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Evaluating the quality of seal of root canals in the presence of separated rotary instrument when obturated with different obturation techniques/material

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Abstract

Introduction: Adequate sealing of the root canal system is important for a successful outcome of the endodontic treatment. Therefore this study aimed to compare apical micro leakage in root canals containing broken rotary instruments filled with Biodentine, Gutta Flow 2, laterally compacted gutta-percha and thermo plasticized gutta-percha.

Methods and Materials: In this in vitro, experimental study, 80 extracted human premolars were decoronated and then the roots were randomly divided into four groups (n=20). Root canals were instrumented with Neoendo rotary files. The files were scratched 3 mm from the tip by a high speed hand piece and they were intentionally broken in the apical third of the canals. The middle and coronal thirds of the canals were then filled with biodentine ,GuttaFlow 2, Gutta-percha with lateral compaction technique and thermo plasticized gutta-percha. Apical microleakage was measured using a glucose leakage model. Data were analyzed using ANOVA and Tukey's test.

Results: Root canals filled with Biodentine cement and GuttaFlow2 performed significantly (p>0.05) better and provided a better seal when compared to laterally compacted and thermo plasticised Gutta-percha.

Conclusion: Due to their superior sealing ability, Biodentine and GuttaFlow2 are suitable for filling of root canals in presence of a separated rotary instrument.

Keywords: Broken Instrument; Biodentine; Gutta-Percha; Leakage; Gutta Flow2; Obturation techniques.

Introduction

Non-surgical root canal treatment has a higher success rate given that sufficient cleaning and shaping and efficient obturation of root canals are performed (1). Efficient obturation must provide a seal to prevent re-entry of microorganisms (2). A good apical seal plays very important role in success of endodontic treatment and healing of periapical tissues and can increase the success of endodontic treatment by up to 97% (3, 4). Unfortunately there could be instrument separation during biomechanical preparation making it difficult in achieving a fluid tight seal.

The overall occurrence of fractured endodontic instruments left in the root canal after treatment was found to be 3.3% of treated teeth and comprised 78.1% rotary Ni Ti files (5). Ni Ti instruments tend to fracture more commonly in the apical region of root canals, where it is difficult to retrieve (6).Evidence shows that broken instruments left in the root canal has no negative effect on prognosis given that the root canals are effeciently cleaned and sealed(5,7).

Lateral condensation technique is commonly practiced for root canal obturation with gutta-percha due to relative simplicity and low cost. However, it has a few disadvantages such as risk of void formation and difficulty in curved canals (8). Use of thermo plasticised gutta-percha was later introduced for better adaptation of gutta-percha to canal walls and irregularities (8). This technique is fast but is very technique-sensitive and also has a risk of void formation, over-extension or under-filling (9).

GuttaFlow2 is an improvement of the existing GuttaFlow material and has the very same excellent material properties. It does not shrink but expands slightly by 0.2% and has a very good adhesion to gutta-percha points and dentin walls. This combination of expansion and adhesion creates an excellent seal.

Biodentine is silicate-based biologically active cement which has dentin-like mechanical properties and designed as a “dentin replacement” material. This material is actually formulated using the MTA-based cement technology while improving its physical and mechanical properties (10).

No study in literature has evaluated and compared apical microleakage in root canals filled with GuttaFlow 2 and Biodentine in presence of separated instrument. Therefore this study aimed to compare apical micro leakage in root canals containing broken instrument filled with four different obturation materials/techniques.

Materials and Methods

Eighty freshly extracted mandibular premolars with straight and single root canals were selected for this study.Sample size was calculated to be 20 in each group. The teeth were selected using convenience sampling. All the teeth were decoronated at Cemento-enamel junction using a carborundum disc, maintaining the rootlength of approximately 18 mm and examined under a stereomicroscope to eliminate any specimens with cracks.

The roots were then divided into four groups for root canal filling with Group 1-Biodentine (Septodont, France),Group 2- GuttaFlow 2(Coltene Endo),Group 3-Thermo plasticised gutta-percha (Meta biomed),Group 4-Gutta-percha (Dentsply) using lateral compaction technique.

Roots were then radiographed in buccolingual direction. Working length was determined and the root canals were instrumented with hand K-files (DentsplyMaillefer, Ballaigues, Switzerland) followed by flex rotary file(NeoEndo) up to size 25/0.06 to the working length and 30/0.06 to 1.5 mm short of the working length. During chemo mechanical preparation, 15% ethylenediaminetetraacetic acid (EDTA) gel (Glyde File Prep-MailleferDentsply, Switzerland) was used as a lubricant with instrument. After instrumentation, the canal was irrigated with 3 ml of 3% sodium hypochlorite (Vishal DentocarePvt.Ltd., India) using a 27 -gauge needle.

A #30 rotary file was scratched at 3 mm from its tip by a high speed hand piece and was intentionally broken in the canal in the apical region (figure 1). The middle and coronal sections of the canals were filled with the abovementioned root canal filling materials/techniques. The roots were radiographed after file fracture and after filling (figure 2).

For assessment of micro leakage using a glucose leakage model, the roots in the experimental groups were coated with triple layers of nail varnish, except at the coronal end and apical 1 mm of the root end. Micro leakage along the root canal was evaluated using the glucose leakage model as described by Xu et al (11). The concentrations of leaked glucose (mg/dL) were measured after 1 day and then after 1and 4 weeks with a Glucose kit) in a spectrophotometer) at a wavelength of 505 nm.

Preparation of model

Coronal 4 mm of the root specimens was embedded in acrylic. Resin block around the coronal part of each root was connected to a rubber tube.. Cyanoacrylate glue was used for achieving leak-free interface between the rubber tube and acrylic. The other end of the tube was similarly connected to a 16 cm long pipette (erythrocyte sedimentation rate [ESR] tube). Again, cyanoacrylate glue was applied to interface between rubber tube and ESR tube to achieve better seal. A uniform hole with dimension corresponding to ESR tube end was drilled in the screw cap of the bulb using a bur with low -speed micromotor for placement of prepared assembly. The assembly was then placed in a sterile bulb with a screw cap, sealed with sticky wax.

Two milliliters of 0.2% NaN3 solution was inserted into the glass bottle such that the root samples were completely immersed. NaN3 was used to inhibit the growth of microorganisms that might influence the glucose readings. The tracer used here was 1 mol/L glucose solution (pH 7.0) that has a low molecular weight and is hydrophilic and chemically stable. About 4.5 mL of the glucose solution, containing 0.2% NaN3, was injected into the pipette until the top of the solution was 14 cm higher than the top of the tooth that created a hydrostatic pressure of 1.5 kPa or 15 cm H2O (Xuet al. 2005).[5,8] All specimens were then returned to the incubator at 37°C for the duration of 4 weeks. A total of 100 µL of the solution was drawn from the glass bottle using a micropipette at 1st and 4th weeks. The same amount of fresh NaN3 was added to the glass bottle reservoir to maintain a constant volume of 2 ml.

Statistical Analysis

Data were analyzed using descriptive and analytical statistics. The mean and standard deviation of glucose leakage were reported. ANOVA was used to compare microleakage among the groups. Tukey's test was applied for pairwise comparisons. Interclass correlation coefficient was calculated to assess agreement between two observers. All statistical analyses were performed using SPSS software (SPSS version 18, SPSS, Chicago, IL, USA) at 0.05 level of significance.

Results

Comparison of mean glucose leakage in mg/dl along the root canal fillings at 1st and 4th week was assessed when obturated using the four different techniques(Table 1)

Micro leakage data were found to have normal distribution $(P<0.05)$.

Table 1 shows the mean and standard deviation of glucose leakage (indicative of micro leakage) and differences in this regard among the four groups.

As shown in table 1 and figure 3 the mean glucose leakage was the lowest in the group 4 (biodentine) and the highest in the group 1(lateral compaction)

ANOVA test exhibited a significant difference in micro leakage among the four groups $(P<0.05)$. Tukeys test was applied for pairwise comparisons, which showed no significant difference between laterally compacted and thermo plasticised gutta-percha (P>0.05) but biodentine and GuttaFlow2 groups had significant differences with laterally compacted and thermo plasticised gutta-percha group(P<0.05)

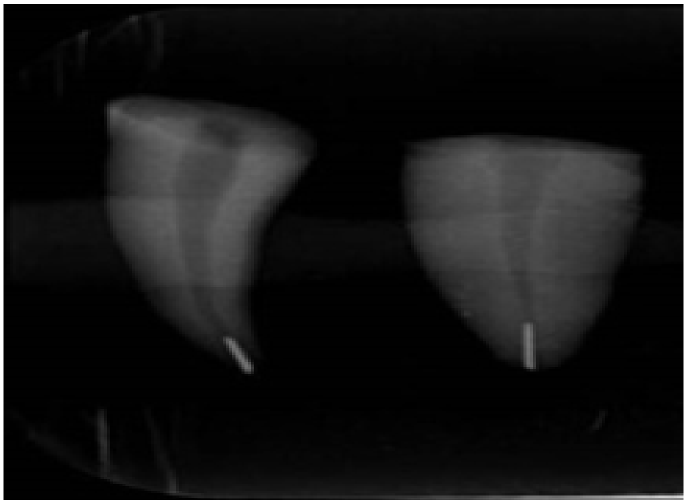

Figure 1: Radiographic image of broken file in the apical part of root canal

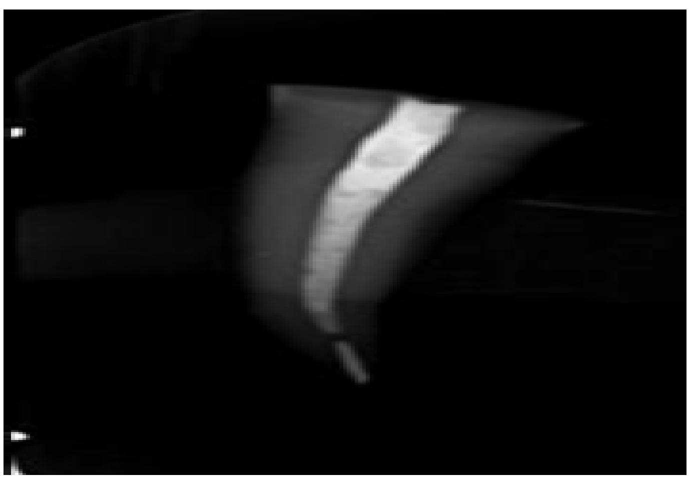

Figure 2: Radiographic image of root canal filling material over the broken file

	1st Week	4th Week
Group 1	5.31+-1.51	13.45+-3.21
Group 2	5.02+-1.42	12.04+-1.03
Group 3	3.66+-2.01	7.17+-1.93
Group 4	2.23+-1.04	6.54+-3.34

Table 1: Glucose concentration in mg/dl (mean +- standard deviation)

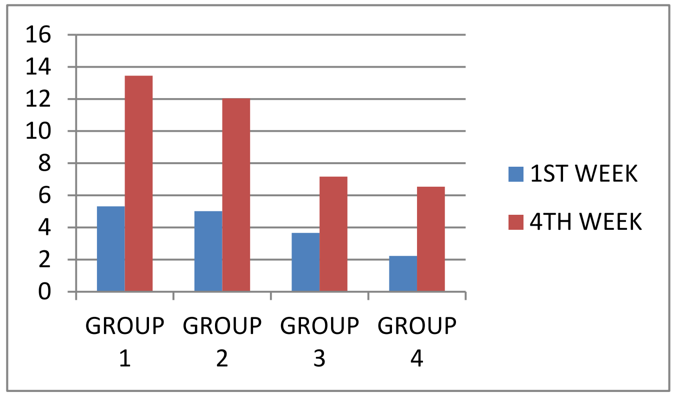

Figure 3: Bar graph representing the mean glucose concentration in mg/dl at 1st week and 4th week

Discussion

File separation is a common occurrence in endodontic treatment. The clinicians very often attempt to retrieve the broken instrument but it is not always possible. Studies show that a separated instrument left in the root canal does not have a significant negative effect on the quality of seal by root canal filling materials and the success of endodontic treatment mainly depends on coronal seal and adequate cleaning of the middle and coronal thirds [7]. However, it has been shown that type of broken instrument also could influence the quality of seal provided by restorative materials [12]. Saunders et al. [7] showed that micro leakage in canals containing a broken instrument was higher than those without it but after filling of root canals with gutta-percha, no significant difference in micro leakage was noted.

Gutta-percha is the most commonly used obturating material, and cold lateral compaction of gutta-percha is one of the most commonly used obturating techniques in endodontics. But its ability to replicate the internal structure of the root canal has been questioned because of the voids, spreader tracts, and incomplete fusion of the gutta-percha cones and there is lack of surface adaptation. To overcome these drawbacks of lateral condensation, thermo plasticized injectable obturation technique was introduced to improve the homogenicity and adaptation of gutta-percha (13). Many studies have shown that despite its enhanced adaptation to the dentine of root canal, the use of a root canal sealer is essential to achieve the optimal seal.[14] Hence, in the present study, both the techniques were compared for its sealing ability over separated instrument using AH plus as sealer.

Studies have reported that reported the glucose penetration model seemed to have a superior sensitivity in measuring the sealing ability of root canal filling materials when compared to the fluid penetration model. The choice of tracer material should be made carefully because its size and physicochemical properties will influence the result. A smaller molecular size (MW ¼ 180 Da) and stricter testability should be seen as more relevant to clinical outcomes. (15, 16)

Therefore, in the current study, glucose penetration method was selected to evaluate the possible micro leakage of root canal filling materials. The difference between the current version of the glucose penetration model and the original model introduced by Xu et al(11) was mainly in the environment, in which the equipment was stored: To overcome evaporation of fluids, specimens were placed in a closed jar with 100% humidity.

The results showed that root canals filled with biodentine showed the least (6.54+-3.34)and those filled with lateral compaction showed the highest micro leakage (13.54+-3.21) at 4 weeks. No significant difference ($p>0.05$) was noted between biodentine and GuttaFlow2 or between laterally compacted and injected gutta-percha in micro leakage

In the present study, the amount of leakage was less in roots with thermo plasticized obturation(group 2) when compared with lateral condensation group(group 1), which is in agreement with a similar study by Moreno et al., were the apical sealing of two filling techniques, thermafil and lateral cold compaction technique were assessed, in the presence of an instrument fractured at apical level and showed that when filling with thermafil, more satisfactory results were obtained than those achieved by the lateral technique(17).

GuttaFlow 2 is an enhanced version of RoekoSeal, which is a cold-flowable, self-curing material, composed of gutta-percha powder with particle size of less than 30 μm, polydimethylsiloxane, and nanosilver particles. It produces a better seal, good adaptability and flowability with a slight expansion of 0.2% on setting, supplementing its adaptation to root dentin walls (18). In the present study GuttaFlow2 performed significantly better when compared to lateral compaction and thermo plasticized gutta-percha.These findings can be expalined on the basis of the setting expansion of the GuttaFlow2 system combined with the close adaptation of the gutta-percha cone against the prepared root canal wall promoting the sealer flow and adaptation against the dentinal walls in the apical part of the root canal (19). The presence of the powdered gutta-percha in GuttaFlow helps in the better bonding between the GuttaFlow and the gutta-percha core material. In case of the lateral condensation technique using AH Plus sealer, the reason for the higher leakage values could be due the fact that the lateral condensation technique results in a less homogenous obturation and the presence of voids.

The quality of seal provided by Biodentine and GuttaFlow2 has also been compared for other applications using fluid filtration and bacterial leakage models. In the present study Biodentine performed the best which could probably be as it is a hydrophilic endodontic cement capable of penetrating into small dentinal tubules (10.)

Glucose leakage model (GLM) is considered a very sensitive and clinically relevant sealability test (11) compared to other leakage tests. However, its disadvantages include the long experimental period, the difficulty in maintaining a bacteria-free system to prevent consumption of glucose and the risk of water evaporation(20).

Conclusion

Biodentine and GuttaFlow2 have a significantly greater sealing ability compared to laterally compacted and Thermo plasticised gutta-percha and could be considered suitable for filling of root canals containing a broken instrument.

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