

Comparative study of the sealing ability of the lateral condensation technique and the BeeFill system after canal preparation by the Mtwo NiTi rotary system

Bahareh Dadresanfar, Zohreh Khalilak, Mahshid Shiekholeslami and Samira Afshar

Department of Endodontics, Dental School, Islamic Azad University of Medical Sciences, Tehran, Iran

(Received 18 September 2009 and accepted 17 March 2010)

Abstract: The purpose of this *in vitro* study was to compare the sealing ability of the lateral condensation technique and the BeeFill system after canal preparation by the Mtwo rotary system. Forty extracted single-rooted teeth were prepared by using the Mtwo rotary system. The teeth were then divided into 2 experimental groups ($n = 15$ each) and 2 control groups ($n = 5$ each). The specimens in groups 1 and 2 were obturated using the lateral condensation technique and the BeeFill system, respectively. The teeth in the negative control group were also obturated with the lateral condensation technique, and the specimens in the positive control group were not root-filled. The specimens were then immersed in an aqueous solution of 2% China ink for 1 week, after which the roots were cleared and the linear extent of dye penetration was measured with a stereomicroscope by 2 endodontists. The data collected were then analyzed by using the 1-sample Kolmogorov-Smirnov test and independent t test, with a significance level of $P \leq 0.05$. Although the mean (\pm standard deviation) dye leakage in the BeeFill thermoplasticized injection group was less than that in the lateral condensation group (1.497 ± 0.7 vs. 2.521 ± 1.733), there was no significant difference between the experimental groups on the parametric independent t -test ($P = 0.209$). (J Oral Sci 52, 281-285, 2010)

Keywords: BeeFill; lateral condensation technique; sealing ability; thermoplasticized technique.

Introduction

Complete obturation of the root canal system is the main goal of endodontic therapy, and nearly 60% of all endodontic failures have been attributed to incomplete obturation of the root canal system (1). Because proper canal preparation can affect the quality of obturation, many different preparations and obturation techniques have been introduced to achieve a homogeneous well-sealed filling. Gutta-percha is the most widely used obturation material because of its inertness, biocompatibility, plasticity when warmed, and ease of removal for post-treatment and retreatment (2,3).

Cold lateral condensation of gutta-percha is one of the most accepted root canal obturation methods and is still taught in most dental schools. Although this technique has remained a standard in studies focusing on comparison of obturation techniques (4-6), it has been criticized for its lack of homogeneity, poor adaptation to canal walls, prolonged duration, and high possibility of canal fracture (2). Indeed, Brayton et al. (7) reported that this technique resulted in many irregularities in the final gutta-percha mass and that it failed to reproduce canal fins and irregularities.

To achieve better 3-dimensional filling of spaces and isthmuses, and to avoid problems caused by lateral condensation, different warm gutta-percha techniques have been introduced. One example of this is root canal obturation with injected thermoplasticized gutta-percha, which was introduced by Yee et al. (8). The sealing ability of high- and low-temperature thermoplasticized injectable techniques and the lateral condensation technique have been

Correspondence to Dr. Zohreh Khalilak, Department of Endodontics, Dental School, Islamic Azad University of Medical Sciences, Number 3, 10th Neyestan Street, Pasdaran Avenue, Postal Code: 19468, Tehran, Iran
Tel: +98-21-22564571-3
Fax: +98-21-22564577
E mail: dr.z.khalilak@gmail.com

compared in previous studies (9-13).

Recently, a new thermoplasticized injection device, the BeeFill system, was developed to simplify obturation after canal preparation by the Mtwo rotary system. It is a high temperature gutta-percha injection unit with 2 pluggers; the gutta-percha cannula is set in a handpiece with a 360° operation angle. According to the manufacturer, canal obturation by the BeeFill system results in reliable obturation of lateral canals, minimal risk of root fracture, gutta-percha filling to the desired level for immediate placement of a fiber post, and adhesive restoration in 1 appointment. The present study compared the sealing ability of the lateral condensation technique with the BeeFill system after canal preparation by the Mtwo rotary system.

Materials and Methods

Forty recently extracted single-rooted premolar teeth were selected and stored in saline. The soft tissue remnants and calculus on the external root surface were removed mechanically. All specimens were inspected to identify any defect or root fractures and to confirm the complete formation of apices.

The crowns were removed at the cemento-enamel junction with a low-speed, water-cooled, diamond saw blade (D&Z, Darmstadt, Germany). The working length was established by subtracting 1 mm from the actual canal length, which had been determined by inserting a #10 K file (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until the tip of the file was just visible at the apical foramen. All teeth were radiographed with a #10 file placed in the canal, and the root curvature was determined according to the Schneider technique (14). Canals that were patent to greater than International Standards Organization (ISO) size 15, and those with a curvature greater than 35° or less than 20°, were discarded and replaced. To minimize procedural errors, all root canal preparation and fillings were standardized and performed by 1 operator, who was fully trained in the Mtwo rotary system and the relatively new BeeFill obturation technique.

Instrumentation and obturation of the root canals

The root canals were prepared by using Mtwo nickel-titanium rotary instruments, with a master apical rotary from #10 with a 0.04 taper to #35 with a 0.04 taper. Files with 0.05 and 0.06 tapers were used during canal preparation, as per the instructions of the manufacturer (VDW, Munich, Germany). After the use of each instrument, canals were rinsed with 2 ml of 2.5% sodium hypochlorite (NaOCl). To control speed and torque, the Endo IT Professional electric motor (VDW, Munich, Germany) was also used.

The dentinal smear layer was removed from all specimens using EDTA 17% for 1 minute, followed by 5.25% NAOCL. The canals were then washed with distilled water and dried with paper points. Then, the teeth were randomly assigned to experimental groups 1 and 2 ($n = 15$ each), and to the negative ($n = 5$) and positive control groups ($n = 5$).

Group 1

The specimens in this group were obturated using the lateral condensation technique. A size 35 master gutta-percha cone (Gapadent, Tianjin, China) was selected and tug-back was checked. AH-26 sealer (Dentsply Maillefer, Ballaigues, Switzerland) was mixed according to the manufacturer's instructions. The master cone was coated with sealer and positioned in the canal. Then, accessory cones were laterally compacted until they could not be introduced more than 5 mm into the canal.

Teeth in the negative control group were also obturated with the lateral condensation technique, as described above. The teeth in the positive control group were not obturated.

Group 2

Well-mixed AH-26 sealer was carried to the canal using a size 35 gutta-percha cone. Then, an apical plugger (ISO 40, taper 0.03; VDW, Munich, Germany) that penetrated within 3-5 mm of the working length was selected. The BeeFill system (VDW) was set to 180°C and 60% flow rate. Five seconds before extruding the gutta-percha, the needle was placed into the root canal to a length 5 mm shorter than proper working length. After injecting the apical portion with gutta-percha, the needle was removed and the warm mass was vertically compacted with the selected plugger for 5 s. Backfill of the canal was done by holding the needle against the apical gutta-percha. The mass of gutta-percha was allowed to force the needle coronally to the canal orifice, and the needle was removed after a 1-s pause. A plugger (ISO 60, taper 0.06; VDW) was used to firmly compact the gutta-percha mass at the orifice level.

The access cavities were filled with Coltozol (Coltene, Altstätten, Switzerland). Teeth were radiographed in the buccolingual and mesiodistal directions to confirm the adequacy of the root canal obturation. Finally, all teeth were stored in a humidior at 37°C for 2 weeks to allow complete setting of the sealer.

Dye penetration

All but the final 2 mm of the roots were covered with 2 layers of nail polish. The teeth in the negative control group were completely covered with nail polish, and the

teeth in the positive control group were not covered with nail polish. The specimens were immersed in an aqueous solution of 2% China ink (Etedal, Tehran, Iran) for 1 week.

Teeth clearing procedure

After removal from the dye, the roots were rinsed in tap water, and the nail polish was completely scraped off with a #11 scalpel (Supa, Tehran, Iran). The specimens were placed in 10% chloridric acid (Merck, Darmstadt, Germany) for 24 h, then washed in running tap water for 24 h to remove the acid. Dehydration was completed by placing the specimens for 5 h each in progressive solutions of 70% to 100% ethyl alcohol (Panreac, Barcelona, Spain). The roots were then cleared in methyl salicylate 50% (Polfa, Poland) and viewed under a stereo-zoom microscope (Olympus, SZX9, Tokyo, Japan) at $\times 20$ power.

Leakage measurement

Two endodontists measured apical leakage, which was defined as the distance from the anatomical apex to the maximum extent of dye penetration in the coronal direction.

Statistical analysis

The data were analyzed using the 1-sample Kolmogorov-Smirnov test and the independent *t*-test. A value of $P \leq 0.05$ was considered statistically significant.

Results

Mean (\pm standard deviation [SD]) dye penetration for each group is shown in the Table. Dye leakage was seen in both experimental groups. The negative controls showed no evidence of dye penetration, whereas all positive controls showed dye penetration throughout the entire length of the canal. Although the mean (\pm SD) dye leakage in the thermoplasticized group was less than that in the lateral condensation group (1.497 ± 0.7 vs. 2.521 ± 1.733), the difference was not significant on the parametric independent *t*-test ($P = 0.209$).

Table Mean leakage plus standard deviation (SD) in the experimental and control groups

Group	Linear leakage (mm)	
	<i>n</i>	Mean \pm SD
Lateral condensation	15	2.521 ± 1.733
BeeFill	15	1.497 ± 0.7
Positive control	5	Maximum leakage
Negative control	5	No leakage

Discussion

The aim of this study was to compare the sealing ability of the BeeFill system with that of the lateral condensation technique in canals prepared by the Mtwo rotary system. The results showed that, although there was more leakage in the lateral condensation group, there was no significant difference between the experimental groups.

The sealing ability of the BeeFill device has been confirmed in a small number of reports. Yilmaz et al. (15) noted that the fluid conductance value was identical in canals obturated with BeeFill and the lateral condensation technique. They also found that these techniques resulted in significantly better sealing efficiency, as compared with the System B/Obtura II technique. Our findings accord with theirs, although we used a different method to evaluate apical leakage.

With respect to other thermoplasticized gutta-percha techniques, most studies have found that injection-molded thermoplasticized gutta-percha techniques provide apical seals that are superior or similar to those produced by the lateral condensation technique (9-11). In a study by Weller et al. (16), the Obtura II injectable technique resulted in the best adaptation to the prepared root canal, followed in order by the plastic and titanium Thermafil obturators, the stainless steel Thermafil obturators, and, finally, by the lateral condensation technique. Gutmann and Rakusin (17) emphasized that proper shaping is essential for the flow of softened material, particularly in curved canals. The BeeFill system was developed to heat, soften, and inject gutta-percha into the canal, especially those prepared by Mtwo rotary files. The fact that we found no significant difference in apical leakage between the BeeFill high-temperature injection gutta-percha technique and the lateral condensation technique might be due to the use of rotary files for canal preparation, and the resultant flare of the canals. The presence of properly flared canals might have facilitated guidance of the thermoplasticized gutta-percha through the length of the canal, and thus resulted in obturation as good and leak-proof as that of laterally condensed canals.

Single-rooted premolars with an angle of curvature ranging between 20° and 35° were used in this study. It should be noted that the modest canal curvatures of the samples in this study might have resulted in easier preparation and obturation. All root canals were prepared with an Mtwo #35 with 0.04 taper as the master apical rotary. Schafer et al. (18) used a master apical rotary of the same size in a study of curved canals and found that the Mtwo instruments were better than the K3 and RaCe at maintaining canal curvature.

In a study by LaCombe et al. (10), teeth obturated by

lateral condensation showed significantly less dye penetration than did teeth obturated by high- or low-temperature thermoplasticized injection gutta-percha techniques, although the difference was not significant when a spectrophotometer was used to measure apical leakage. However, in their study the smear layer had been left in the canals, which might have affected dye penetration and influenced the results. In the present study, the smear layer was removed because several studies have suggested (19-21) that the adaptation of heated gutta-percha to the prepared dentin is superior in the absence of the smear layer.

Rotary systems have been recommended for preparing root canals (22). Studies suggest that root canal preparation with nickel-titanium rotary files results in a canal that is more uniform, better centered, and rounder (23,24). The Mtwo nickel-titanium rotary system was introduced by VDW. Several studies have shown that Mtwo rotary files can properly shape curved canals while maintaining the original canal curvature (18,25).

One concern regarding the Obtura II system is the difficulty in cleaning the handpiece after use. Because the BeeFill system uses gutta-percha cartridges, there is no need to clean the handpiece, and the cartridge can be changed quickly by means of the drop-in/out design.

A variety of techniques have been used to evaluate the quality of root fillings, including leakage tests (13), fluid filtration (26), cross-section, and microscopic evaluation (6). We used a dye penetration method to evaluate the apical seal of root canal fillings. More penetration has been reported with methylene blue than with India ink, but methylene blue can dissolve during the clearing process (27). In order to minimize the risk of dye dissolution, ink was used in this study. The root clearing method utilized in this study was practical and avoided the need for root sectioning (13, 27-29).

The effect of high-temperature thermoplasticized obturation techniques on root surface temperature is an important concern (30-32). Weller and Koch (31) reported that temperature increases were safe (<10°C) when using gutta-percha thermoplasticized to 200°C. The BeeFill system used in the present study was set to 180°C. Nevertheless, the effect of this system on root surface temperature increase should be evaluated by *in vivo* studies.

In conclusion, under the conditions of the present study, the BeeFill thermoplasticized injection technique and the lateral condensation technique resulted in similar apical leakage; thus, the BeeFill system appears acceptable for obturation.

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