Evaluation of the Efficiency of Three Different Obturation Techniques to Obturate the Isthmus Area of Roots Canals Prepared by Two Different Instrumentation Techniques (An *In Vitro* Study)

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ABSTRACT

Background: The isthmus is a difficult area in the root canal complex to manage. The research aimed to evaluate the efficiency of three different obturation techniques (lateral condensation, EandQ (thermoplasticized gutta percha system) and Soft Core (thermoplasticized core carrier gutta percha system)) to obturate the isthmus area of roots prepared by two different instrumentation techniques (rotary ProTaper universal and ProTaper Next systems).

Material and method: Sixty freshly extracted teeth were randomly divided into two main groups (A and B) of 30 teeth each. Group A was prepared by rotary ProTaper Universal whereas group B was prepared by ProTaper Next system. Each main group was then randomly subdivided into three subgroups of 10 teeth each, to be obturated with the three obturation techniques. All specimens were then placed in cold cure acrylic mold just from the side of the crown leaving the root unmolded to facilitate the sectioning process, then three sections were obtained from each specimen by using microtome at 2, 6 and 10 mm from the apex. Each section was viewed under stereomicroscope(40X) and imaged with digital camera(4X). Each image was managed with image J program to calculate the surface area of the whole isthmus and that of the gutta percha and/or sealer extended into the isthmus so the collected data represented the percentage of extension degree of gutta percha and /or sealer into the isthmus(EDGS).

Results: The highest mean value of (EDGS) was evident with Soft Core technique in the apical area and was significantly higher than that of the EandQ and lateral condensation techniques.

Conclusion: Under the conditions of this study, Soft Core system showed a higher efficiency in obturating the isthmus area than the other obturation techniques.

Keywords: Isthmus, ProTaper Next, Soft Core, EandQ, image J program. (J Bagh Coll Dentistry 2016; 28(2):14-18).

INTRODUCTION

The aim of endodontic therapy is the removal of all tissues whether vital or necrotic, microorganisms, and microbial byproducts from the root canal system. Although this may be accomplished by chemomechanical debridement [(1)], it is difficult do it efficiently [(2)] because of the complex nature of root canal anatomy [(3)]. Isthmi, fins, webs, and other irregularities within the root canal often harbor tissue, microbes, and debris after instrumentation [(4)].

The isthmus is a narrow connection between two root canals that contains pulp tissue [(5)]. It is also known as corridor [(6)], lateral interconnection [(7)] and transverse anastomosis [(8)].

Isthmi may be present in all types of roots in which two canals are normally found, including the mesial roots of maxillary and mandibular molars, the distal root of mandibular molars, the maxillary and mandibular first and second premolars and mandibular incisors. Instrumentation of the root canal system must always be assisted by irrigation to remove pulp tissue remnants and other loose material.

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The efficacy of an irrigation delivery system is dependent not only on its ability to deliver the irrigant to the apical and non-instrumented regions of the canal space and to create a current strong enough to carry the debris away from the canal systems but also on the ability of the irrigating solutions to dissolve both organic and inorganic matter [(9, 10)]. Irrigation is essential for eliminating or reducing the number of bacteria in an infected root canal.

Few studies have focused on filling of the isthmus area by obturation. So the present study will focus the light on the efficiency of three different obturation techniques to obturate the isthmus area of roots prepared by three different instrumentation techniques.

MATERIALS AND METHODS

Sixty freshly extracted mandibular first molar teeth with their mesial roots having two canals and mature apices were selected for this study from several dental treatment centers. The age of the donors of the teeth was in the range of 25-35 years of age.

The gender, pulpal status and reason for extraction were not considered, and criteria for teeth selection included the following:

1. Patent apical foramen. A #15 file had to bind to the working length.
2. Roots were devoid of any resorptions, cracks or fractures.
3. The mesial roots were not less than 12 mm in length from the apex up to the canal orifice.

After extraction, all the teeth were stored in 0.1 % Thymol solution at room temperature. Any soft tissue remnants on the root surface were removed with sharp periodontal curette. Using a diamond disc bur with a straight handpiece and water coolant, each tooth was hemisectioned to separate the roots. The mesial half of the crown remained attached to the mesial root to facilitate grasping of the tooth during sectioning process by the microtome device.

The access opening was prepared and the pulpal tissue was removed by using barbed broach. Then the exact location of the apical foramen and the patency of the canals were verified by insertion of a No. 10 K-file into the canal and advancing until it could be visualized at the apical foramen. The correct working length was established by subtracting 1 mm from this measurement. All specimens were then randomly divided into two main groups (A and B):

Group A: Thirty teeth were prepared by rotary ProTaper Universal system.

Group B: Thirty teeth were prepared by ProTaper Next system.

All the canals in both of the groups were agitated by using the Endoactivator irrigation device in the presence of NaOCl for 30 seconds for each canal. Each main group was then randomly subdivided into three subgroups:

Subgroups A1 and B1 were obturated with Soft Core thermoplasticized cones.

Subgroups A2 and B2 were obturated with lateral condensation

Subgroups A3 and B3 were obturated with EandQ thermoplasticized gutta percha obturation system.

AH26 sealer was used in all the groups. After obturation, the roots were placed in a moist container in an incubator for 37º C for 1 week for aging. All the samples were then sectioned by using microtome device under water coolant. The sections were made at three levels 2, 6 and 10 mm from the apex.

Each sectioned piece was then viewed under a stereomicroscope with a magnification power of (40X) and images were then captured with a digital camera (4X) and each image was analyzed by using (image J) program to calculate the percentage of extension degree of gutta percha and / or sealer into the isthmus.

RESULTS

The collected data represents the means of percentages of the extension degree of gutta percha and/or sealer (EDGS) into the isthmus area (in relation to the whole surface area of the isthmus) in each section area (apical, middle and coronal) for both groups.

The highest mean values were found in the apical area followed by middle and then coronal area in both groups. The Soft Core subgroups (A1 and B1) showed the highest mean values of EDGS into the isthmus followed by EandQ (A3 and B3) and finally by cold lateral condensation (A2 and B2). ANOVA and LSD tests were used for statistical analysis.

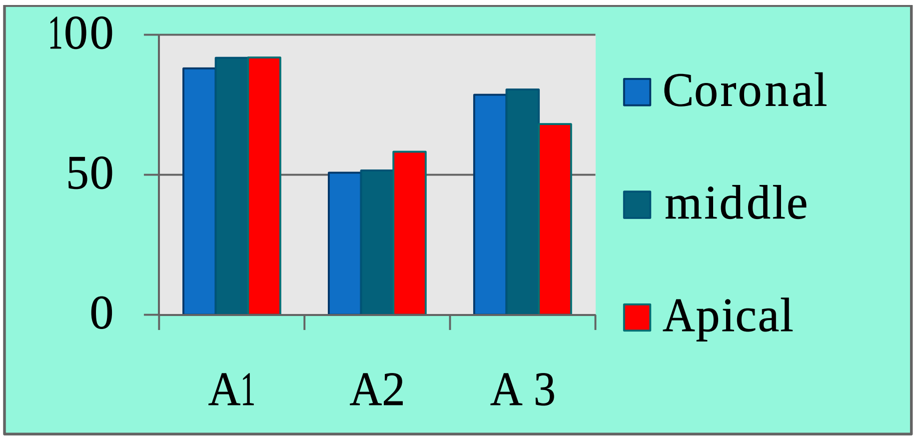

Figure 1: Bar chart of Group A (instrumentation with ProTaper Universal system)

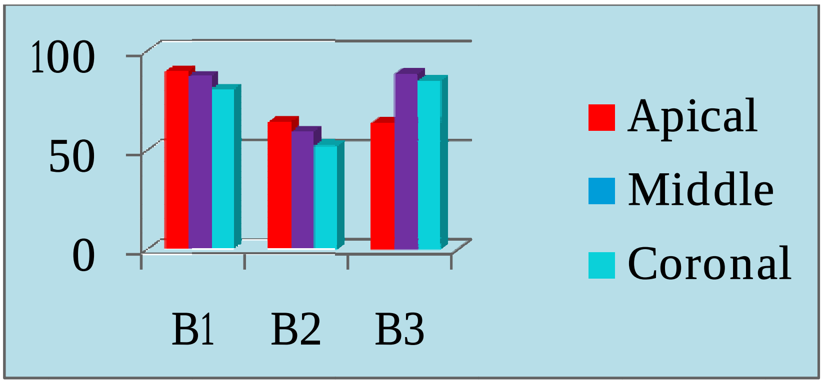

Figure 2: Bar chart of group B (instrumentation with ProTaper Next system)

Statistical analysis of Group A presented a non significant difference in the Soft Core subgroup (A1) and significant difference in the EandQ system (A2) and cold lateral condensation technique (A3) (Table 1). Group B presented non significant difference for all the subgroups.

Microscopical pictures of the cross section of the obturated teeth are shown in figures 3-5 for all the subgroups. Figure 3 shows the complete obturation of the isthmus area by the Soft Core system.

Figure 4 shows the entrance of the sealer in the isthmus area with no gutta percha when obturated with cold lateral condensation technique. The EandQ system showed incomplete obturation of the isthmus by gutta percha (Figure 5).

Table 1: Statistical analysis of data of Group A (ProTaper Universal System)

Subgroups	ANOVA test			LSD test		
	F-test	d.f.	p-value	Apical-Middle	Apical-Coronal	Middle-Coronal
A1	2.934	29	0.070 (NS)	-	-	-
A2	7.128	29	0.003 (HS)	0.005 (HS)	0.002 (HS)	0.725 (NS)
A3	13.735	29	0.000 (HS)	0.000 (HS)	0.000 (HS)	0.464 (NS)

Table 2: Statistical analysis of data of Group B (ProTaper Next System)

Subgroups	ANOVA test			LSD test		
	F-test	d.f.	p-value	Apical-Middle	Apical-Coronal	Middle-Coronal
B1	10.944	29	0.000 (HS)	0.188 (NS)	0.000 (HS)	0.003 (HS)
B2	21.955	29	0.000 (HS)	0.012 (S)	0.000 (HS)	0.001 (HS)
B3	84.021	29	0.000 (HS)	0.000 (HS)	0.000 (HS)	0.105 (NS)

Figure 3: Cross section of an obturated tooth with Soft Core cones.

Figure 4: Cross section of an obturated tooth with cold lateral condensation

Figure 5: Cross section of an obturated tooth with EandQ obturation system.

DISCUSSION

The main goal of endodontic therapy is to clean the entire pulp cavity and fill it with aninert filling material. But such a goal could not be easily achieved because there are several challenges that may impair the success of endodontic treatment.

Cambruzzi and Marshall found that the incidence of isthmus was around 30% in mandibular premolar, 60% in mesiobuccal roots of maxillary first molar with two canals [11], while another study found that, the prevalence of isthmuses in the mesial root of mandibular molars has been observed to be as high as 80% [8], so because the root canal system has such complex anatomy, it is difficult to shape and clean the root canal completely. Lee *et al*. said that the isthmuses and irregularities have been shown to be inaccessible to conventional hand and rotary instrumentation [12]. Luebke *et al*. concluded that 60% of endodontic failures are caused by incomplete obturation of the root canal, untreated canals, accessory canals and the presence of an isthmus [13].

Therefore; in this study we tried to find which obturation technique may have the ability to fill the isthmus better than the other techniques.

Although, Cold lateral condensation was considered the golden standard in endodontics, Weller et al in 1997 found that cold gutta-percha techniques rely on a root canal sealer to overcome the problem of the accessory anatomy, as the core filling material will not move out of the main canal. Voids, spreader tracts, incomplete fusion of the gutta-percha cones, and lack of surface adaptation have been reported [5].

Budds *et al*. found that injectable, heated gutta-percha technique were found to be significantly superior to lateral condensation and had a better adaptation to the three-dimensional root canal system [14].

Carrier based system (Soft Core) was used in this study because it was expected that it has improved ability to penetrate the isthmus for considerable distances, improving the quality and durability of the RCT.

(AH26) sealer was used in this study because it has a good sealing ability by incorporating resin monomer into the sealer. AH26 exhibit very low shrinkage during setting and has shown long term stability and strong adhesive property [9].

The highest mean values of the EDGS were obtained in the apical part, while the lowest mean values were obtained in the coronal part. Two factors may interpret this finding 1- the surface area of isthmus is increased considerably from the apical to coronal area and both canals are being closer to each other in the apical area than in other area, so the smaller the surface area of isthmus the higher the EDGS. 2- The presence of smear layer or dentin chips inside the isthmus adversely affects EDGS into the isthmus. However, the results of present study are supported by the results of Rodig *et al.* [15] who showed that more smear layer removal at apical region is effective when endoactivator system was used and our results came in agreement with that of Kadhom and Al-Hashimi [16] who found that the apical area was cleaner than middle and coronal area and ProTaper Universal system has a better cleaning ability than Revo S and twisted file especially in the apical area. This study disagrees with that of Arvaniti and Khabbaz [17], who showed that the smear layer was not removed, especially from the apical part of the canals.

The highest mean value of EDGS into the isthmus area was obtained in the sub group of Soft Core obturation technique, while the lowest mean value was obtained in the sub group of cold lateral condensation obturation technique. The superiority of Soft Core system was because 1- it is a type of thermoplasticized gutta percha and this preheated Soft Core cone was introduced into the canal by single penetration method, so the presence of a core may act as a piston and enhances the penetration ability of gutta percha and sealer into the isthmus. 2- The Soft Core is an alpha type gutta percha which has a lower viscosity and higher flowabilty, sealability and adaptability than that of EandQ and lateral condensation. Our result coincided with that of Deus *et al.* [18] who found that the Core carrier gutta-percha system produced significantly higher percentage of gutta-percha-filled area than lateral condensation and System B techniques and with that of DuLac *et al*. [19] who concluded that the Core carrier based gutta percha had the ability to fill the lateral canals with gutta percha better than other five systems especially in the apical area.

(EandQ) subgroups were lower than that of Soft Core and higher than that of lateral condensation subgroups. These results may be related to several causes which are:

1-The pressure applied on the lateral walls during this technique is lower than that of other techniques.

2- As the pellet of the EandQ system is made in beta form gutta percha , so it has lower ability to penetrate deeply into the isthmus compared with that of Soft Core system because of the beta form has higher viscosity and lower flowability, sealability and adaptability than that of alpha form.

3-The shrinkage or contraction after setting of the beta form gutta percha(EandQ) system is higher than that of alpha form (Soft Core) [20].

4- The gutta percha of EandQ will become cold inside the canal faster than that of Soft Core system and there will not be enough time to penetrate deeply into the isthmus in comparison with Soft Core system. This result coincided with that of the study performed by Mahdi and Kuba [21].

In general speech, the subgroups that were prepared by ProTaper Next showed better results than those prepared by ProTaper Universal. The ProTaper Next files have a bilateral symmetrical rectangular cross section with an offset from the central axis of rotation. However, Van der Vyver and Scianamblo [22] found that some of the advantages of this design were that:

1-It ensures debris removal in a coronal direction.

2-The swaggering (asymmetric) rotary motion of the instrument initiates activation of the irrigation solution.

3-Every instrument is capable of cutting a larger envelope of motion (larger canal preparation size) and as a result, smaller surface area of isthmus and higher percentages of EDGS.

In conclusion, no one of the obturation material can fill isthmus completely. However; Soft Core obturating system was the best to fill an isthmus in all areas (apical, middle and coronal) followed by EandQ system and finally by cold lateral condensation.

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