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Full Length Research Paper

In vitro comparison of apical microleakage following canal obturation with lateral and thermoplasticized gutta-percha compaction techniques

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The purpose of this study was to compare apical microleakage following canal obturation with lateral and thermoplasticized gutta-percha compaction techniques. Ninety extracted single-rooted maxillary teeth were used in this study. Seventy teeth were randomly divided into two groups: One group was obturated by lateral compaction technique and the other was obturated by Obtura II (thermoplasticized gutta-percha compaction technique); 5 teeth were positive controls (without obturation) and 5 teeth were negative controls (with obturation) in each group. The specimens were placed in India ink for 48 h and then divided into two halves. The amount of dye penetration was observed under a stereomicroscope at ×16 magnification and 0.1 mm accuracy. In this study, there was apical leakage in the two experimental groups but the amount of microleakage was not significant. According to the results of independent samples test, there was no significant difference between the two experimental groups.

Key words: Apical seal, gutta-percha, lateral compaction, microleakage, Obtura II.

INTRODUCTION

The aim of canal obturation in endodontic treatment is to prevent communication between the oral cavity and periapical tissues (Sundqvist and Figdor, 1998). Three-dimensional obturation of radicular space is essential for long-term success of endodontic treatment. The root canal system should be sealed apically, coronally, and laterally (Rahimi et al., 2008a). Maintenance of adequate obturation is of critical importance for prevention of bacterial microleakage. The integrity of the apical seal is proportional to the amount of endodontic filling material (Rahimi et al., 2008b). Several techniques had been introduced to achieve complete filling of the root canal system. It had been noted that more research is needed to establish standard techniques of root canal filling, and all the techniques should be compared for filling root canals (Haddix and Oguntebi, 1989). Lateral condensation of gutta-percha is a commonly used technique for root canal obturation and had been widely and frequently practiced by dental practitioners (Dummer, 1991; Peak et al., 2001; Levitan et al., 2003). However, lateral condensation of gutta-percha is more time-consuming and the clinicians need an easy and quick technique to fill root canals. The concept of obturating root canals using injection molded thermoplasticized dental gutta-percha was introduced to the dental practice (Yee et al., 1977). The first commercially available thermoplasticized gutta-percha system was the Obtura system. The Obtura II Unit (Obtura/Spartan, Fenton, MO.) is a high-temperature thermoplasticized gutta-percha system that requires gutta-percha pellets to be inserted into a delivery system gun, and then the gutta-percha pellet is heated to 150-200°C prior to delivery into the canal system (Johnson, 2008). The lateral condensation technique had been

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Figure 1. Obtura II thermoplasticized gutta-percha (Obtura/Spartan, Fenton, MO. USA).

compared with other technique in several studies and no significant differences in microleakage had been reported among the techniques (Chu et al., 2005; Luccy et al., 1990; Karagenç and Nimet, 2006). Apical seal is of utmost importance in endodontic treatment and more than 50% of endodontic treatment failures are due to inadequate obturation of root canals (Ingle et al., 2002). Regarding anatomic variations in canal configuration of the teeth ((Rahimi et al., 2008c; Rahimi et al., 2009), and lack of sufficient studies which prove one technique's superiority to others, the aim of this study is to compare apical microleakage following canal obturation with lateral and thermoplasticized gutta-percha compaction, which are two very common techniques of root canal obturation techniques.

MATERIALS AND METHODS

Ninety extracted human upper central incisors without caries, cracks, calcifications, resorption, or dilaceration, and with intact apices were selected and stored in 10% buffered formalin solution (pH = 7.0). The teeth were immersed in 5% sodium hypochlorite for 20 min to remove organic tissues from the root surfaces. The remaining materials on the root surface were mechanically removed with hand curettes. The access cavity was prepared in all 90 specimens and the working length was established with #15 K-File (Maillefer, Balaiggues, Switzerland) 1 mm short of the apex. The patency was checked using the #15 K-File which passed through the apical foramen during instrumentation. The canals were prepared with a #40 K-File to the working length and shaped with a #70 K-File, subtracting 0.5 mm for each file after #40 K-File. 2.5% sodium hypochlorite was used as the irrigant followed by a saline rinse. After one week, 45 tooth were randomly selected and 40 tooth were filled with lateral compaction technique with gutta-percha using AH26 (Dentsply, Detrey Gmbh, Germany) sealer; 35 tooth were in the experimental group with 5 tooth as negative controls and 5 tooth as positive controls without canal fillings. In the 45 remaining tooth, 40 tooth were filled with Obtura II (Obtura/Spartan, Fenton, MO,USA) (Figure 1) according to manufacturer's instructions using AH26 sealer; the group consisted of 35 tooth as experimental, 5 tooth as negative and 5 tooth as positive controls without canal fillings. In Obtura II group, the canals were dried and coated with AH26 sealer with the last file used to length; gutta-percha was preheated in the gun, and the needle was positioned in the canal so that it reached within 3 to 5 mm of the apical preparation. Gutta-percha was then gradually and passively injected by squeezing the trigger of the "gun". The needle was withdrawn out of the canal as the apical portion was filled. Pluggers were used to compact gutta-percha. A segmental technique was used, in which 3-to-4-mm segments of gutta-percha were sequentially injected and compacted. In either case, compaction continued until the gutta-percha cooled and solidified to compensate for the contraction that takes place on cooling. All the tooth were filled up to 1 mm below the CEJ (cemento-enamel junction); radiographs were taken to confirm the complete filling of all the canal length and the access cavities were sealed with glass-ionomer cement (Fuji II, GC, Tokyo, Japan). The specimens were kept for 7 days at 37°C and 100% humidity. In the two experimental and positive control groups, the entire surface of the roots were covered with one layer of sticky wax and two layers of nail varnish except for the apical 2 mm. The tooth were then

Figure 2. Stereomicroscope view (×16) of apical dye leakage in group 1 (lateral compaction) (Left) and group 2 (Obtura II) (Right).

placed in India ink for 48 h. The specimens were retrieved from the ink and rinsed for 10 min in running water and then dried. The roots were longitudinally divided into two halves by creating two facial and lingual fissures along the long axis of the roots, using a diamond disc (D&Z, Darmstadt, Germany). The filling materials were removed from the canals and the maximum amount of linear penetration of dye was observed under a stereomicroscope (Zeiss, Munich, Germany) at ×16 and measured with digital calipers (0-150 mm, Guangulu, China) with 0.1 mm accuracy (Figure 2). Data were analyzed using independent samples t-test and SPSS 15 software. Statistical significance was defined at $P<0.05$. The normal distribution of the data was evaluated using Smirnov-Kolmogorov test.

RESULTS AND DISCUSSION

The means of apical microleakage based on the amount of dye leakage in the two experimental groups were calculated and statistically analyzed with comparison of the two means. Apical microleakage was seen in the entire surface of the canals in the positive control group but it was not seen in the negative control group. The mean dye leakage in group 1 (lateral condensation) was 2.58 ± 1.09 mm. The least amount of dye leakage was 0.59 mm and the maximum was 5.34 mm. The mean dye leakage in group 2 (Obtura II) was 3.04 ± 1.42 mm (Figure 3). The least amount of dye leakage was 0.96 mm and the maximum was 6.69 mm. Statistical analysis of mean differences for independent groups (Independent samples t-test) showed that there was no statistically significant difference between the two groups ($P = 0.135$, $df = 68$, $t = 151$).

Success in endodontic treatment was originally based on the triad of debridement, sterilization, and obturation with all aspects equally important. Currently, successful root canal treatment is based on broader principles. These include diagnosis and treatment planning, knowledge of anatomy and morphology, and the traditional concepts of debridement, sterilization, and obturation. In an early radiographic study of success and failure, Ingle et al. (2002) indicated that 58% of treatment failures were due to incomplete obturation. Unfortunately, the teeth that are poorly obturated are often poorly prepared. Procedural errors such as loss of length, canal transportation, perforations, loss of coronal seal, and vertical root fracture might occur and had been shown to adversely affect the apical seal (Wu et al., 2000). Dye penetration technique had been used to evaluate leakage in several studies (Rahimi et al., 2008a; Rahimi et al., 2008b; Kim and Kim, 2002; Karapanou et al., 1996). We used dye penetration technique and a stereomicroscope to evaluate leakage of specimens (Rahimi et al., 2008a, b; Miletic et al., 2002; Tamse et al., 1998). AH-26 sealer was used as a sealer for obturation of teeth with gutta-percha because of its good sealing ability (Miletic et al., 2002). The originality of our research could be justified by many existing contradictions about the quality of apical seal as it relates to the methods and techniques of root canal filling in the literature. The majority of studies in this field compared the sealing ability of new obturation techniques. However, there is little information about the sealing ability of two common root canal obturation techniques, including lateral compaction and thermoplasticized gutta-percha compaction (Obtura II system). Lateral compaction is a common method for obturation (Cailleteau and Mullaney, 1997). The technique can be used in most clinical situations and provides for length control during compaction (Gilhooly et al., 2001; Shahi et al., 2007). A disadvantage is that the technique may not fill canal irregularities (Wu and Wesselink, 2001) as well as warm vertical compaction technique (Wu et al., 2002). In a clinical study using the Obtura II system, the results indicated a 96% success rate with a 1-year follow-up in cases obturated only with Obtura II thermoplasticized injection system (Tani-Ishii and Teranaka, 2003). In spite of high success rate of Obtura II system, the difficulty with this system is lack of length control and both over-extension and underextension are common findings. Therefore, the apical terminus should be as small as

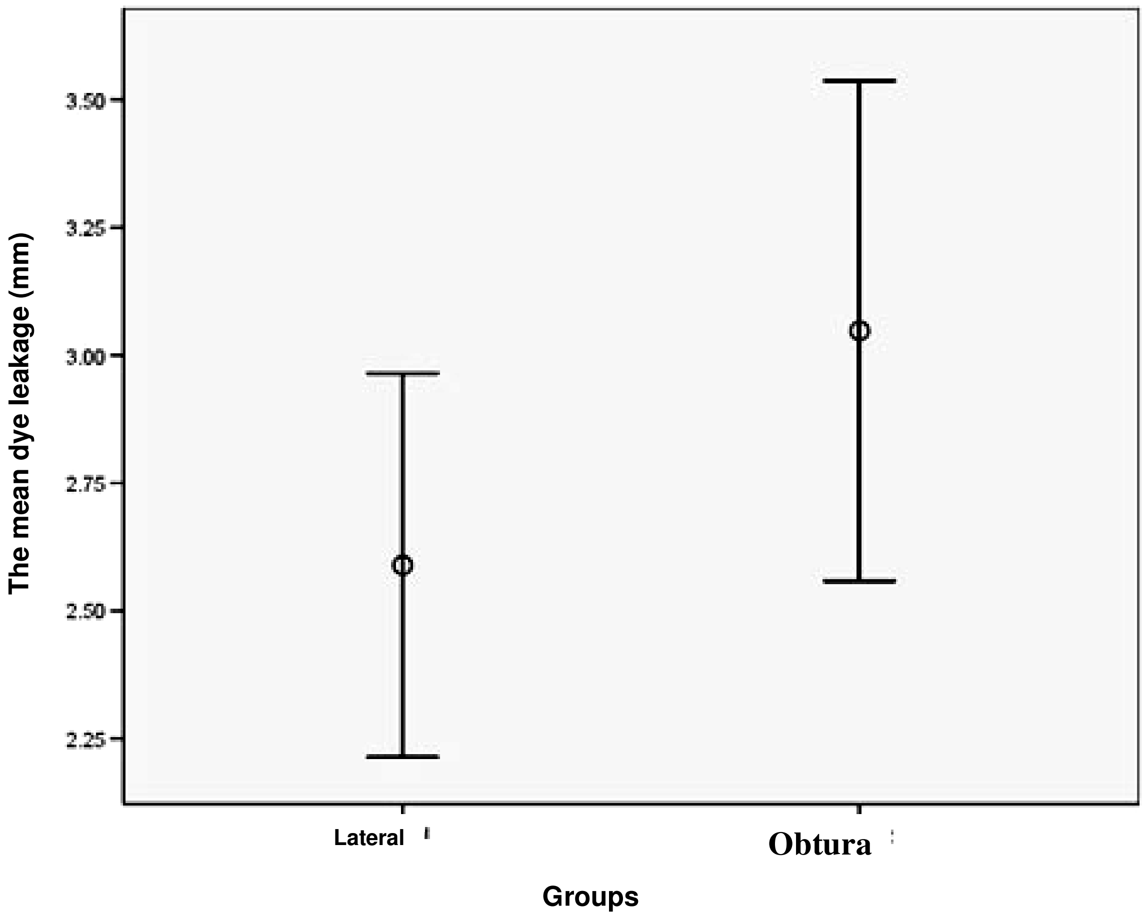

Figure 3. The mean dye leakage in group 1 (lateral condensation) and group 2 (Obtura II).

possible to prevent extrusion of gutta-percha with Obtura II thermoplasticized injection system (Johnson and Gutmann, 2006). Another concern about the Obtura II system is the high temperature on root surface of the teeth, which damages periodontal ligament and bone. Several studies had found the thermoplasticized system to be well below the critical 10℃ rise in temperature, which could cause damage to periodontal ligament and bone (Eriksson and Albrektsson, 1983; Weller and Koch, 1995; Gutmann et al., 1987; Sweatman et al., 2001). In a recent study, it had been shown that the high-temperature thermoplasticized injectable gutta-percha in mandibular incisors may exhibit an increase in temperature above the 10℃ rise that is crucial if damage to the attachment apparatus is to be avoided. Maxillary incisors, however, did not exhibit external temperature rise above 10℃ (Lipisky, 2006). Regarding the advantages and disadvantages of lateral and thermoplasticized gutta-percha compaction techniques, we decided to compare these two techniques. In the present study, there was no significant difference between lateral and thermoplasticized gutta-percha compaction techniques. There are several studies in the literature, which had evaluated the sealing ability and superiority of obturation systems. In a comparative study using lateral condensation of gutta-percha or low-temperature thermoplasticized gutta-percha (Ultrafil), low-temperature thermoplasticized gutta-percha had better sealability but poorer radiographic quality compared to lateral condensation (Al-Devani et al., 2000). Farge showed that lateral condensation technique results in more leakage than thermomechanical compaction technique and the Herofill Soft-Core system (Farge, 2003). These results were different from the results of the present study. In another comparative study, the sealing ability of the Canal Finder system was compared with lateral condensation technique, the Ultrafil system, and the sectional warm gutta-percha technique; there were no statistically significant differences among the four obturation techniques (Greene et al., 1990), which is consistent with the results of the present study. Haikel et al. (2000) in a study of apical microleakage of radio-labeled lysozyme over time showed that 28 days after obturation of the canals lateral condensation technique resulted in less leakage compared to Thermafil and McSpadden; however, on the first day after obturation of the canals, the lateral condensation technique had the greatest leakage. Regarding the lateral and accessory canals, Brothman (1981) and his colleagues reported that the vertical condensation technique, on radiographic examination, shows nearly two times more lateral and accessory canals compared with lateral condensation technique. If Obtura II is assumed a kind of vertical condensation technique, it can be concluded that filling of lateral and accessory canals with Obtura II is more practical than it is with lateral condensation technique. Allison et al. (1979) showed that a standardized taper (incomplete spreader penetration) shows extensive leakage apically than step-back preparations (deep spreader penetration). Microleakage usually extends close to the distance of spreader tip penetration. This probably shows the importance of spreader penetration, which is usually established in lateral condensation technique. Because of the importance of sealing of the entire length of the canals to compare fluid movement (FM) along the coronal two-thirds of gutta-percha/sealer root fillings by three different techniques, including cold lateral compaction (LC), warm vertical compaction (VC) or the single-cone technique (SC), Wu et al. (2003) showed that VC group displayed more FM than the other two groups and no significant difference in FM was found between the LC and SC groups. Chu et al. (2005) showed that there were no significant differences between the use of Thermafil and cold lateral condensation filling techniques, which was consistent with the results of our study. The success of any technique depends on the practitioner's knowledge of the technique, clinical skills, and ability to follow manufacturer's instructions. No technique should be judged as the cause of failing case in which the instructions were not followed and/or the goals of the technique were not achieved**.**

Conclusion

Since the present study did not exhibit any differences in apical microleakage following canal obturation with lateral and thermoplasticized gutta-percha compaction techniques, further studies are needed to determine the best techniques for three-dimensional filling of root canals considering the variety of the obturation devices and techniques.

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