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Apical microleakage evaluation of three different root canal Obturation techniques using dye penetration evaluation method

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Abstract

Background and objectives: The aim of root canal obturation in endodontic treatment is to prevent communication between the oral cavity and periapical tissues. Several techniques had been introduced to achieve complete filling of the root canal system. It had been noted that more researches are needed to establish standard techniques of root canal filling, and all the techniques should be compared for filling root canals. The aim of this study was to compare the apical sealing ability of three different obturation techniques.

Methods: Thirty single rooted teeth were collected and randomly divided into three groups. There were 10 teeth in each group. The teeth were obturated by gutta percha as follows: Groups 1 with Thermafil, Groups 2 with Soft core, and Groups 3 with System B. The apical leakage in these groups was evaluated using a dye penetration method.

Results: The lowest mean rank of leakage was observed for system B and the highest was observed for the thermafil groups. The difference between Thermafil, soft core and system B was statistically not significant by using Kruskal Wallis test.

Conclusion: System B obturation technique show less microleakage than soft core and thermafil techniques although the differences was not significant.

Keywords: Microleakage,apical seal, gutta percha, thermafil, soft core, system B.

Introduction

Complete obturation of the root canal system with an inert filling material and creation of a hermetic apical seal have been proposed as goals for endodontic treatment. Since the most common cause of endodontic failure has been attributed to incomplete obturation, many different obturation techniques have been developed in order to increase the success of root canal treatment. Gutta-percha has been material of choice for obturation since 1867. Lateral condensation has proven to be a very popular gutta-percha obturation

Technique, however, its ability to conform to the internal surface of the root canal has been questioned.[1]

Brayton et al[2] reported voids, spreader tracts, incomplete fusion of gutta percha cones and lack of surface adaptation. Also, this technique relies on sealer to fill accessory canals. Eguchi et al[1] reported that lateral condensation results in excessive amount sealer and apical void[1]. This might decrease the effectiveness of the

root canal obturation. Studies have shown that softened gutta-percha can easily be moved into the canal irregularities, thus replicating the intricacies of the root canal system. There are number of warm gutta-percha methods, these include warm lateral condensation, warm vertical condensation, coated carrier systems, injection systems and thermomechanical compaction.[3]

The Thermafil technique introduced involves placing alpha phase gutta-percha on a metal carrier heating and using it to obturate the root canal. Currently used carriers are made of stainless steel, titanium or plastic[3]. With regard to sealing of and adaptation to canal walls, Beatty et al[4] reported the Thermafil technique to be superior to the lateral condensation technique. Another coated carrier system, Soft Core has recently been introduced. The Soft-Core obturators consist of biocompatible plastic posts, available in ISO standard sizes and coated with thermoplastic alpha phase gutta-percha. The central plastic core of Soft-Core is round and hollow. Its depth corresponds to the diameter and the length of the insertion pin. However, Thermafil has a V shaped central plastic core.[4]

Another warmed gutta-percha technique System B (endodontic heat source unit) designed to obturate the root canal system with single continuous wave of thermoplasticized gutta-percha.[5]

The purpose of this in vitro study was to compare apical microleakage of teeth filled with gutta percha by three different obturation techniques.

Material and methods

1.Teeth collection and preparation

For this study thirty freshly extracted human single-rooted teeth were collected from the clinics of college of dentistry, Hawler Medical University and Erbil dental collective.The age, gender, pulpal status and reason for extraction were not considered, and criteria for teeth selection were: Straight root canal, mature, centrally located apical foramen, patent apical foramen; size 20 is the first file that binds to the working length, roots devoid of any resorption and cracks or fractures. The roots were 12mm in length from the apex up to the cemento-enamel area.

After extraction; the teeth were stored for two days at room temperature in 3% NaOCl for dissolution of the organic debris. After that, they were scaled with ultrasonic scaler and washed with distilled water for removal of any calculus or soft tissue debris. Root surfaces were verified with a magnifying eye lens for any visible cracks or fractures. Then they were immersed in 10% formalin solution until use.

The roots of teeth were sectioned perpendicular to the long axis of the root at cemento enamel junction using a diamond disc bur with straight hand piece and water coolant, to facilitate straight line access for canal instrumentation and filling procedure and to standardize the length of the root to 12mm by using a digital caliber vernier with an accuracy of 0.01mm.

The coronal orifice of each root canal was irrigated with 1 ml. of NaOCl, then each canal was checked by size # 15 K- file to verify the canal patency, in such a way that the k- file must appear from the root apex slightly (just seen). Any root that did not fulfill these criteria (i.e. k-file not appears from the apex) was discarded and not involved in the study.

2. Instrumentation of the canals

The canals were instrumented by the crown down technique using Protaper rotary system by Dentsply engine at 300 rpm with torque number 3. Before instrumentation, the canals were irrigated with 1 ml. NaOCl, and then the instrumentation started as following;

1) From SX up to the full working length until this file becomes loose, irrigating the canal with 1 ml. NaOCl.

2) Enlarging the coronal 2/3 of the canal using S1 instrument with the use of irrigating solution which allows easy entrance of the file.

3) Using S2 instrument to just 2-3 mm. shorter than the estimated working length for each canal, irrigating the canal with the 1 ml. NaOCl.

4) Finally the apical third were prepared by using F1, F2 and F3 files (finishing files) up to the full working length by just passing the file one time to the apical area without excessive rotation of the file when it's in the full working length keeping in mind that the canal is fully filled with irrigating solution. At this stage, all the canals were prepared with a size simulating to that of k-file # 30 at apical terminal.

One ml. of NaOCl solution was irrigated after instrumentation with every size throughout the cleaning and shaping of the canals.

3. Sample grouping

The roots were randomly divided into three groups of ten roots each as follow:

Group 1

In this group the roots were obturated with Thermafil obturators (plastic carrier coated with thermoplacticized gutta percha). The canal preparation was evaluated with No. 30 Thermafil verifier, which fits snugly to the working length. A properly cleaned and shaped root canal was dried and prepared for obturation. Zinc oxide eugenol sealer (Tubli-Seal endodontic sealer-kerr company) was mixed on a dry, clean glass slab with spatula till the mixture had a homogenous creamy consistency with string out at least 1 inch when spatula was raised slowly from the glass slab. The canal of each tooth was dried with paper points. A reamer one size smaller than the master apical file was selected, rubber stopper positioned at the working length and a small amount of sealer picked up with its tip. The reamer was placed to the correct working length in the canal and turned counterclockwise for three times spinning the sealer into the canal. Thermafil obturators were warmed in the ThermaPrep Oven. The time required and the temperature to which the cones were heated was predetermined in the oven by the manufacturers, then the warmed obturators were slowly inserted into the canals up to the working length.

The handle of the carriers were cut at the canal orifice with a high speed bur. The gutta percha, which was still in the thermoplacticized phase, was vertically compacted around the carrier with a hand pluggers [6].

Group 2

Obturation with Soft Core cones. A properly cleaned and shaped root canal is dried and prepared for obturation. The zinc oxide eugenol sealer was mixed and placed in the canal as described in group 1.

Soft core cones were warmed in the Soft core Oven. The time required and the temperature to which the cones were heated was predetermined in the oven by the

manufacturers, then the warmed obturators were slowly inserted into the canals up to the working length.

Group 3

Following the master cone selection and fitting, a properly cleaned and shaped root canal was dried and prepared for obturation. A System B plugger that fits to 3 mm of working length without binding was selected and placed in the plugger hand piece. The master cone was coated with a zinc oxide eugenol sealer as described in group (1), and seated to length in the canal. The System B plugger was placed at the canal orifice and activated. While holding on the heat activator the plugger was advanced apically. At 6mm from the working length the heat activator is released and the apical advance of the plugger was continued up to 3mm from the working length. Apical pressure was held for 10 seconds to allow the apical plug of gutta-.percha to cool without shrinking. Heat was activated for 1 second, providing a separation bust of heat, and the plugger was removed from the canal with the excess gutta-percha adhered to the plugger. Sealer applied to the walls of the canal before beginning to backfill, the applicator tip of the Obtura II thermoplasticized delivery system was inserted into the coronal aspect of the apical plug. It was allowed to warm the gutta-percha and a 4 mm increment is delivered, then pluggers were used to condense the thermosoftened gutta-perch. Slow measured delivery ensures the densest mass of material. After obturation, the roots of the three groups were radiographed to verify the proper condensation of the obturations, Fig (1). Obturated roots were wrapped in saline moistened gauze in closed glass vials allowing the sealer to set for 7 days with 100% humidity at37°C in an incubator

4. Dye applications

After obturation, all specimens were stored in 37°C and 100% relative humidity for 72 hours. For evaluation of apical leakage, the coronal portion and the root surfaces of each tooth was coated with three layers of nail varnish, leaving at least 1.0mm around the apical foramen exposed. The teeth were placed in closed glass vials containing 2% methylene blue dye (pH 7.0) and incubated for 7 days at 37°C. After removal from the dye, Fig (2) the specimens were rinsed in tap water for 30 minutes and dried with air syringe carefully. The nail varnish was removed with scalpels.

5. Root sectioning

After drying, the samples were embedded in clear orthodontic resin. The acrylic was prepared by mixing powder and liquid as recommended by the manufacturers in a porcelain jar. The jar was covered to prevent the evaporation of the monomer. The material was left undisturbed for few minutes until it reached the workable stage. Two ml disposable plastic syringes were used as molds into which the freshly prepared acrylic paste was loaded.

The flat coronal end of the obturated roots were fixed on the face of the plastic piston of the syringes with a resin adhesive as recommended by the manufacturers before loading the syringes with acrylic so that the roots would be almost centrally located within the acrylic blocks and to ensure that the sectioning would be almost perpendicular to the long axis of the roots.

After loading the syringe with the freshly prepared workable acrylic

paste, the piston of the syringe with the root fixed on its face was pushed into the acrylic paste with gentle pressure to allow the complete embedding of the root into the acrylic, and to allow the escape of the excess material through the opened syringe tip.

The material was allowed to cure under cooled water 20ºC which was necessary to compensate for the anticipated rise in the temperature of the samples subsequent to the exothermic curing reaction of the cold cure resin. The acrylic molds were allowed to cure completely for at least 30 minutes which was recommended by the manufacturers. Finally the plastic syringes were cut off. The access acrylic was cut off so that the acrylic layer over the root apex would not exceed 1mm in thickness (Fig. 3).

Serial cross sections in distances of 1 mm were made using diamond wheel bur mounted on straight hand piece and engine with a rotation speed regulator, the hand piece was assembled in a modified cutting device. [6] The sections were made under heavy flow of cold water (19-25ºC) to minimize smearing (Fig. 4).

At the end of roots sectioning the obtained slices were mounted on glass slides using resin adhesive each slide containing 6 slices of one sectioned root. Each slide was numbered by two digit number, the first number indicating Obturation group number while the second number was representing the tooth number.

6. Data collection

Sections of each slide were examined by an expert dental specialist at an original magnification of 20X by mean of stereomicroscope to determine the presence or absence of dye. A group was selected randomly and re-examined after one week by the same examiner and also examined by a second examiner to evaluate inter and intra examiner differences.

Each slide was scored from 0-6 depending on the following criteria:-

Score (0): No dye penetration

Score (1):- dye was penetrating the first slice.

Score (2):- dye was penetrating the second slice.

Score (3):- dye was penetrating the third slice.

Score (4):- dye was penetrating the fourth slice.

Score (5):- dye was penetrating the fifth slice.

Score (6): dye penetration reaching the final slice.

7. Statistical Analysis

Data were collected and analyzed using mean rank value of dye leakage. Differences between groups were examined by Kruskal Wallis test.

Results

The mean rank of apical microleakage based on the amount of dye leakage in the three experimental groups were calculated and statistically analyzed.

The mean rank of dye penetration values for Thermafil, soft core and System B were, 18.35, 15.50 and 12.65 respectively. The lowest mean leakage values were observed for system B and the highest were observed for the thermafil groups. By using Kruskal-Wallis test the difference between three groups was statistically non-significant Table (1).

P values of 5% and more were regarded as statistically insignificant, whereas values less than 5% ($P<0.05$) were considered as significant and

those values less than 1 %(P<0.01) were considered as highly significant.

Discussion

In this study methylene blue dye was used because it easily allows quantitative measurement of the extent of the dye penetration by linear measurement techniques.Its molecular size is similar to bacterial by product such as butyric acid which can leak out of infected root canals to irritate periapical tissues.[7,8]

In the present study, the apical sealing abilities of Thermafil, System B and soft core techniques were compared using linear dye penetration method. The lowest mean leakage values were observed for system B and the highest mean leakage values were observed for thermafil.

Consistent with our results, Kleoniki et al.[9] compared the apical leakage between thermafil, soft core and system B they found that the leakage of the Thermafil group was higher than soft core system followed by System B, with no significant difference. This is may be due to the fact that gutta percha with system B will cool with less shrinkage than soft core and thermafil, so the apical seal with system B will be better than other two obturation techniques.[3]

Manal et al[10] found that no significant differences in microleakage between thermafil and system B.

Norberti and Ivaldo[11] compared the apical microleakage of thermafil and soft core, they found no significant differences between two techniques used.

Nimet et al[3] also agreed with the results of this study but reported that the microleakage following canal fillings with System B created a better apical seal than thermafil. This may be due to the fact that thermafil exhibited dye penetration due to probable mass shrinkage of gutta-percha after it cools down while system B is applied in increments depending on continuous wave theory so always when it cools down there is less shrinkage than single mass shrinkage as in thermafill soft core and also voids may be present in the apical area of the canal after obturation with thermafil may be incorporated in increasing microleakage.

Garrett et al[12]and Ugar and Tamer [13]disagree with the result of this study .They found that thermafil show less microleakage than system B and soft core although there is no significant differences ,also Hanna HP[14] disagree with the result of this study they found that system B show more microleakage than soft core . Boussetta, et al[15] found that the roots that filled with thermafil showed less microleakage than those filled with soft core. This differences may be due to different type of sealer used and different instrumentation techniques and methods of testing used.

Conclusion

System B obturation technique showed less microleakage than soft core and thermafil techniques although the differences was not significant.

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Table (1):mean Rank of dye leakage of three groups and Kruskal Wallis test for comparison between three groups.

Groups	N	Mean Rank	p
Thermafil	10	18.35	0.327
Soft core	10	15.50	
System B	10	12.65	

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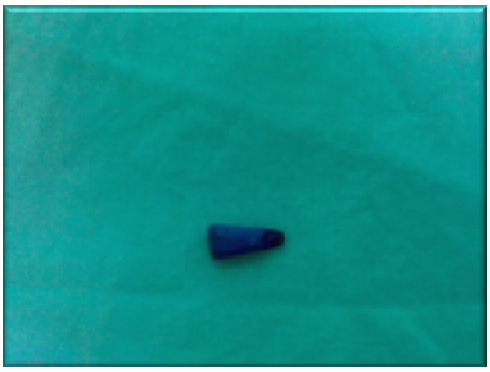
Fig(1).A radiograph to verify obturation condensation.



Fig(2):specimen after removal from methylene blue dye.

Fig. (3):- Obturated root embedded in clear acrylic block.

Fig. (4):- The cutting device