSeal1 bonded obturation.
Materials and methods: Sixty freshly extracted maxillary first molars with straight palatal roots .Using diamond disc bur with straight hand piece and water coolant the palatal roots of teeth were sectioned perpendicular to the long axis at the furcation area. All roots were prepared with crown-down technique using hand ProTaper system (Sx-F4).The prepared roots randomly divided into 4 groups of fifteen roots each; the groups obturated with different obturation technique. In Group 1 roots obturated with(lateral condensation of gutta-percha), Group 2 was obturated with(lateral condensation of Resilon),group3 was obturated with (Thermafil) while in group4 obturated with(RealSeal 1 bonded obturation).All the samples sealed coronally and stored in normal saline at 37°C for one week ,then all the roots submerged Indian ink for one week. The roots were cleared and the degree of linear dye penetration was measured in millimeter by stereomicroscope under 40X magnification with calibrated scale ocular grid.
Results: The results showed that the RealSeal1 bonded obturation leaked apically significantly higher than other test groups, while the group of lateral condensation of gutta-percha exhibited the least value of apical microleakage.
Conclusion: The complete hermetic apical seal cannot be created neither with gutta-percha nor with Real Seal 1bonded obturation.
Keywords: Apical microleakage, gutta-percha, RealSeal 1bonded obturation. (J Bagh Coll Dentistry 2012;24(2):21-26).

INTRODUCTION

Complete obturation of the root canal with an inert filling material and creation of a fluid-tight seal are among the major goals of successful endodontic treatment [(1)]. The main three functions of obturation are to entomb any bacteria remaining within the root canal system; to stop the influx of periapical tissue derived fluid from entering the root canal to feed the surviving bacteria; and to prevent coronal leakage of bacteria. Although gutta-percha has many desirable properties, including chemical stability, biocompatibility, non porosity, radiopacity and the ability to be manipulated and removed, it does not always meet the three functions of obturation[(2)].

Gutta-percha does not bond to the internal tooth structure, resulting in the absence of a complete seal [(3)]. Many attempts have been made to resolve the problem through the variation in obturation technique including vertical and lateral condensation and the use of reverse-fill or touch and heat system.

These methods have reduced microleakage to ascertain degree but still have failed to eliminate the problems [(4)].

In 2004, a new core material Resilon (Resilon Research LLC, Madison, CT, USA) in conjunction with an adhesive system (Epiphany, Pentron Clinical Technologies, Wallingford, CT, USA) was introduced to the market. Thisthermoplastic-filled polymer core polycaprolactone-based has potential to challenge gutta-percha the ‘gold standard as a root filling core material [(5)]. Resilon is a thermoplastic synthetic polymer- based root canal filling material. Based on polymer of polyester, Resilon contains bioactive glass and radiopaque fillers. Epiphany is a dual curable resin composite used as a sealer combined with Resilon points. According to manufacturer, Epiphany sealer bonds both to dentin and also to root canal filling material. This may be an important fact to eliminate microleakage since it is well-known that microleakage occurs not only through sealer-dentin but also through sealer and root canal filling material Interfaces [(6,7)].

MATERIALS AND METHODS

Samples Selection

Sixty freshly extracted maxillary first molars teeth. The criteria for teeth selection Straight root canal mature centrally located apical foramen, patent apical foramen, roots devoid of any

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resorption, cracks or fracture and the palatal roots will be 10mm in length from the apex up to furcation area[8].

Samples preparation

After extraction, all teeth will be stored in distilled water at room temperature. Any soft tissue remnants on the root surface were removed with sharp periodontal curette. The crown of the tooth was sectioned perpendicular to the long axis of the root at the furcation area with a disc diamond and the root length adjusted to 10mm from flat reference point to the root apex. The patency of the canal was checked by passing# 10 K file 1mm through the apical foramen and the working length equal to 9 mm. Silicon rubber base (heavy body) was mixed (Base and catalyst) according to the manufacturer instructions loaded with hand and inserted it in a perforated plastic container (dimension 13mm, height 52mm) using spatula to adapt heavy body to the wall of the plastic container then the sectioned root centered inside the rubber base. Heavy body left to set forming small blocks to facilitate handling of roots during instrumentation and obturation**.** The canals were prepared with crown-down technique using (hand use) Protaper system (Sx to F4). According to the manual instruction, the motion of instrumentation was clockwise reaming action with sufficient apical pressure till the file engaged the dentin about four rotations at each time till the file became passive, then the file was pulled and its flutes cleaned from the dentin debris frequently and inspected for any sign of distortion.

Obturation of the roots:

Group 1: In this group roots were obturated with cold gutta-percha points (lateral condensation technique) using AH-26 sealer. AH-26 was mixed a, on a dry, clean glass slab with spatula. The mixture had a homogenous creamy consistency that string out at least one inch when the spatula was raised slowly from the glass slab. The canal was dried using paper point and sealer was introduced into the canal to full working length using file F4 by pumping action of the file with simultaneous rotary movement in a counterclock direction to coat the canals with thin film of sealer**.** The tip of master gutta-percha cone corresponding to the last file size #40 was dipped into the sealer and placed in the canal. The previously checked finger spreader size 35 is inserted between the master cone and the canal wall within 1-2 mm from the working length. Spreader taper is the mechanical force that laterally compresses and spreads gutta-percha creating a space for additional accessory cones. The tip of accessory point size #20 was dipped in the sealer and inserted into the canal by space left by the spreader; this was followed by more spreading and more accessory cone until the spreader could not enter more than 2-3 mm into the canal orifice. When obturation of teeth was accomplished, the excess gutta-percha removed with heated endodontic plugger to a level (1mm) higher than the coronal end of roots and vertically condensed with root canal plugger, so the gutta-percha obturate the entire canal up to the coronal terminus. The roots were coronally sealed by temporary filling.

Group 2: In this group roots were obturated with Resilon and Real Seal SE sealer by lateral condensation technique. The dual syringe (with mixing tip) was used to express the sealer onto the mixing pad then the sealer was carried to the canal on the paper point according to manufacturer instruction .The master cone size 40 was coated with the sealer and placed into its correct working length within the canal. A finger spreader size 35 was inserted between the master cone and the canal wall within 1-2 mm from the working length. Spreader taper is the mechanical force that laterally compresses and spreads Resilon creating a space for additional accessory cones. The tip of accessory point size #20 was dipped in the sealer and inserted into the canal by space left by the spreader; this was followed by more spreading and more accessory cone until the spreader could not enter more than 2-3 mm into the canal orifice. The excess Resilon was seared off with a hot endodontic plugger and vertically was condensed with endodontic plugger and then the coronal third of each root was cured using the light curing device for 40 seconds according to manufacturer instruction. The coronal 1 mm of each root sealed with glass ionomer cement as a temporary restoration according to manufacturer of Real Seal system.

Group3: In this group roots were obturated by Thermafil cones and AH-26. The stoppers were placed on the cone according to the working length and then the matching size verifier was inserted into the canal to the working length. The sealer was introduced into the canal in the same manner as Group 1. Thermafil cones (size 40) were placed in one of the heating chamber of ThermaPrep plus oven (Size 30-60 button is chosen). After beep sound, the oven was switched off then the cone raised without rotation and inserted inside the canal firmly and slowly to working length without any twisting or rotation. The handle was removed after the gutta-percha cooled by inverted cone bur in high speed hand piece**.** The roots were coronally sealed by temporary filling (Citodur).

Group4: In this group roots were obturated with Real Seal 1 obturator and Real Seal SE sealer according to manufacturer instruction. The stopper was placed on the matching size verifier and then it inserted into the canal to the working length. The verifier should fit passively in the canal. Then RealSeal 1 (size 40) were placed in one of the heating chamber of RealSeal 1 oven (Size 40-60 button is chosen). The heating time needed to heat RealSeal1was regulated automatically about1:30 minutes, during this time SE sealer was dispensed and introduced to the canal in the same manner as Group 2. After the first" beep" signal the obturator is ready for removal from the unit and inserted in the canal within 6 seconds without any twisting or forcing. The handle and the shaft were removed with inverted cone in a high speed hand piece then was light cured the coronal surface of the RealSeal1 obturator for 40seconds. The coronal 1 mm of each root sealed with glass ionomer according to the manufacturer instruction.

Sample storage: After obturation the samples were stored in incubator at 37°C for a week to ensure complete setting of the sealer [(9).]

Leakage study: Each group had one root as a negative control and one root as a positive control**.** The negative control roots were coated completely with one layer of nail varnish and two layers of sticky wax, while positive control roots were left uncoated .While each experimental root was coated with one layer of nail varnish and two layers of sticky wax except for the apical 2mm. Indian ink was used as leakage indicator for all groups [(10)].A puncher was used to make hole in the center of the rubber cap to create space into which the coronal third of each root passed and fixed to rubber cap. The apical 3 to 4 mm of each root was immersed in a glass vial containing Indian ink and deposited in an incubator at 37ºC for a week. At the end of this period, the roots were removed from the ink and washed under running water in a position opposite to the apical foramen for one minute. The sticky wax was scraped from the root surface with a lacron carver and washed again under running water [(10).]

Clearing process: The roots were decalcified (the tooth can be pricked by sewing pin) with 5% nitric acid for a period of 5 days, renewing the acid daily. The roots were then washed under running tap water for 30 minutes and dehydrated by 99-100% ethyl alcohol for 3 days with daily change of alcohol, and then all the roots became transparent by immersion in methyl salicylate for 24hours [(11).]Linear dye penetration was measured from the apical foramen to the maximum extension of the dye using light stereomicroscope under 40X magnification with calibrated scale ocular to establish the degree of apical dye penetration in millimeters.

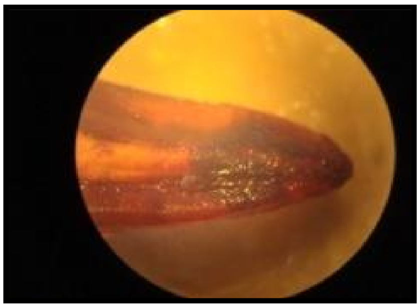

Figure 1: The cleared sample of Real Seal 1 bonded obturation.

RESULTS

Table 1: Descriptive statistic of analysis for experimental groups

Group	N	Mean	S.D	SE	Min	max
1	13	0.4385	0.08697	0.02412	0.30	0.60
2	13	0.8692	0.16013	0.04441	0.40	1.00
3	13	0.5115	0.13095	0.03632	0.30	0.75
4	13	0.9154	0.08987	0.02493	0.80	1.00

Table 1 shows that, group 1 (lateral condensation of Gutta-percha) have the lowest mean value of dye penetration (0.4385) while the highest mean value of dye penetration was for group 4 (Real Seal 1) (0.9154). The rest values of other groups were fluctuation between these values. To identify the presence of statistically significant difference for apical dye penetration between groups, ANOVA test and t- test was carried on. The results of t-test showed that there is a high significant difference between all the groups except for 1&3 and for2&4 the difference was non-significant.

DISCUSSION

Three dimensional sealing of all portals of exist present in the root canal system have been the ultimate goal of different obturation materials and techniques for many decades. Perfect adhesion qualities achieved by newer bonding systems tempted clinicians to adopt such technology in an attempt to provide better seal for the root canal system. A new resin obturating materials "RealSeal1" was tested in the present study for its ability to provide three dimensional sealing for root canals. In this study the maxillary first molar have been used ,the palatal roots were sectioned at the furcation area to eliminate the variables in access preparation design, since if the crown present each tooth would1 and to get flat reference point for measurements[(12).]Root canals were prepared using ProTaper hand system because it provide minimum degree of apical microleakage when compare with Rotary ProTaper[13]. EDTA was used as irrigant in order to remove the smear layer because many studies advocate its removal to reduce microleakage[14] also deionized water is used as a final irrigant according to manufacturer instruction. AH-26 sealer was selected and used in this study because have the lowest leakage value compared with other types of endodontic sealer [15]. SE Real Seal sealer have been used with a synthetic polymer-based core material (Real Seal 1, Resilon) a according to the manufacturer instruction. **4.2** Leakage studies constitute a major part of contemporary endodontic research. .The most common method used remains the measuring of liner penetration of dye, but the nature and amount of leakage observed with this technique cannot be extrapolated to an in vivo situation. Measurements of dye penetration were made after decalcifying and clearing the root which it renders the root transparent, enables three dimensional observation of the dye penetration, which can be recorded to its maximum extent and also evaluate whether or not associated with porosities, the presence of empty spaces and stripping of gutta-percha from solid core system[16]. This explains using clearing method for measuring microleakage for this study. This method commonly used because it is easily accomplishes and does not require sophisticated materials [17-19].

1. Real Seal 1 and Resilon: In this in vitro study, the highest mean of leakage value was observed in RealSeal1 and Resilon with no significant differences, this might be related to same composition of materials and both contain methacrylate monomer.

2. Real Seal 1, Gutta-Percha and Thermafil: The Real Seal 1 showed the most leakage value with highly significant difference was found with gutta-percha and Thermafil groups. This might be related to that the methacrylate-based materials undergo volumetric shrinkage during the polymerization process[20-22] also the root canal have high cavity configuration factor that contribute to polymerization stresses created by resin-based materials along root canal walls[23]. Tay et al.[24]found that polymerization of the sealer may be promoted by heat generated during softening of the material. Another plausible explanation for high leakage value is that the resin sealer should be light –cured for 40 seconds to create an immediate coronal seal according to instruction, this prevents stress relief by resin flow and the resin sealer may detach from dentin walls thus creating interfacial gaps[25, 26]. The results of present study disagreed with Testarelli et al.,[27],they found that the new RealSeal1 material (carrier-based Resilon) showing significantly better sealing ability than the traditional carrier-based gutta-percha systems, this may be explained by different evaluation method because they used fluid filtration method and also disagree with study conducted by Duggan et al.,[28] that found that RealSeal1 appeared to resist bacterial penetration more effectively than Thermafil this disagreement may be attributed to their study which is carried on a dog model after inoculation coronally for 4 months.

3. Resilon, Gutta-Percha and Thermafil

The Resilon showed higher leakage value and a highly significant difference was found with gutta-percha and Thermafil groups, this may be related to the same reasons that are mentioned in paragraph 4.2, in addition to that inadvertent stripping of sealer off the canal wall during placement of cones [29, 30] and disruption of the maturing resin root dentin bond during lateral condensation or other technique[29, 30]. The results of present study were in agreement with[31,32,33]and disagreed with Lumnije et al.[34] they found that Resilon had less dye penetration in comparison with gutta-percha and this may be related to different type of sealer used and different method of evaluation because they used dye extraction determined with spectrophotometer. Wedding et al.[35] found that Resilon exhibited a statistically significant increased resistance to fluid movement compared with gutta-percha and AH-26 sealer. This may be due to different method of preparation and different evaluation methods because they used fluid filtration microleakage test.

4. Gutta-percha and Thermafil : In this in vitro study, lateral condensation of gutta-percha group show the least leakage with non-significant difference with Thermafil group which they provides best apical sealing .This finding was in agreement with[36-38,10,39]while these results disagreed with Inan et al.[40]found that Thermafil have the lowest mean leakage values than the highest were observed for lateral condensation of gutta-percha., this may be attributed to difference evaluation methods because they used electrochemical evaluation .

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