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Evaluation of microleakage in single-rooted teeth obturated with thermoplasticized gutta-percha using various endodontic sealers: An in-vitro study

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Evaluation of Microleakage in Single-Rooted Teeth Obturated with Thermoplasticized Gutta-Percha Using Various Endodontic Sealers: An *In-Vitro* Study

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ABSTRACT

Objective: To compare apical microleakage of extracted, single-rooted teeth obturated with thermoplasticized injectable gutta-percha using two different endodontic sealers (calcium-hydroxide and resin based).

Study Design: An experimental study.

Place and Duration of Study: The Aga Khan University Hospital (AKUH), Dental Clinics and Laboratory from June to September 2015.

Methodology: The study was conducted using extracted teeth. After access cavities were made, cleaning and shaping of root canals was done in 70 teeth. Teeth were randomly allocated into two groups and obturated with thermoplasticized injectable gutta-percha (Obtura II) using two sealers (Sealapex *vs.* AH plus). After immersing the teeth in 2.0% methylene blue, they were split longitudinally, viewed under light microscope (magnification X4) and images were taken by a camera connected to microscope. The extent of dye penetration was assessed from apex to its coronal part and recorded in millimeters. Independent sample t-test was used to compare microleakage in the two groups. Pearson correlation coefficient was used for inter-examiner reliability of dye penetration measurements. A p-value of <0.05 was taken as statistically significant.

Results: Teeth obturated with Obtura II gutta-percha with AH plus sealer had a mean dye penetration of 1.20 ±0.79 mm. This was significantly better than Obtura II with Sealapex sealer (p=0.003).

Conclusion: Obtura II-AH plus sealer was a better combination for obturation as it showed a lesser degree of microleakage. Obtura II with Sealapex group showed higher microleakage, so this combination should be avoided in single-rooted teeth.

Key Words: *Thermoplasticized injectable gutta-percha. AH plus sealer. Dye penetration. Microleakage.*

INTRODUCTION

The ultimate objective of the root canal treatment is to achieve maximum eradication of microorganisms from the root canal space and to form an impervious apical, lateral and coronal seal to prevent re-colonisation by the disease causing microorganisms.[1] Poor apical sealing of the root canal space accounted for as many as 60% of endodontic treatment failures.[2]

In contemporary dental literature, the historic term, 'hermetic' seal has been replaced by bacteria-tight or fluid-impervious seal, when defining the ideal apical seal expected in endodontic therapy.[3] A core obturation material along with a sealer placed by varying techniques is employed to provide this seal. Warm condensation techniques using gutta-percha have also been employed in clinical practice to fill in the root canal space with varying success. A wide variety of sealers are available for use with the gutta-percha to effectively fill in any voids present around the core material and to flow into the difficult to reach intricate areas, i.e. accessory and lateral canals.[4] Calcium hydroxide based sealers are considered to retard the growth of microbes in the root canal space, thus decrease the chances of root canal re-infection, but studies have found a neurotoxic effect in case the sealer comes in direct contact with nerve tissues.[5] A paradigm shift in dentistry has taken place over the years with the advent of adhesive materials for restoration of teeth. Similarly, resin based sealers have been introduced in an attempt to achieve bonding of the root filling with the root dentine, thereby forming a monoblock to better seal the root canal space.[1]

In endodontics, microleakage is described as clinically imperceptible movement of microorganisms, ions, fluids and molecules between the root canal dentinal walls and obturation material or in spaces within the obturation material.[6] The most prevalent technique for the evaluation of microleakage is the use of dyes. The dye penetration test is employed because of the ease and

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simplicity of its methodology. In endodontic microleakage studies, an aqueous solution of 2% methylene blue is commonly used. Inconsistent results of *in-vitro* studies regarding the sealing ability and microleakage of obturation materials has been the reason for continuous research to develop a material with near ideal properties to seal the root canal space.

The present study was carried out to ascertain which endodontic sealer, when used along with the thermo-plasticized gutta-percha as the core filling material, would result in the best sealing of the tooth-obturation material interface.

The objective of the study was to compare the apical microleakage of extracted, single-rooted teeth obturated with thermoplasticized injectable gutta-percha using two different endodontic sealers (calcium hydroxide, and resin based).

METHODOLOGY

This *ex-vivo*, experimental study was conducted at the Dental OPD and Juma Building Research Laboratory of the Aga Khan University Hospital. Extracted single-rooted teeth were selected for the study sample. Roots with cracks or fractures, root decay, resorptions, open apices or already endodontically treated teeth were excluded from the sample.

Ethical Committee approval was taken before the commencement of the study (3271-Sur-ERC-2014). All procedures were done by the investigator (MML). Extracted teeth that satisfied the inclusion criteria were cleaned of any debris with ultra-sonic scaler, disinfected by immersing in 5.25% sodium hypochlorite (NaOCl) and then placed in normal saline at 37°C until the experiment.

After preparing endodontic access openings, patency was established and glide path made by ISO number 8, hand K-files (Mani Inc., Japan). Working length of the canals was measured by placing a 15-K file from the coronal reference point to 1 mm short of apex. Cleaning and shaping of the root canal was carried out by ProTaper rotary system (Protaper rotary files, DENTSPLY, USA) using a torque control motor (X-Smart plus, DENTSPLY, USA) using shaping and finishing files. EDTA (RC Prep, Premiere Dental Inc.) used with each file helped in minimizing friction during instrumentation, removing inorganic debris and smear layer from the dentinal tubules. In between each file, 5.25% NaOCl was used intermittently to flush dentinal debris out of the canal space. Once prepared, teeth were then dried using F3 paper points. Before obturating the teeth, they were randomly allocated into two sets to be obturated with thermoplasticized gutta-percha using Sealapex sealer in Group I and AH Plus sealer in Group II.

Canal walls were coated with freshly mixed sealer using a paper point. A rubber stopper was placed 4-5 mm short of working length on a 23-gauge Obtura II needle. At the initiation of every obturation, a new gutta-percha pellet was placed into the Obtura II gun. When the temperature of the unit touched 200°C, the premeasured needle was positioned in the canal before expressing 3-4 mm of gutta-percha passively into the canal. Vertical pressure with an endodontic plugger was applied for compaction in the apical area. Increments of 3-4 mm were placed in a similar manner, filling the canal to the orifice. Access cavities were then sealed using Cavit. The teeth were then placed at 37°C, 100% humidity, for one week for the sealer to set completely. After 7 days, the teeth were air dried and except for 1-2 mm around the apex, 2 layers of nail polish were applied to the rest of the root. Specimens were then immersed for 10 minutes in 2.0% methylene blue dye at room temperature, removed, washed and dried (Figure 1). Slow speed diamond saw was used to obtain longitudinal sections of the roots; cutting in the buccolingual direction. After sectioning, the split root segments were observed under a light microscope at X4 magnification. The digital images were captured by a camera connected to the microscope (Olympus CX41 microscope, OLYMPUS CORPORATION, JAPAN) (Figures 2a and 2b). The outcome variable (microleakage around root filling in apical area) was recorded by measuring the amount of dye penetration from coronal side to the apex, (in millimeters).

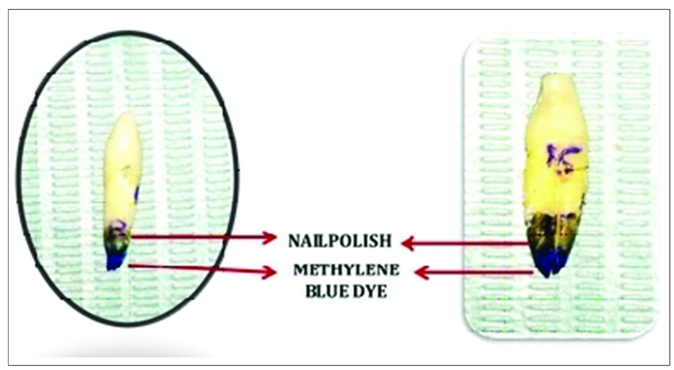

Figure 1: Specimen after application of two coats of nail polish and immersion in methylene blue dye.

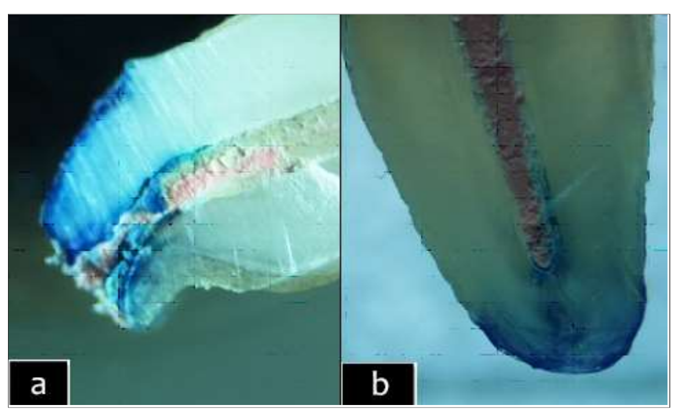

Figure 2: Digital images of specimen as seen under the microscope at 4X magnification:
a. Group I (Obtura II and Sealapex).
b. Group II (Obtura II and AH Plus).

Table I: Apical dye penetration in millimeters according to the arch type.

Study Group	n	Minimum (mm)	Maximum (mm)	Mean (mm)	Standard deviation	p-value
Maxillary	30	0.18	4.40	1.58	1.06	0.87
Mandibular	40	0.00	3.68	1.54	1.04	

Independent sample t-test was applied at 5% level of significance.

Table II: Comparison of dye penetration in the experimental groups.

Study Group	n	Minimum (mm)	Maximum (mm)	Mean (mm)	Standard deviation	p-value
Obtura II & Sealapex	35	0.00	4.40	1.91	1.15	0.003
Obtura II & AH Plus	35	0.00	3.45	1.20	0.79	

Independent sample t-test was applied at 5% level of significance.

Data analysis was done using SPSS 20.0 (by MML and FRK). Mean and SD of the continuous variables were computed. Frequency distribution of the categorical variables was determined. To assess inter-examiner reliability 7/70 (10%) samples were selected at random and assessed by a second evaluator. The inter-examiner reliability was then calculated using Pearson product moment correlation test. Independent sample t-test was used for comparison of microleakage in the two groups. A p-value of <0.05 was considered as statistically significant.

RESULTS

There were 35 specimens in each of the two experimental groups, giving a total of 70 readings. The two groups had 30 maxillary and 40 mandibular teeth. The mean length of maxillary and mandibular teeth was 21.95 ±2.23 mm and 19.69 ±1.89 mm, respectively. As shown in Table I, maxillary teeth exhibited slightly higher dye penetration compared to the mandibular teeth, but the difference was not statistically significant (p=0.87). The mean microleakage around Obtura II-Sealapex group was 1.91 ±1.15 mm. This was higher than the Obtura II-AH plus group, i.e. 1.20 ±0.79 mm (Table II). A statistically significant difference was observed between the two groups (p =0.003). For inter-examiner reliability, 7/70 samples (10%) were randomly selected and assessed for dye penetration by a second evaluator blinded of the original set of readings. The correlation coefficient turned out to be 0.78, (p=0.03) showing an excellent correlation among the measurements done by the two independent evaluators.

DISCUSSION

The present study evaluated sealing ability of two different sealers; AH Plus (resin based) and Sealapex (calcium hydroxide in salicylate base); when used in combination with thermoplasticized injectable gutta-percha as the core obturation material.

Out of the two groups, the higher mean apical leakage in this study was recorded in the Obtura II-Sealapex group. Sealapex has been used along with gutta-percha since 1980's to obturate the root canal space. Numerous studies have been conducted on the microleakage associated with Sealapex and have reported varying results. The seal provided by Sealapex has been found to be adequate at the time of obturation, but deteriorate over time.[7,8] This can be attributed to the higher solubility of the sealer when in contact with tissue fluids. In comparison to the resin based sealers, Sealapex has shown a higher apical leakage, similar to the results of this study.[8]

Obtura II used with AH plus sealer exhibited lesser amount of microleakage values. This can be attributed to the properties of the resin based AH plus sealer. The relatively better mechanical properties of AH plus compared to Sealapex, and more importantly the adhesive nature of the resin based sealer that results in a better bond to dentin explains the better sealing ability of the apical area with this sealer.[9,10] Rather than undergoing setting shrinkage as seen with some sealers, AH plus sealer undergoes up to 1.0% setting expansion suggesting better adaptation and subsequently lesser leakage at the tooth-filling interface. The low solubility of AH plus can also be a reason for its enhanced sealing ability.[11,12]

In contrast, some studies have concluded that both the AH plus and Sealapex sealers resulted in comparable microleakage values with no statistically significant difference in the two groups.[5] Such inconsistencies in outcomes may be as a result of different methodologies and varying sample size in different studies. Pommel *et al*. assessed the apical leakage on the same teeth by three dissimilar methodologies, and concluded that there was a strong influence of the testing technique on the test results.[13]

In the present study, linear measurements from the apical foramen to the coronal level of dye penetration were recorded to quantify the seal provided in the two experimental groups. Various other techniques reported in literature for microleakage assessment of obturated root canals include fluid filtration, bacterial and glucose penetration, radioisotope penetration and scanning electron microscopy. According to Wu *et al*.,[14] over 80% of leakage studies related to endodontics have employed radioisotope penetration or dye penetration.

When using dyes, 2.0% methylene blue is favored for microleakage evaluation for its cost effectiveness and easier to perform with minimum of armamentarium. Methylene blue was favored as its molecular size is analogous to a bacterial by-product, i.e. butyric acid, that is said to leak from diseased root canals, leading to periapical irritation.[15,16]

In this study, incremental obturation was carried out, with the thermoplasticized gutta-percha compacted vertically in between every increment so as to decrease the voids within the gutta-percha mass and at the gutta-percha-dentine interface that might otherwise form because of shrinkage of α-gutta-percha on cooling.

In this study, the amount of dye penetration was measured in millimeters on calibrated digital images captured by a camera connected to the microscope. This quantitative measurement aids in precise assessment of microleakage as evaluated by the penetration of dye through the apical foramina. Comparable methodology for measurement of dye penetration has been done in several other studies.[15,17-20] Variations to the methodology have been suggested and performed whereafter immersion of obturated root canals in the dye, the teeth were treated with nitric acid to demineralize the tooth, thereby achieving transparency and permitting a better three-dimensional evaluation of dye penetration.[4,5,21,22] Instead of longitudinal section, a few authors have suggested transverse sectioning of the roots at predetermined distances from the apex to assess the dye penetration at each level.[23,24] Transverse sectioning is considered as more damaging than longitudinal sectioning. Although it allows a better visualization of the dye penetration, the objective measurement of dye penetration in these sections is more difficult to measure with accuracy. The tracer dye may also be lost as a result of coming in contact with the different solutions used for clearing of teeth.[25]

The present study addressed a relevant research question regarding the decision making of obturation. For obturation of single-rooted teeth where thermo-plasticized obturation is planned, we recommend AH plus as the preferred sealer.

CONCLUSION

Within the limitations of this study, Obtura II with AH plus sealer was a superior combination than Obtura II with Sealapex in terms of dye permeability.

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