Percentage of Gutta-percha–filled Areas in Canals Obturated by 3 Different Techniques with and without the Use of Endodontic Sealer

Antonio Libonati, DDS, PhD, Edoardo Montemurro, DDS,† Roberto Nardi, DDS,† and Vincenzo Campanella, MD, DDS†*

Abstract

Introduction: This study had 2 purposes: to compare the Microseal, continuous wave, and Thermafil techniques and to compare the same techniques with and without endodontic sealer. **Methods:** Ninety extracted mandibular premolars were allocated into 6 groups obturated with Microseal (Analytic, Glendora, CA) and sealer (Mseal), Microseal without sealer (Mnoseal), System B (EIE Analytic Technology, Orange, CA) and sealer (SBseal), System B without sealer (SBnoseal), Thermafil (Dentsply, Tulsa Dental, Tulsa, OK) and sealer (Tseal), and (Tnoseal) Thermafil without sealer (Tnoseal). The teeth were sectioned at 1 and 3 mm from the apex. The total area of each canal segment was measured, and the areas were converted to the percentage of gutta-percha–filled areas, sealer-filled areas, and void areas. Data obtained were statistically elaborated using the *t* test ($P \leq .01$). **Results:** At 1 mm, SBseal produced a higher VA than Mseal and Tseal. At 3 mm, Tseal produced a lower VA than Mseal and SBseal, whereas Mseal produced a lower VA than SBseal ($P > .01$). At 1 mm, Tnoseal produced a significantly higher VA than Mnoseal and SBnoseal ($P = .001$). At 3 mm, Tnoseal produced a higher VA than Mnoseal and SBnoseal ($P = .01$). Tnoseal produced a significantly higher VA than Tseal both at 1 mm ($P = .001$) and 3 mm ($P = .001$). **Conclusions:** Endodontic space filling is traditionally provided by sealer and gutta-percha. In this study's conditions, gutta-percha alone showed better filling at both 3 mm and 1 mm in the Microseal and System B techniques. Considering the limits of our study, we can affirm that endodontic techniques using sealer could counteract thermoplasticized gutta-percha progression. *(J Endod 2017;■:1–4)*

Key Words

Apical taper, continuous wave technique, microseal, sealer, thermafil, thermoplasticized gutta-percha

Significance

Our 2 main purposes were to compare the Microseal, continuous wave, and Thermafil techniques and to compare the same techniques with and without sealer to understand if the space occupied by sealer in conventional techniques can be replaced by hot gutta-percha's flow.

Root canal obturation in a 3-dimensional space with a stable, nontoxic material and the creation of a hermetic apical seal are the goals of endodontic treatments (1, 2). The root filling seals the communications between the periodontium and the endodontium and, along with shaping and disinfection, allows a further bacteriological defense (1, 3). Gutta-percha with sealer has been used successfully as core material for filling the canal space (2). A hermetic seal cannot be obtained without using a sealer because gutta-percha does not bond to dentin walls (4) and the sealer is capable of filling imperfections and increasing the adaptation (5). It has been reported that some sealers shrink upon setting, whereas others are susceptible to dissolution in contact with tissue fluids (6, 7); therefore, the amount of sealer should be kept at the lowest, whereas the amount of gutta-percha placed into the canal must be maximized (5, 6, 8, 9).

Several techniques accomplish good adaptability of the root canal filling into the canal space. One of the first described was warm vertical compaction of gutta-percha (1). The warm vertical compaction technique was later modified by incorporating the use of the System B spreader/plugger (EIE Analytic Technology, Orange, CA), the so-called "continuous wave technique" (10). The Thermafil technique involves root canal obturation with heated alpha-phase gutta-percha on a carrier (11). The Microseal system is a thermoplastic technique that uses a master gutta-percha cone that is compacted laterally and thermoplasticized gutta-percha with a different viscosity that is placed to complete the canal filling (12). The Microseal system evolved from the thermomechanical compaction technique (13), which was later modified to the multiphase technique (14).

A cross section of filled roots, leakage tests, and the association of both have been used widely to evaluate the quality of root filling (15, 16). The methodological model used in our study has been thoroughly explored by several authors (17–20). Some past studies (4, 21, 22) evaluated the possibility of avoiding the combination of endodontic sealer with obturation techniques such as vertical condensation, lateral condensation, McSpadden's thermomechanical compaction, and injection-molded thermoplasticized gutta-percha. In our opinion, obturation technique implementation has changed over the years, improving apical zone management, as many studies testify by reporting

From the *Department of Surgical Sciences, Catholic University of Our Lady of Good Counsel, Tirana, Albania; and †Department of Clinical and Translational Medicine, Tor Vergata University of Rome, Rome, Italy.

Address requests for reprints to Dr Antonio Libonati, Department of Surgical Sciences, Catholic University of Our Lady of Good Counsel of Tirane, Laprakë, Rruga Dritan Hoxha, Tirana, Albania. E-mail address: antlib76@libero.it
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optimal filling percentages and the minimization of void spaces. Our goal was to confirm these techniques' performances by eliminating sealer variables in terms of space occupied by sealer, gutta-percha, and void areas (VAs).

Our 2 main purposes were to compare the Microseal, continuous wave, and Thermafil techniques and to compare the same techniques with and without sealer to understand if the space occupied by sealer in conventional techniques can be replaced by hot gutta-percha's flow. We obtained data through the analysis of digital images in terms of the percentage of gutta-percha–filled areas (PGFAs), sealer-filled areas (PSFAs), and VAs in root obturations performed with or without endodontic sealer.

Materials and Methods

Selection of Teeth

Ninety single-canal human mandibular premolars were extracted and examined by studying buccal and proximal radiographs. Teeth with single straight canals and a single apical foramen were chosen; roots with oval canals and isthmuses were excluded from the study. After coronal access, the presence of calcified canals and the apical patency of the canals were checked. Crowns were removed, and each tooth was adjusted to 14 mm in length.

Tooth Preparation

The working length (WL) was determined by introducing a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) until the tip was visible at the apical foramen. The WL was defined by subtracting 0.5 mm from the measured length. Cleaning and shaping were performed on specimens of each group with Mtwo rotary instruments (Sweden & Martina, Padova, Italy). The instrumentation sequence was 10.04, 15.05, 20.06, and 25.06. During the preparation, each canal was irrigated using 30-G side-vented syringes with 2 mL 5.25% sodium hypochlorite and 10 mL 17% EDTA. Apical gauging was verified using a nickel-titanium size 25 Miti Turbo file (JS Dental Manufacturing Inc., Ridgefield, CT). An additional step of shaping using a rotating apical 25/40 0.02 taper (Sweden & Martina, Italy) was performed to provide apical stop and complete instrumentation necessary for all 3 techniques. The teeth were dried with paper points and randomly allocated into the following 6 groups:

1. Microseal with sealer (Mseal): canals were obturated with Microseal techniques and endodontic sealer. After the canal drying procedure, a .02 taper size 40 master gutta-percha point (Dentsply Maillefer) was introduced at 1 mm from the WL. Zinc oxide eugenol–based Pulp Canal Sealer (Kerr, Salerno, Italy) was applied using a paper point; a smaller amount was applied on the tip of the master cone. A 25.04 Microseal spreader (Sweden & Martina) was set at 300 rpm up to 2 mm from the WL. The Pac-Mac 25.04 condenser (Sweden & Martina) was coated with warm gutta-percha using a microflow cartridge (EIE Analytic Technology). The Pac-Mac was inserted to 2 mm from the WL and rotated at 6000 rpm. The procedure was repeated at least 3 times per canal in order to obtain a sufficient filling.
2. Microseal without sealer (Mnoseal): canals were obturated with Microseal techniques using the same procedures in group 1 without endodontic sealer.
3. System B with sealer (SBseal): canals were obturated with System B and endodontic sealer. Before verifying apical gauging, Mtwo instrumentation was finished with a 25.07 instrument. The root canal was thinly coated with Pulp Canal Sealer. A .06 taper nonstandardized gutta-percha cone was set at 0.35-mm diameter with a caliper. Tug back adaptation was checked. The sealer-coated cone was placed to 0.5 mm of the WL. A Fine-Medium System B (EIE Analytic Technology) insert tip was pushed at 4 mm from the WL and was used for condensation. System B was preset to 250°C during apical condensation of the primary cone. The tip was inserted to the predetermined length of 4 mm from the WL using steady pressure. Once at the proper depth, heat was removed, and the apical pressure was maintained for 10 seconds. Backfill of the canal was accomplished by condensing the fragments of the additional gutta-percha cones.
4. System B without sealer (SBnoseal): canals were obturated with System B without endodontic sealer.
5. Thermafil with sealer (Tseal): canals were obturated with Thermafil and endodontic sealer. Each canal was coated with Pulp Canal Sealer, and a no. 35 Thermafil obturator was heated in a Thermaprep oven (Dentsply Tulsa Dental, Tulsa, OK) for at least 10 minutes. The heated obturator was slowly inserted into the canal within 0.5 of the WL.
6. Thermafil without sealer (Tnoseal): canals were obturated with Thermafil without endodontic sealer.

Teeth were stored for 14 days at 37°C and 100% humidity to allow the sealer to set completely.

Evaluation and Statistical Analysis

The teeth were embedded in epoxy resin blocks (Buehler Ltd, Evanston, IL) and sectioned at 1 and 3 mm from their apex orthogonally to their long axis with a 320-μm saw (Remet s.a.s., Bologna, Italy) under water cooling. These are critical levels for apical seal evaluation. The most coronal face of each section was lapped with decreasing grain sandpaper (320-, 1200-, and 2500-grit) to obtain a smooth, deformity-free surface. The sections were observed under an optical microscope (Carl Zeiss AG, Oberkochen, Germany) at $\times 40$ magnification using directional illumination at optical fibers (Leica, Wetzlar, Germany), and pictures were taken with a FinePix S1 Pro (Fujifilm, Tokyo, Japan).

Image analysis in a noncompressed format (.TIFF) and measurements were performed using Adobe Photoshop Cs3 (Adobe, San Jose, CA). For each section, 3 different operators repeated the measurements 3 times, and the means were calculated. Areas of gutta-percha, sealer, and void were converted to percentages (PGFA, PSFA, and VA) of the total area. Data obtained were statistically elaborated using a t test ($P \leq .01$).

Results

Comparing the 3 techniques with endodontic sealer, we found the following results (Table 1): at the 1-mm level (Fig. 1), Mseal produced a higher PGFA and lower PSFA than SBseal and Tseal. At the same level, SBseal produced a higher PGFA and lower PSFA than Tseal; furthermore, SBseal produced a higher VA than Mseal and Tseal. At the 3-mm level, Mseal produced a higher PGFA and lower PSFA than SBseal and Tseal. At the same level, Tseal produced a higher PGFA and PSFA than SBseal. Tseal produced a lower VA than Mseal and SBseal, whereas Mseal produced a lower VA than SBseal. The latter data showed clinical evidence but no statistical significance.

Comparing the 3 techniques without endodontic sealer, we discovered the following (Table 1): at the 1-mm level (Fig. 1), SBnoseal produced a significantly higher PGFA than the Tnoseal and Mnoseal groups. At the same level, Tnoseal produced a significantly higher VA than Mnoseal and SBnoseal ($P = .001$). At the 3-mm level, Mnoseal and SBnoseal produced a significantly higher PGFA than Tnoseal, which produced a higher VA ($P = .01$).