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A STUDY COMPARING THE ABILITY TO REMOVE FOUR DIFFERENT ENDODONTIC ROOT CANAL FILLING MATERIALS USING ROTARY INSTRUMENTS USED IN CURRENT PRACTISE.

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ABSTRACT

The aim of the present study was to assess the ability to remove four different root canal fillings performed by using current methods during re-treatment with rotary instruments. Seventy-two freshly extracted human anterior teeth with single straight root canals were instrumented with Mtwo rotary files. The teeth were randomly divided into 4 obturation groups of 18 specimens each as follows: group 1, Resilon and Epiphany; group 2, GuttaFlow obturation system; group 3, EndoTwinn obturation system; group 4, gutta-percha with AH Plus sealer. The filled canals were re-treated by using Mtwo-Retreatment instruments and Mtwo instruments. The time required to remove the obturation material was recorded. After splitting the roots, the amount of residual filling material on the canal walls was imaged and measured with image analyzer software. Statisticalanalysis was accomplished by Kruskal-Wallis and MannWhitney U tests for the analysis of root canal cleanliness. There was no statistically significant difference among the 4 filling techniques regarding the amount of residual material in the apical, middle, and coronal thirds and inside the whole canal area (P .05). Regarding the mean time of re-treatment, the fillings performed by using GuttaFlow and EndoTwinn methods were removed much more quickly compared with the other 2 methods (P .001). It was observed that the fillings performed with the above canal filling methods were removed in a similar fashion with rotary instruments during re-treatment.

BACKGROUND

One of the primary objectives of root canal filling is to seal the canal system completely in such a way as to prevent the penetration of tissue liquid, bacteria, and/or their products into the canal and to avoid reinfection after cleaning and shaping (1). To be able to seal the prepared canal space completely, many endodontic obturation materials, techniques, and sealers have been developed. The ideal root canal filling material should be easy to use, radiopaque, and an easily removable one that is biocompatible with periapical tissues and that expands slightly as it hardens and provides long-term perfect sealing (2). Lateral compaction (LC) of gutta-percha with a sealer has been used for years as a conventional canal filling method, and it is regarded as a reference when considering other techniques. However, it has been reported that the quality of adaptation between the surface of the root canal and the gutta-percha is uncertain in fillings using the LCtechnique (3). Thus, efforts have been pursued to find the canal filling material or method that provides three-dimensional sealing that can be removed easily. The minimization of both the amount of the sealer used in the canal filling and the ratio of sealer/gutta-percha is considered to be a factor that affects the

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long-term seal of a root filling (4), because sealers become variably soluble after a certain time (5, 6), whereas gutta-percha is not similarly subject to such dimensional degradation (7). In light of this phenomenon, the preferred filling techniques are those that minimize the amount of the sealer component. Compared with LC, the warm vertical compaction of gutta-percha minimizes the sealer amount (8, 9). Currently, a new device has been developed called EndoTwinn-v2 (EndoTwinn B.V., Amsterdam, The Netherlands), in which heat and vibration are combined during vertical compaction.

Previousreports have shown that an EndoTwinn plugger used with vibration and heat produced a higher percentage of gutta-percha when compared with the sections obtained by using only the heat function (10). In recent years, a thermoplastic synthetic polymer-based root canal filling material, Resilon (Pentron Clinical Technologies, Wallingford, CT), has been developed. Resilon includes bioactive glass and radiopaque fillers. It performs like gutta-percha and has the same handling properties, and it can be softened with heat or solvents like chloroform for re-treatment purposes. Just like gutta-percha, it has master cones in all International Standards Organization sizes and accessory cones in different sizes. The sealer, Epiphany Root Canal Sealant (Pentron Clinical Technologies), is a dual curable dental resin composite sealer. Resilon points and Epiphany sealer fill the root canals by adhering to one another and to the root canal walls, thus forming a "monobloc" structure (11, 12). More recently, GuttaFlow (Coltène/Whaledent, Langenau, Germany) was introduced into the market as a new material that includes the combination of gutta-percha in powder form and polydimethylsiloxane. Nanometer-sized particles of silver were added to gutta-percha powder, acting as a preservative (13). GuttaFlow is a modification of the RSA RoekoSeal (Roeko Dental Products, Langenau, Germany). The manufacturer claims that the material provides a perfect sealing because it has increased fluidity and expands slightly during hardening, and it can be easily removed. Positive results were obtained from the studies in which this material was used in sealing the canal (1). Nonsurgical endodontic re-treatment is indicated when infection persists or recurs after treatment, especially if the existing root canal therapy is technically deficient (14). Thus, the main objective of nonsurgical re-treatment is to remove all material filling from the root canal and to regain access to the apical foramen. There is limited information about the removability of this new canal filling method and materials for re-treatment purposes. The techniques used to remove gutta-percha are varied and include the use of hand or rotary instruments with or without heat and solvents and/or ultrasound (15–17). Nickel-titanium (NiTi) rotary instruments have also been used for the removal of filling materials from root canal walls, and various studies have reported their efficacy, cleaning ability, and safety (18–20). One of the newest rotary systems produced for this purpose is Mtwo (VDW, Munich, Germany) re-treatment instruments. Theaimofthis study was to investigate the current filling materials (Resilon/Epiphany, GuttaFlow) and the warm vertical compaction method in which heat and vibration are used (EndoTwinn) in terms of their removability with rotary instruments by comparing them with the LC method using gutta-percha and AH Plus sealer, which was used as a control group.

MATERIALS AND METHODS

A total of 72 freshly extracted human anterior teeth with single straight root canals were used in this study. Only root canals in which apical diameter had sizes15–20 were selected. The crown of each tooth was removed to obtain root segments of approximately 15mm in length.

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The working lengths weredeterminedbyplacingasize10K-file into the root canal until it was visible at the apical foramen and subtracting 1mm from that length. The coronal thirds were first enlarged with Gates Glidden drills of sizes 3 and 2.

Root Canal Preparation

All canals were prepared with Mtwo rotary instruments. According to the manufacturer, the Mtwo instruments should be used in a single length technique with a gentle in-and-out motion. Therefore, all files of the instrumentation sequence were used to the full working length of the root canal. Six rotary instruments were used: Mtwo10/.04, Mtwo15/.05, Mtwo20/.06, Mtwo25/.06, Mtwo30/.05, andMtwo35/.04. File Care ethylenediaminetetraacetic acid (EDTA) (VDW) was applied to the rotary files to serve as lubrication during cleaning and shaping. The instruments were set into permanent rotation, with the torque-limited rotation handpiece Mtwo direct (Sirona, Bensheim, Germany) at a maximum speed of 300 rpm. Torque settings were selected, with a turning ring chosen for each according to the manufacturer's instructions. Patency of the canals was maintained throughout the procedure by passing a size10 K-file approximately 1 mm through the apex. The canal was irrigated with 2 mL freshly prepared 2.5% sodium hypochlorite solution with a 27-gauge needle after every instrument. A final rinse with 10 mL 17% EDTA was given to remove the smear layer followed by rinsing with a 10-mL saline solution. The canal was then dried with paper points. The prepared roots were randomly divided into 4 groups (n 18/group).

Root Canal Filling

Group I

The root canals were filled with caliber 0.04/35 Resilon cones and Epiphany sealer, also by the LC technique, used in accordance with the manufacturer'sinstructions. The self-etching primer (Epiphany Primer; Pentron Clinical Technologies) was placed into the canal with a transfer pipette. Excess primer was then removed with paper points. Epiphany sealer was placed into the canal by using a lentulo spiral (Dentsply Maillefer, Ballaigues, Switzerland). The tip of the master cone was lightly coated with sealer and slowly inserted within the canal to the full working length, and accessory cones were condensed by spreaders. After that, the material was light-cured for 40 seconds to ensure setting.

Group II

The root canal filling was performed with a single size 0.04/35 gutta-percha master cone (Roeko, Coltène/Whaledent) and GuttaFlow as a sealer. The GuttaFlow capsule was triturated for 30 seconds in an amalgamator. The sealer was inserted into the root canal by using the dispenser and "Canal Tip" provided by the manufacturer. GuttaFlow was also directly applied on the trimmed master cone that was then inserted into the canal. The remaining space was backfilled by reinserting the Canal Tip between the master cone and canal walls.

Group III

The root canals were filled with warm vertical compaction technique with heat and vibration byusingtheEndoTwinn-v2heatsource.Theplugger F (EndoTwinnB.V.) was taken to adepthof3mmfromtheworkinglength. A size 0.04/35 alpha phase gutta-percha master cone (VDW) was fitted 0.5 mm short of the working length with tug-back. The trimmed gutta-percha cone, lightly coated with sealer (AH Plus; Dentsply, De Trey, Konstanz, Germany), was placed into the canal 0.5 mm short of the full working length. The plugger tip was

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activated (heat and vibration) and placed3mmcoronaltotheapicalforamenfor2seconds.Subsequently, apical pressure was maintained for 8 seconds. The heat was applied for1 second, and the plugger was removed from the canal. Backfilling other canal was achieved by using warm vertical compaction. Small gutta-percha pieces were picked up with plugger and introduced into the canal asrecommendedbythemanufacturer.Thiswasrepeateduntilthe canal was filled.

Group IV

The root canals were filled with size 0.04/35 gutta-percha master cone (Roeko)andAHPlussealerbyusingLCofmedium-fineaccessory cones (Beutelrock; VDW). Themasterconewasinsertedtotheworking length, and a tight fit was assured. Sealer was introduced into the canal by using a lentulo spiral instrument. The master gutta-percha cone was then coatedwiththesealerandplacedintotherootcanaltothe working length. Accessory gutta-percha cones were inserted until they could not be introduced more than 3 mm into the root canal. The teeth were radiographed in the buccolingual and mesiodistal directions to confirm the adequacy of root filling. A heated instrument was used to sear the filling material off at the orifice of the canal. The access cavities weresealedwithatemporaryfillingmaterial(CavitG;3M Espe, Seefeld, Germany), and the teeth were stored at 37°C in 100% humidity for 6 weeks.

Root Canal Re-treatment

The temporary filling material was removed, and size 3 Gates Glidden drills were used to remove the coronal 3 mm of the root filling. Then, 0.05 mL of chloroform solvent was dropped into each canal to soften the filling material. Two or 3 additional drops of solvent were applied as required to reach the working length. The root canal filling material gradually was removed by Mtwo R25/.05 and Mtwo R15/.05 instruments, respectively, until slight resistance was encountered. These 2 instruments were used with circumferential filing movements and without downward pressure. A C-pilot file (VDW) size 10 was used to negotiate the root canal to full working length. After the working length wasreached,conventional Mtworotaryinstrumentswereusedto remove the filling material in a circumferential filing motion while pressing against the root canal walls: Mtwo 10/.04, Mtwo 15/.05, Mtwo 20/.06, Mtwo 25/.06, Mtwo 30/.05, Mtwo 35/.04, and Mtwo 40/.04. Duringre-treatment,therootcanalswereconstantlyirrigatedwith2.5% sodium hypochlorite solution, and instruments were used at a constant speed of 300 rpm and torque recommended by the manufacturer.

During re-treatment, all instruments were used in 2 root canals and were then discarded. Any deformed instruments were discarded. The filling material removal was judged to have been completed when the working length was reached, and no more material could be removed with the instruments used. The time needed for the procedure was measured with a stopwatch for each sample.

Evaluation

Once removal of the root filling material was complete, the teeth were grooved longitudinally on the buccal and lingual surfaces with the steel discs and split in half with a chisel. Both halves were photographed with a digital camera (Nikon Coolpix 885; Nikon, Tokyo, Japan), adaptedtoatrinocular stereomicroscope.Thephotographsweretransferred to a computer, and an image analysis program (IMAGE-PRO PLUS 4.5; Media Cybernetics,

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Silver Spring, MD) was used to calculate the area of the canal and the remaining filling material as a percentage.

Statistical Analysis

Statistical analysis was accomplished by Kruskal-Wallis and Mann WhitneyUtestsfortheanalysis of rootcanalcleanliness. The differences in re-treatmenttimeamongtheexperimentalgroupswereanalysedwith one-way analysis of variance. Statistical significance level was established at P .05.

RESULTS

Residue of the root-filling materials was observed in all specimens regardless of the root-filling material used. The mean ratio of residual filling material on canal walls is shown in Table 1. When the filling amounts inside each third and the whole root canal were compared, there were no statistically significant differences between the filling methods (P .05). After the removal of the material, there were more filling remnants in the apical third compared with the middle and coronal thirds independent from the material (P .001), and also the middle third showed more filling remnants than coronal third (P .05). Regardingthemeantimeofre-treatment,thefillingsmadewiththe clinical techniques associated with GuttaFlow and EndoTwinn were removed more quickly (P .001, Table 2).

DISCUSSION AND CONCLUSION

Oneof the basic properties of an ideal root canal filling material is that it should be removable whenever necessary for re-treatment purposes (21). Therefore, newly developed root canal filling materials, sealers, or filling techniques should be investigated in this respect. The present study showedthatcurrentfilling materials canberemovedfrom the root canal during endodontic re-treatment when rotary instruments and chloroform solvent are used. Conventionally, the removal of gutta-percha by using hand files with or without solvent can be a tedious, time-consuming process, especially when the root-filling material is well-condensed (22). Therefore, the use of rotary NiTi instruments in re-treatment might decrease patient and operator fatigue. Various rotary systems were used in removing the filling material during endodontic re-treatment. Recently, new instruments produced for re-treatment purposes were added to conventional rotary instruments for canal preparation (Mtwo-Retreatmentinstruments). These re-treatment instruments have a cutting tip so that the instrument can progress easily in the filling material, and they might open the way to other instruments that will be used in the future.

Previousstudiesreportedthatthefillingresiduetracedinthecanal would be minimized when the enlargement in the re-treatment was bigger than the enlargement performed before canal filling (23, 24). Therefore, re-treatment procedure was completed with 1 size larger (Mtwo 40/.04) of the instrument used in enlargement before filling (Mtwo 35/.04). In the present study, chloroform solution during the instrumentation wasusedbecauseitismoreefficientindissolving gutta-percha than other chemicals (25, 26). Chloroform was quite an effective solvent for gutta-percha, Resilon/Epiphany, and GuttaFlow. However, possible adverse health effects from exposure to chloroform should not be overlooked (25). In previousstudies, the amountoffilling material remaining inside the canal after the re-treatment procedure was assessed radiographically (27, 28), by computed

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tomography (14, 29), or by clearing theroots (30, 31). Operation microscopes (31) have been used for this purpose. In addition, the roots were split longitudinally, and the residual gutta-percha and sealer were measured with a scoring system (16, 19, 32) or linearly (18, 20, 33). In the present study, the roots were separated longitudinally, andtheevaluationofremainingfillingmaterial wasperformedbycalculatingthepercentageofdebrisinthecanal.Four different aspects of the tooth were evaluated: the apical, middle, and coronal thirds and the entire canal space in each half of a split root specimen. It was reported that this method was effective in determining the amount of filling residue and minimized subjectivity in the scoring method based on a scale (20). In the present study, when the amount of filling residue in the root canals after re-treatment was investigated, it was observed that the filling methods did not differ in terms of their removability, and none of the materials couldberemovedcompletelyfromthecanalwalls.Mostofthe previous studies noted that Resilon/Epiphany system could be removed more effectively compared with the fillings made with gutta-percha and sealer (17, 22, 30). On the other hand, Hassanloo et al. (24) stated thatthere was less filling residue in the gutta-percha/sealer combination than in the Epiphany system when they performed re-treatment in the teeth after they had kept them in an anaerobic environment for 8 weeks after obturation. This contradiction between different studies was associated with methodologic differences and with the possibility that the fillings made with the Epiphany system in other studies might have been removed before they had completely hardened during 1–3 weeks in the aerobic environment (24). In the present study, the similar amount of filling residue in the gutta-percha/sealer and Epiphany groups might be due to the fact that the teeth were kept in an aerobic environment for 6 weeks. Previous studies noted that successful root canal fillings were made with GuttaFlow and EndoTwinn methods (2, 10). Yet there is limited information concerning the re-treatment of teeth filled by using both methods. Kosti et al. (19) reported that RoekoSeal, which is considered as the initial form of GuttaFlow, was removed more easily from the canals than AH 26 sealer. In the EndoTwinn group, using minimum sealer and obtaining a more homogeneous filling in the apical region through heat/vibration combination might have enabled the filling to be removed as a whole. Within the experimental conditions of the present study, currently available endodontic-filling systems were re-treatable with chloroform and rotary files. There were no significant differences between the experimental groups regarding the amount of residual material. The fillings performed by using GuttaFlow and EndoTwinn systems were removed more quickly.

GROUP	N	CANAL LEVEL			
		CORONAL	MIDDLE	APICAL	TOTAL
Resilon/Epiphany	18	5.41 (4.95)	6.40(5.47)	14.18(7.73)	9.05(4.29)
Gutta Flow	18	7.36(8.33)	10.94(10.24)	18.33 (13.22)	9.84(7.58)
Endo Twinn	18	5.64(5.68)	11.03(9.51)	17.02 (9.27)	11.40(6.31)
Gutta percha	18	4.66(6.07)	9.35 (6.98)	24.10(13.42)	9.07(4.49)

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Sealer					
P value	>0.5				

TABLE 1. Percentage of Filling Material Remaining in the Canal [mean (standard deviation)]

GROUP	N	MEAN (STANDARD DEVIATION)
Resilon/Epiphany	18	352.11(47.63)
Gutta Flow	18	238.44(21.74)
EndoTwinn	18	262.66(34.08)
Gutta percha Sealer	18	325.83(43.46)

TABLE 2. Time Required (seconds) to Remove the Filling Material

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