



## Evaluation of Residual Obturated Material at Apical Area After Retreatment Using Different Obturation Techniques (In Vitro Study)

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### Abstract

**Aim:** This study aimed to estimate the effect of different obturation techniques using a Guttaflow2 sealer on the amount of residual filling material at the apical region after retreatment, focusing on factors such as canal cleanliness, residual material quantity, and ease of retreatment

**Method:** Thirty fresh extracted human mandibular premolar teeth were used in this study. Afterwards the preparation of the root canals using hand protaper technique to F3, the teeth were divided into three groups with 10 sample in each group. G1 obturated with single cone technique, G2 obturated with Lateral Condensation, and G3 was obturated with Soft Core. Guttaflow2 sealer was used After the incubation period of two weeks, obturation materials in all samples were removed using the ProTaper Universal Retreatment files D1, D2, and D3. all procedure was done in vantom lab in the collage of dentistry/ mustansiriyah university. After mechanical removal, use ultrasonic activation with 5.25% NaOCl for 60 seconds to enhance sealer dissolution. Final irrigation with saline to ensure thorough cleansing. Then, the samples were split longitudinally and examined by a digital stereomicroscope at 12.5X magnification. and the examination of samples done in the Department of Materials Engineering, University of Technology After that, the remnants of root-filling materials at apical area were calculated as a percentage at 3mm from the apical foramen.  
**Results:** The ANOVA test revealed **no statistically significant difference** between the mean values of G1, G2, and G3 ( $p > 0.05$ ). Higher percentages of unfilled areas were observed in Group 2, followed by group3.

**Conclusion:** The retreatment technique used was incapable of complete removal of filling material within root canal walls, especially at the apical region

## Introduction:

Endodontic therapy's main goals are to produce a complete, good seal with filling materials and completely disinfect the root canal system using chemomechanical cleaning in order to stop germs from infiltrating the periapical tissues (1). Numerous tools and methods have been created over time to improve the effectiveness of root canal sealing. Easy to apply, dimensionally stable, radiopaque, able to seal the apex, bacteriostatic, biocompatible, and non-irritating to surrounding tissues are all characteristics of the perfect sealing material (2). Sealers are employed in conjunction with core filling materials since no single material can satisfy all of these requirements. Because they create adaptation between the obturation material and the dentinal walls, fill gaps, lateral canals, and accessory foramina, and serve as a lubricant to facilitate the implantation of the core material, sealers are crucial in root canal therapy (3,4). Regardless of the obturation method, gutta-percha does not adhere to dentine. In order to achieve a hermetic closure and lower the likelihood of root canal treatment failure, a solid core and a root canal sealer are essential for filling auxiliary root canals, voids, gaps, and abnormalities (4). It was discovered that the root canal system's incomplete obturation was the cause of over 60% of endodontic failures (5,6).

Among numerous obturation techniques and filling materials available, gutta-percha continues to be the material used, owing to its unique chemical and physical properties. Root canal sealers have been extensively studied and classified based on their chemical composition, including zinc oxide eugenol, epoxy-resin based such as AH Plus (Dentsply, Konstanz, Germany) (6), calcium hydroxide, glass ionomer, resin, silicone, and the recently introduced bioceramic sealers (BCs) (7).

GuttaFlow 2 is an advanced root canal obturation system developed by ROEKO (Coltene) that uniquely combines gutta-percha and a sealer in a single, flowable cold-filling material. This innovation streamlines endodontic procedures, enhancing both clinical efficiency and treatment outcomes, Consists of

gutta-percha powder (particle size <30  $\mu\text{m}$ ) embedded in a polydimethylsiloxane matrix, with additional components like a platinum catalyst, zirconium dioxide for radiopacity, and pigments(8) . Many techniques are available to remove root obturation materials, ranging from the use of hand (9), and rotary and reciprocating (10). files, ultrasonic systems, heat-carrying instruments lasers, and solvents (9,10,11). The most commonly used system for removing root canal filling materials is the ProTaper® Universal Retreatment (PTUR; Dentsply Sirona, Ballaigues, Switzerland). Its efficacy has been well established

## Material and Methods

In this study 30 freshly extracted human mandibular premolars with single straight canals used, after the Ethics Committee approved study MUOPR6. These teeth were mature and non-carious and had been extracted for orthodontic reasons. After being immersed in 3% sodium hypochlorite for 30 minutes (12), the teeth were cleaned with distilled water and kept in regular saline, which was replaced every day until it was utilized (13).

### Preparation of samples

The teeth were measured using a digital caliper and permanent marker to a length of 14 mm from the anatomical apex. The decoronation was performed using a diamond-coated separating disk affixed to a slow-speed straight handpiece with water cooling, oriented perpendicular to the long axis of the tooth. Subsequently, the length of the specimen was measured with a digital vernier for confirmation. The working length was verified on a #10 K-file. The file was put into the canal until the tip traversed the foramen. Subsequently, the specimens were encased in a transparent plastic tube filled with a dense silicone compound.

### Tooth Preparation

The specimens were prepared with ProTaper hand files in a crown down manner according to the manufacturer's instructions using a gentle in-and-out motion. The shaping file SX was used first and moved apically to 1mm short of the

working length, followed by S1 and S2 for shaping the coronal two-thirds of the canal. The apical one-third of the canal was finished using F1, F2, and F3 sequentially to the working length. the instrumentation done with use of 17%EDTA( ethylenediaminetetraacetic acid) gel to prevent file fracture and to remove smear layer. Once the instrument negotiated the end of the canal and rotated freely, it was removed. Root canal irrigation was performed using 5.25% NaOCl and finally with saline.

### **Obturation of the Root Canals**

Following the drying of the canals using paper points, the teeth were randomly allocated into three groups of 10 teeth each for obturation employing various techniques, with gutta flow2 utilized as a sealer across all groups.

**Group 1 (lateral condensation):** GuttaFlow2 was applied into the canal before with tip, and the master cone was inserted in the canal, after which an endodontic finger spreader was introduced in the canal with the master cone in place for 5 seconds. An accessory cone (size #20) was placed after dipping in the GuttaFlow2 sealer.

**Group 2 (single cone technique):** gutta flow2 sealer was applied into the canal before and the master cone was inserted in the canal

**Group 3 (Soft Core system):** while the obturators were heated using “the Soft-Core DT Oven (CMS Dental, Copenhagen, Denmark)” a Guttaflow2 sealer was applied into the canal. Upon the oven signaling readiness through a beep and illumination of a green diode, the obturator was meticulously extracted. The plasticized Soft-Core was subsequently placed into the apical stop using apical pressure. Upon cooling the gutta-percha, the handle and insertion pin were detached through a bending motion.

### **Removal of obturation materials:**

After the incubation period and the removal of the temporary restorations, the retreatment was conducted utilizing the PTUR system at a constant speed of 500 rpm and a torque of 4.0 Ncm, in accordance with the manufacturer's guidelines for the X-smart TM Plus. D1 (size 30,

0.09 taper) was employed to remove the coronal third of the root filling (up to 4 mm), subsequently followed by D2 (size 25, 0.08 taper) for the middle third (up to 8 mm). D3 (size 20, 0.07 taper) was utilized at the working length of 13 mm. The X-smart TM Plus endomotor was utilized alongside the ProTaper NEXT's preprogrammed settings of 300 Rpm and 2.0 Ncm for instrument operation. Following each instrument, the canals were irrigated with 1 mL of 5% NaOCl for a duration of 10 seconds (14). The retreatment procedure for all groups was deemed complete upon reaching W.L, with no root-filling materials found on instruments (14). The final irrigation for each sample involved the application of 2 mL of 17% EDTA (ethylenediaminetetraacetic acid), which was retained in the canal for 3 minutes prior to rinsing with 3 mL of 5% solution (14). All experimental procedures described above were performed at the Vantom Laboratory, College of Dentistry, Mustansiriyah University, during the period when the study was conducted

### **Root sectioning& Image scanning**

Once the impression material was removed, the root was carefully examined by drawing longitudinal lines parallel to the root's long axis along its buccal and lingual surfaces with a red marker. The next step was to slice through the underwater-drawn lines using the disc bur attached to a straight handpiece. Thereafter, a digital stereomicroscope in the University of Technology's Department of Materials Engineering was used to scan and image the specimen at a 12.5X magnification. We uploaded the sharp photos to the computer from stereomicroscope (15). The sample examinations were performed in the Department of Materials Engineering, University of Technology in 15/4/2025.

The images shown in figure. (1), (2), (3) was imported into Adobe Photoshop, where the root canal area was divided into three equal thirds (apical, middle, and coronal) by using superimposing lines. The software tool (magnetic lasso tool) was used to trace the remaining root filling materials; the total number of pixels occupied by root filling materials was

calculated by the histogram function of the program. The total area of the apical third was calculated by analyzing the pixels that occupy the area using the previously mentioned function (16). The percentage of remaining root filling materials was determined by dividing the pixel count of the remaining filling materials in each third by the total pixel count for the entire third of the splitting canal. The percentage of residual obturation materials was determined solely for the apical third of each canal (16,17).

$$\frac{\text{Percentage of the remnants}}{\frac{\text{The pixels of remnants at each third}}{\text{Total pixels of entire canal third}}} \times 100$$

## Results

The statistical analysis was carried out using SPSS version 21. At the 5% level of significance, the percentages of voids and gaps areas were examined using ANOVA and LSD tests. Descriptive statistics were computed to summarize the data for the three groups (G1, G2, G3). The mean, standard deviation, minimum, maximum, and count of observations were calculated. The results showed some variation in mean and data spread across the groups as shown in Table 1

Table 2 displays the results of a one-way Analysis of Variance (ANOVA) that was conducted to further investigate whether there were statistically significant differences between the groups. The mean values of G1, G2, and G3 did not differ statistically significantly, according to the ANOVA test ( $p > 0.05$ ). This implies that rather than a real underlying difference, any observed variations in the group means may just be the result of chance.

Additionally, a Tukey's Honest Significant Difference (HSD) post hoc test was conducted to perform pairwise comparisons between the groups as shown in Table 3. The results confirmed the ANOVA findings, showing **no significant differences** between any pair of groups (G1 vs G2, G1 vs G3, G2 vs G3) as all p-values were greater than 0.05.

## Discussion

Detecting voids in root canal fillings is crucial, as thorough obturation of the canal space post-

instrumentation is essential for the success of root canal therapy. Voids or gaps can serve as places for microorganisms, potentially leading to persistent infections. However, the simple presence of such defects doesn't always result in endodontic failure. The outcome often depends on factors like the extent of voids, the presence of residual bacteria, and the quality of coronal sealing. Therefore, while obturation defects can harbor microorganisms, their impact on treatment success varies based on multiple clinical factors. When obturation defects extend continuously to the apex, they can create pathways for microorganisms to migrate into periradicular tissues, potentially leading to reinfection of the canal or surrounding areas.

Studies have shown that bacteria such as *Enterococcus faecalis* can persist in root canals even after obturation, often due to inadequate canal preparation and debridement. Additionally, apical or coronal leakage through defective restorations can allow bacterial penetration, compromising the seal and increasing the risk of endodontic failure (18).

Success of nonsurgical root canal retreatment depends on the thorough removal of existing filling materials, such as gutta-percha and sealers, from the root canal system. This step is crucial to facilitate effective cleaning, shaping, and subsequent refilling of the canal, aiming to eliminate residual bacteria and promote periapical healing. Various techniques are employed to remove these materials, comprising endodontic hand files, nickel-titanium rotary instruments, ultrasonic equipment, and solvents.

In spite of these methods, studies have shown that complete removal of filling materials is challenging, with remnants often persisting on canal walls. These residual materials can harbor bacteria and impede the success of retreatment. Therefore, careful removal of previous filling substances is essential to enhance the efficacy of retreatment procedures and improve clinical outcome (18,19).

This study demonstrated that GuttaFlow 2, when used with the lateral compaction technique, exhibited the lowest mean percentages of voids and gaps. This outcome can be attributed to the material's expansion upon setting, its homogeneous composition, and its favorable flowability, which is enhanced by gutta-percha

nanoparticles that improve wetting ability, adaptation to the gutta-percha cone, and penetration into dentinal tubules (19). The application of the master cone contributed to minimizing the occurrence of voids and gaps in this group by facilitating the displacement of material toward canal irregularities, thereby improving adaptation to canal anatomy. This approach also increased the volume of core material while decreasing the amount of sealer, which subsequently lowered the frequency of voids and the potential for communication between them. GuttaFlow2's near-zero solubility and robust adhesion to dentin and gutta-percha complicate complete removal, especially in apical regions. Research indicates that residual sealer and gutta-percha frequently persist on canal walls, despite the use of advanced retreatment systems (19,20,21).

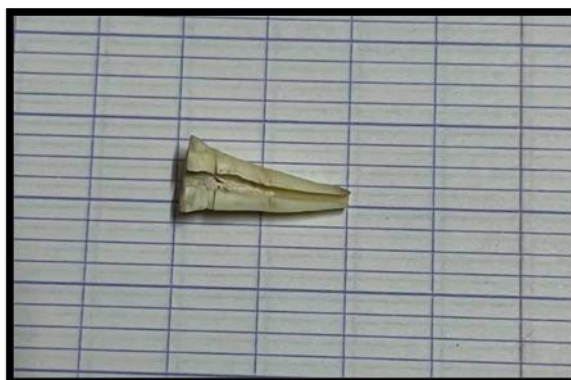
According to the findings of earlier research, none of the root filling materials could be entirely eliminated, as this study's results showed (22, 23). The greater remaining obturated area may be related to the use of a guttaflow2 sealer, which has a stiffer formulation compared to earlier versions and reduces flow during initial placement but complicates retreatment by creating a more tenacious bond (24,25). Residual material is most prevalent in the apical third, increasing reinfection risk. It may be advised to use rotary files with ultrasonic activation and solvents (despite limited efficacy) for optimal debris removal.

## **Conclusion**

This in vitro investigation concludes that the employed retreatment procedure was ineffective in entirely eliminating the filler material from the root canal walls.

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**Conflicts of interest:** The authors claim to have no conflicting interests.



**Figure (1):** photo for remnant assessment after using lateral compaction obturation technique



**Figure (2):** photo for remnant assessment after using single cone obturation technique



**Figure (3):** photo for remnant assessment after using obturated with soft core technique

**Table (1):** Descriptive Statistics(mean, standard deviation, minimum, maximum, and values) of three obturation technique

index	G1(lateral condensation)	G2(soft core)	G3(single cone)
count	10.0	10.0	10.0
mean	29.15	39.76	45.46
std	32.65	34.87	37.00
min	0.61	4.61	1.07
max	80.47	102.01	96.94

**Table (2):**one-way Analysis of Variance for the percentage of remnants in each obturation group.

index	sum sq	df	F (sig.)	PR(>F)
C(Group)	1370.48	2.0	0.56	0.57
Residual	32871.03	27.0	0	0

**Table (3):** Tukey HSD Post Hoc Test to compare between groups

group1	group2	meandiff	p-adj	lower	Upper	reject
G1	G2	10.61	0.77	-28.07	49.30	False
G1	G3	16.30	0.55	-22.37	54.99	False
G2	G3	5.69	0.92	-32.99	44.38	False

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