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The effect of immediate versus delayed dowel space preparation on the apical seal of Resilon/Epiphany obturation system

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Abstract

Aim: The aim of this in vitro study was to compare the effect of immediate versus delayed dowel space preparation using two techniques (peeso reamers and hot pluggers) on the apical seal of Resilon/ Epiphany obturation system.

Methodology: Fifty freshly extracted human teeth with single and straight canals were used in this study. The roots were instrumented using the step-back technique, K-files with circumferential filing action and copious irrigation of 2.5% sodium hypochlorite and 17% solution of aqueous EDTA to remove smear layer. The canal obturation of all roots was performed with lateral condensation technique using Resilon/Epiphany Obturation system. Then the obturated roots were randomly distributed into 5 experimental groups (10 teeth for each group); one control group, and 4 experimental groups according to the technique of dowel space preparation (peeso reamers and hot pluggers) either immediately after obturation or after one week later. After this period, 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 3 days at 37ºC. Then 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 more apical leakage ($P<0.05$) in groups that received delayed dowel space preparation using either peeso reamers or hot pluggers compared with control group and no significant differences ($P>0.05$) between immediate and delayed dowel space preparation using either technique.

Conclusion: Resilon/ Epiphany obturation system can received immediate and delayed preparation using conventional methods of dowel space preparation, however immediate preparation was preferred according to the results of this experiment.

Keywords: Resilon, Dowel space preparation, Peeso reamer, Hot plugger

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 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. The required post space may be prepared either immediately after the completion of the endodontic procedure or alternatively after 1 week or later to ensure complete setting of root canal sealer.[2-4] 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. However, there is a major flaw with filling root canals with gutta-percha and sealer. Hovland and Dumsha in 1985 [5] stated that all root canal sealers leak, but there is probably a critical level of leakage that is unacceptable for healing which leads to endodontic failure. They also found that leakage could occur at the interface of the sealer to dentin, sealer to gutta-percha, and through the sealer itself, or by dissolution of the sealer. Resilon/ Epiphany obturation system (Pentron Clinical Technologies, Wallingford. CT, USA) is a new obturation material that was developed to replace gutta-percha and sealer. This system consists of a self-etch primer, a dual-cure resin sealer, and Resilon cones. Resilon cone is a thermoplastic synthetic polymer-based (polyester) root canal core material that performs, handles, looks like gutta-percha.[6] 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. Resilon/Epiphany system has a few advantages over gutta-percha. It has been shown to create a superior seal through-out the root canal which resist microbial leakage and was also shown to be associated with less apical periodontitis compared to gutta-percha and AH26 sealer.[7] The bonding ability of Resilon/Epiphany system is also thought to strengthen the root. Teixeira and colleagues in 2004 [8] found that root canals filled with Resilon were more resistant to fracture when compared to gutta-percha and AH26 sealer. Another major advantage of Resilon over gutta-percha is it is ability to thermoplasticize at much lower temperature.

Materials and Methods

Sample Selection & Preparation:

Fifty freshly extracted human teeth with single, straight canals, and mature apices were used in this study. The teeth were stored in normal saline solution at room temperature. External soft tissues and calculus were removed from the teeth using a cumine scaler. All teeth were examined for any visible fracture or crack by using light curing unit. 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 and water coolant.

Root canal preparation:

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. The size of first file that bound to the working length was either 20 or 25, otherwise the tooth was

discarded and replaced by another tooth. A step back preparation technique was used to prepare the root canals using K-files with circumferential filing action. The canals were instrumented to the size #50 master apical file, 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 file. Recapitulation to full working length with master apical file after each flaring file with 2.5 % NaOCL irrigation. After instrumentation, a size # 15 K-file was passed through the apical foramen to remove dentinal debris. A total of 10 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 (pH 7.4) rinses were used during and after instrumentation for 1 minute to remove smear layer followed by 5 ml of deionized water.

Root canal obturation:

The canal obturation of all roots performed with lateral condensation technique using Resilon/Epiphany Obturation system. Each root was dried with paper points, Resilon 0.02 taper master cone size 50 must fit to the full working length, it must be impossible to be forced further beyond the apical foramen, and have a good tug back. 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 Resilon cone laterally and to create a space for subsequent accessory cone. A 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 Resilon was seared off with a hot instrument and vertical condensation of warm Resilon with endodontic plugger was done. 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 buccolingually and mesiodistally to evaluate the density of the filling materials.

Sample Grouping and Dowel Space Preparation:

The obturated roots were randomly distributed into 5 experimental groups (10 teeth for each group); **Group I:** Control, obturated roots without dowel space preparation were sealed coronally with glass ionomer cement as a temporary restoration and stored in 100% humidity condition at 37ºC in an incubator for one week to ensure complete setting of the sealer. **Group II:** The roots received dowel space preparation immediately after obturation using peeso reamers beginning with largest size No.3 that would fit the canal and then No.2 until 5 mm of the apical filling material remained in the canal. **Group III:** The roots received dowel space preparation immediately after obturation, using hot pluggers sizes (2, 4), the rapid placement and removal of a well-heated root canal plugger removed the

obturation material as it softens and adheres to the pluggers. This process continues until 5 mm of apical obturation material remained. No vertical condensation was performed after removal of filling material. **Group IV:** After one week storage in 100% humidity condition at 37ºC in an incubator, the obturated roots received dowel space preparation using peeso reamers. **Group V:** After one week storage in 100% humidity condition at 37ºC in an incubator, the obturated roots received dowel space preparation using hot pluggers.

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.

One-Way Analysis of Variance (ANOVA) test was performed to determine if there was a significant difference among the experimental groups, then student t-test was used to evaluate the significance of difference between each pair of groups, 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 experimental groups are presented in Table (1). While mean leakage for these groups 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 experimental groups. The results 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 groups:

The results of table (2) showed no significant differences ($P>0.05$) among immediate dowel space preparation groups and control group while there was a Significantly more apical leakage ($P<0.05$) in groups that received delayed dowel space preparation using either peeso reamers or hot pluggers compared with control group and no significant differences ($P>0.05$) among immediate and delayed dowel space preparation using either technique.

Discussion

Proper cleaning and shaping of the root canal and the total obturation of the root canal system with an

impervious, biocompatible and dimensionally stable filling material with the development of a fluid-tight seal at the apical foramen are considered as essential factors for successful endodontic therapy. Leakage studies on the sealing ability of endodontic materials are still important and necessary. Different methods have been used to evaluate the sealing of endodontic materials. Linear dye penetration is a common method used for measuring apical leakage of root fillings after splitting the roots. **(9-11)**

All groups in this experiment had apical leakage to a certain extent. 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 (Groups II & III) and those prepared after one week (Groups IV & V) when peeso reamers or hot pluggers used. However the immediate and delayed dowel space preparation groups using hot pluggers (Groups III & V) showed less mean leakage compared with peeso reamers (Groups II & IV) but not significant difference between them, this may be due to the one of advantage of Resilon that thermoplasticize at much lower temperature and easy to removal compared with gutta-percha. The delayed preparation groups (Groups IV & V) had more apical leakage compared with control group. 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 delayed dowel space preparation. These gaps were probably created by rapid polymerization contraction of the methacrylate resin-based sealer (Epiphany sealer) during setting. **(12)** However the Resilon/Epiphany obturation system is a relatively new material that was developed to replace gutta-percha and root canal sealer and further studies are necessary 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.

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Table (1): Statistical summary

Groups	Mean	±S.D.	S.E.	Min.	Max.
Group I	1.76	±0.855	0.270	0.5	3.2
Group II	2.20	±0.714	0.226	1.1	3.3
Group III	2.02	±0.940	0.297	0.7	3.3
Group IV	2.98	1.056	0.333	1.7	4.8
Group V	2.69	0.710	0.224	1.5	3.8

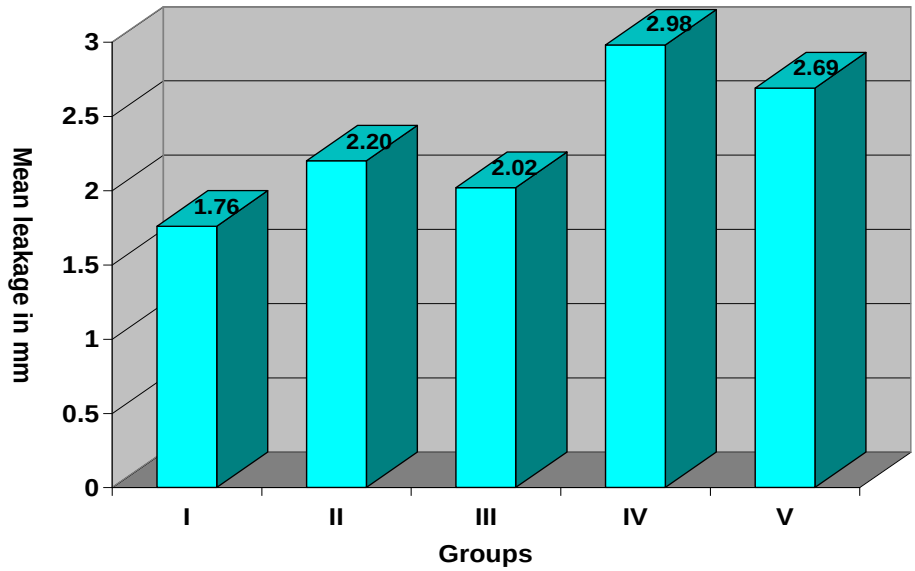

Fig. 1 Bar chart graph to compare the mean leakage among the experimental groups.

Table (2) Student t-test results

Comparison Groups	**t-test**	**P-value**	**Statistical Sig.**
I & II	1.404	0.194	N.S.
I & III	0.586	0.572	N.S.
I & IV	2.736	0.023	S.
I & V	2.524	0.033	S.
II & III	0.666	0.522	N.S.
II & IV	1.767	0.111	N.S.
II & V	1.313	0.222	N.S.
III & IV	2.017	0.074	N.S.
III & V	1.929	0.086	N.S.