A comparative study to evaluate the effect of immediate versus delayed dowel space preparation on the apical seal of Epiphany obturation system with different obturation techniques (An in vitro study)

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ABSTRACT

Background: The aim of this in vitro study was to compare the effect of immediate versus delayed dowel space preparation using rotary instruments (peeso reamers) on the apical seal of roots filled with epiphany obturation system by two different obturation techniques: Lateral condensation technique and Thermo-plastic Injection technique (Obtura II).

Materials and Methods: Forty freshly extracted human teeth with single and straight canals were used in this study. These teeth were cleaned and their crowns were removed at the cemento-enamel junction, the roots were instrumented using the step-back technique, instrumentation was accomplished by using the Gates-Glidden drills with copious irrigation of 2.5% NaOCL and 17% buffered solution of EDTA was used as the final rinse to remove smear layer. All roots of all groups were obturated with epiphany obturation system and the roots were randomly divided into 4 groups (10 teeth for each group): Group A (Lateral condensation technique + immediate dowel space preparation), Group B (Lateral condensation technique + delayed dowel space preparation), Group C (Thermo-plastic Injection technique (Obtura II) + immediate dowel space preparation) & Group D (Thermo-plastic Injection technique (Obtura II) + delayed dowel space preparation). The roots of groups A & C received dowel space preparation immediately after obturation using peeso reamers to a depth that left 5mm of the filling material apically while the roots of groups B & D received dowel space preparation after one week storage in 100% humidity condition at 37°C in an incubator. The external surfaces of all roots were coated by two layers of sticky wax except for apical 2 mm and then were submerged in 2% methylene blue dye for 3 days at 37°C. After that all roots were longitudinally sectioned for linear measurement of dye penetration through the apical forman using a stereomicroscope at X40 magnification with calibrated scale ocular grid.

Results: The results showed that for immediate dowel space preparation group C showed the lowest mean of dye leakage (1.525 mm) while for delayed dowel space preparation group D showed the lowest mean of dye leakage (2.335mm).

Conclusion: Significantly less apical leakage in roots obturated by thermo-plastic Injection technique than those obturated by lateral condensation technique for both immediate & delay dowel space preparation and highly significant less apical leakage in roots received immediate dowel space preparation than those received delayed one despite the type of obturation technique.

Keywords: Epiphany obturation systems, obtura II, dowel space preparation. (J Bagh Coll Dentistry 2009; 21(4):41-46)

INTRODUCTION

Success in endodontic treatment is predominantly determined by complete obturation of root canal system. Gutta-percha which has commonly used for this purpose, does not prevent bacterial leakage and further complications ever when applied together with a sealer because gutta-percha is considered an impermeable core material; therefore, leakage through an obturated root canals expected to take place at the interfaces between sealer and dentin or sealer and gutta-percha or through voids within the sealer (1).

Thus, finding a gutta-percha substitute that would provide a superior seal of the root canal system has become a challenge in modern endodontics. A new material based on composite resins, the resilon-epiphany system with its novel formula consists of three parts: resilon core material, epiphany sealer and primer. So this system allows formation of the so-called mono-block made of root dentin, sealer and resin-percha, which has the potential to strengthen the structure of the tooth attenuated by endodontic treatment, at the same time ensuring complete sealing of the root canal and resistance to bacterial leakage (2).

MATERIALS AND METHOD

Sample selection

Forty freshly extracted human teeth were used in this study. Criteria for selection included the following:

(1) Professor, Department of Conservative Dentistry, College of Dentistry, Baghdad University
(2) MSc student, Department of Conservative Dentistry, College of Dentistry, Baghdad University
1. The existence of straight and single root canal.
2. Completely formed apex with a patent foramen.
3. Apical foramen size 20 (first file that binds to the working length).
4. Roots without cracks, fracture or resorption.

**Sample preparation**

After extraction, all teeth were stored in normal saline solution at room temperature. Any soft tissues remnants and calculus on the root surface were removed using a cumine scaler and the root surfaces were verified with a magnifying eye lens (X10) and light curing unit for any visible cracks or fractures \(^{(3)}\).

Using a diamond disc bur with straight handpiece and water coolant the crowns of teeth were sectioned perpendicular to the long axis of the root at the cemento-enamel junction to facilitate straight line access for canal instrumentation and filling procedure and to get flat reference point for measurement \(^{(4)}\).

The length of roots ranged between (13-15) mm and the access opening was prepared for each tooth using carbide round bur with conventional hand piece and water coolant. The pulpal tissue was removed by using 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 20 \(^{(5)}\).

**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 instrumented to the size #40 master apical file, flaring began after completion of apical preparation by stepping back to three sizes after the master apical file till size #55 with a 1 mm reduction in the working length with each larger file \(^{(6)}\).

To flare the coronal and middle third of the canal a size 2 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 3 Gates-Glidden at 7 mm short of the working length and size 4 at 10 mm short of the working length with copious irrigation of 2.5 % NaOCL between each larger size. Then all around the canal walls were smoothed with vertical push-pull strokes using Headstroem files #40 \(^{(7)}\).

After instrumentation, a size 15 K-file was passed through the apical foramen to remove dentinal debris. Additionally, patency of the canals was ensured by forcing NaOCL solution through the apical foramen \(^{(8)}\). A total of 10 ml of 2.5% NaOCL was used for irrigation during instrumentation then 5ml of 17% EDTA rinses were used 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.

To facilitate the grasping and control of the samples during the obturation procedure, the roots were wrapped with one thickness of lead foil backing from an x-ray film to level of cemento-enamel junction and lubricated with Vaseline. Cold-cure acrylic resin was mixed and poured into stainless steel cylindrical mould lubricated with Vaseline. The root was then embedded in fresh mix of acrylic resin to the level of cemento-enamel junction. A dental surveyor was used to position the long axis of the tooth parallel to that of the stainless steel mould. After the acrylic resin had set, the root was removed a long with the lead foil. Silicone impression material was mixed and loaded into an impression syringe was injected into the acrylic mould. The root was repositioned in its created acrylic resin socket. Space left by removal of the lead foil become a silicon substitute for the periodontal ligament \(^{(9)}\).

**Root Canal Obturation**

All roots were obturated with Epiphany obturation system. Forty roots were randomly divided into 4 experimental groups (10 teeth for each group):

- **Group A**: Lateral condensation technique + immediate dowel space preparation.
- **Group B**: Lateral condensation technique + delayed dowel space preparation.
- **Group C**: thermo-plastic Injection technique (Obtura II) + immediate dowel space preparation.
- **Group D**: thermo-plastic Injection technique (Obtura II) + delayed dowel space preparation.

The root canal spaces were filled with Epiphany primer using a pipette provided by the manufacturer then dry paper points # 40 were used to pick up the excess primer from the canal, followed by placement of Epiphany sealer. The dual syringe (with mixing tip) was used to express the sealer onto the mixing pad then the Epiphany sealer was carried to the canal in small amounts on a master apical file #40 using a pumping action with rotary movement in a counter clockwise direction according to the manufacturer’s instruction.

Group A & group B were obturated with .02 taper Epiphany obturation system by Lateral...
condensation technique. After the placement of Epiphany sealer in to canal, the master cone #40 was coated with the sealer and placed into its correct working length within canal. An endodontic #40 stainless steel handled spreader, which would reach within 2 mm of the working length, was used to compact the master Resilon cone #40 laterally and to create a space for subsequent accessory cone. 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.

Group C & group D were obturated with resilon pellets by obtura II system Figure 1. Resilon pellet was inserted in to the gun of obtura II device and heated to 115°C when 23-guage injection needle was used according to the manufacturer instruction of Epiphany system. A segmental technique was used in which 4-5 mm segments of resilon were sequentially injected and compacted \(^{(10)}\). Finger pluggers (#40, #60, #80) were pre-fitted inside the canal before the placement of primer and sealer, so they reach (the coronal two thirds of the canal, to the coronal one third & to coronal 2-3 mm from the orifice respectively) with complete freedom and were used to compact the resilon segments vertically. The needle tip was inserted in to the canal 3-5 mm shorter than the working length and the softened resilon was injected by squeezing the trigger of the gun. The needle backs out of the canal as the apical portion was filled. The first segment was compacted by # 40 finger plugger the compaction was continue until the resilon cools and solidifies to compensate for the contraction that takes place on cooling then the needle was re-inserted in to the canal and the second segment was injected and compacted by # 60 finger plugger followed by the insertion of needle to inject the third segment which was compacted by # 80 finger plugger until the resilon solidified.

The coronal 2-3 mm of each root was sealed with glass ionomer cement as a temporary restoration. Each root was radiographed to evaluate the density of the filling materials.

**Dowel space preparation**

1. **Immediate dowel space preparation.** The roots of groups A & C were received dowel space preparation immediately after obturation using peeso reamers starting with 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 \(^{(8)}\). They were then sealed with glass ionomer cement and wrapped in saline moistened gauze allowing the sealer to set completely for 7 days with 100% humidity condition at 37°C in an incubator.

2. **Delayed dowel space preparation.** After one week storage in 100% humidity condition at 37°C in an incubator, the obturated roots of groups B & D were received dowel space preparation using peeso reamers in the same manner of immediate preparation.

**Apical leakage study**

Each root was coated with two layers of sticky wax except for the apical 2 mm using electrical wax knife so that tracer could penetrate the canal via the apical region only. 2% methylene blue dye was used as leakage indicator for all groups. Each root was bound to a rubber cap and the apical 3-4 mm of each root was immersed in a plastic vial containing 4 ml of 2% methylene blue dye and deposited in an incubator at 37°C for 72 hours Figure 2. At the end of this period, the teeth were removed from the dye and washed under running water in a position opposite to the apical foramen for one minute \(^{(11)}\).

**Figure 1:** Obtura II system

**Figure 2:** The root was bound to a rubber cap and the apical 3-4 mm was immersed in 2% methylene blue dye.

Then the sticky wax was scrapped from the root surface with a lacron carver. 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 placing the edge of chisel in the groove and
applying a gentle pressure, care was taken to include the apical foramen in the fracture line (Figure 3). The filling materials were removed from the canals of the sectioned samples and then the samples were examined for the degree of dye penetration using a stereomicroscope at x40 magnification with calibrated scale ocular grid to establish the degree of dye penetration in millimeters (11).

Figure 3: Splitting the root longitudinally by light tap on a chisel.

The 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 split halves of each root was recorded by two evaluators one of them was unaware of the obturation techniques used and the average of the two measurements of each root was considered for statistical analysis (12).

RESULTS

Descriptive statistical analyses was carried out on the collected data to establish the values of the standard deviation (SD), minimum (Min), maximum (Max) and mean in millimeters for each experimental group used in the study, as shown in the table 1. Student t-test was used to evaluate the significance of difference between each two groups. The results of student t-test are listed in table 2.

Table 1: Descriptive of groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Min</th>
<th>Max</th>
<th>Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>1.35</td>
<td>2.85</td>
<td>2.04 ±0.509</td>
</tr>
<tr>
<td>Group B</td>
<td>2.25</td>
<td>4.45</td>
<td>3.295 ±0.706</td>
</tr>
<tr>
<td>Group C</td>
<td>1.15</td>
<td>1.9</td>
<td>1.525 ±0.284</td>
</tr>
<tr>
<td>Group D</td>
<td>1.85</td>
<td>2.9</td>
<td>2.335 ±0.363</td>
</tr>
</tbody>
</table>

The results of student t-test table 2 showed the following:

1. There was significant difference (P< 0.05) between group A (obturated by LCT and received immediate dowel space preparation) and group B (obturated by LCT and received delayed dowel space preparation).

2. There was highly significant difference (P< 0.001) between group C (obturated by TPIT and received immediate dowel space preparation) and group D (obturated by TPIT and received delayed dowel space preparation).

3. There was significant difference (P< 0.05) between group A (obturated by LCT and received immediate dowel space preparation) and group C (obturated by TPIT and received immediate dowel space preparation).

4. There was significant difference (P< 0.05) between group B (obturated by LCT and received delayed dowel space preparation) and group D (obturated by TPIT and received delayed dowel space preparation).

5. There was non significant difference (P> 0.05) between group A (obturated by LCT and received immediate dowel space preparation) and group D (obturated by TPIT and received delayed dowel space preparation).

6. There was highly significant difference (P< 0.001) between group C (obturated by TPIT and received immediate dowel space preparation) and group B (obturated by LCT and received delayed dowel space preparation).

DISCUSSION

In this study, all experimental groups were obturated with Epiphany obturation system and all groups showed apical leakage to a certain extent.

The dye leakage results of this study indicated that the immediate dowel space preparation actually leaked less than the delayed dowel space preparation as shown in tables 1, 2.

The same findings of this study were also reported by Rosenstiel et al (13), they found that less apical micoleakage occurred when the post space preparation was accomplished at the same time that the root canal was obturated. Since the endodontist had a better knowledge of the root length and diameter of the treated tooth and knows how much filling material should be
removed and the clinician can go back and recondense the remaining filling material before the sealer has set and this will result in a well-condensed apical filling.

The possible hypothesis is that when the post space is made at the time of obturation, the sealer has not formed a lasting bond to the filling material or canal wall. When rotary instruments are used to remove the filling material, the sealer is still within its working time and allows the sealer to set without introducing micro-fractures where the sealer is in contact with the filling and dentin. When the sealer is set during delayed post space preparation, it is possible that the rotational forces of the rotary instrument causes movement of the filling material, thus breaking the bond at the sealer interface and facilitate dye penetration.

For epiphany obturation system bonds breaking occurred between the sealer and root dentin, this agreed with Gesi et al. (15) who compared the interfacial strengths for resilon/epiphany sealer and gutta percha/AH plus sealer using a thin-slice push-out test design and SEM. They found that the gutta percha root slices failed along the gutta percha / sealer interface while the resion root slices failed along the sealer/dentin interface with recognizable fractured resin tags.

So during delayed dowel space preparation, the weak link in Resilon-filled root canals that resided predominantly along the sealer-dentin interface resulted in debonding from dentinal walls because of gaps formation which facilitate apical dislodgement during dowel space preparation especially when rotary instruments were used. These gaps were probably created by polymerization contraction of the methacrylate resin-based sealer (Epiphany sealer) during setting. This agreed with Tay et al (16) who in SEM compared the tightness of root canal obturation with resilon / epiphany sealer and gutta-percha / AH plus sealer using system B and obtura II. In both groups, they observed both gap-free and gap-containing regions. It is assumed that these gaps are probably created by rapid polymerization contraction promoted by heat generated during material condensation with a hot plugger and showed that neither obturation materials achieved a complete hermetic apical seal. The results of this study also coincided with Saleh & Al-Azzawi (17) who found that immediate dowel space preparation using peeso reamers for resilon-filled roots produced the lowest apical dye leakage comparing with delayed one.

In this study, the best apical sealing was achieved by TPIT than LCT and the difference between them was statistically significant as in tables 1,2. This agreed with Gilhooly et al (18) who proved the better sealing ability of TPIT compared with LCT and this may be attributed to that LCT produces a less homogeneous obturation with poorer adaptation to canal walls compared with TPIT and Glickman (19) who supported the use of the TPIT and confirmed its ability to achieve a detailed replica of cavitations and defects within the root canal system.

Schilder (20) found that LCT developed little homogeneous mass and the final filling consists of a large number of separated cones tightly pressed together and joined by frictional grip and the cementing substance only and the use of TPT allows the filling of accessory canals and foramina and permits great density to be created in the apical portion of the filling. Conflict with these results, Devčić et al (21) found that LCT produced better apical seal than TPT, while Deus et al (22) found no differences between the LCT and TPIT. These variations may be attributable to differences in the methods of canal preparation and in the way of leakage evaluation. Te results of this study are in line with Verissimo et al (23) who compared the level of apical leakage between canals filled with gutta-percha/AH-Plus (GP) and the Resilon/Epiphany System (RES), when submitted to two filling techniques [lateral condensation and Hybrid technique (system B & O.II)]. After 7 days in an oven (37 degrees C, 100% humidity), the teeth were immersed in India ink and cleared. Leakage was measured by the NIH image J program. There was a statistically significant difference when RES was compared with GP which leaked more than RES. With RES, leakage was confined to the apical third and hybrid technique could be used to thermoplasticize RES with satisfactory results.

REFERENCES