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Evaluation of dentinal wall adaptation ability of two recently introduced silicate based root canal sealer: A stereo microscopic study

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Abstract
Aim: The purpose of this study was to evaluate and compare the dentinal wall adaptation ability of two recently introduced silicate-based root canal sealer
Materials and Methods: 24 extracted human maxillary single rooted teeth with intact roots were selected. The crown portion removed followed by canal preparation up to F3 PTG. The teeth were then randomly divided into two groups and dentinal wall adaptation ability was studied under stereomicroscope.
Results: The statistical analysis showed no significant difference between two sealers in terms of gap formation ($P > 0.05$). Both the groups at some level or the other exhibited some degree of gap formation.
Conclusion: Bioceramic sealer Hiflow has a similar dentinal wall adaptation ability as Endosequence MTA.

Keywords: Dentinal wall Adaptation, gap formation, Endosequence MTA, stereo electron microscope

Introduction

Along with a proper root canal preparation and disinfection, an effective obturation guarantees a long-term successful endodontic treatment [1]. It is well known that microleakage between the root canal filling and root-canal walls may adversely affect the results of root-canal treatment.

Therefore, complete obturation of the root canal with an inert filling material and creation of a good apical seal have been proposed as goals for successful endodontic treatment [2]. A sealer associated with gutta-percha is generally used to achieve an impervious apical seal. The most common orthograde obturating method world-wide is gutta-percha. As, gutta-percha by itself cannot obturate the complete root canal system three dimensionally due to its poor sealing properties hence a sealer is used in conjunction with gutta-percha [3]. Besides sealer also fills the irregularities left by Gutta-percha in main canal and also fills lateral canals. Thus, all contemporary obturating techniques make use of the sealer to enhance the seal of the root canal filling [4].

Endosequenc BC sealer HiFlow (Brasseler, Savannah, GA, USA) is a recently introduced bioceramic sealer based on calcium silicate composition. It is available as premixed, injectable paste containing water-free thickening vehicles and has excellent flow ability and dimensional stability. It utilizes the moisture that remains within the dentinal tubules to initiate and complete its setting reaction.

Mineral trioxide aggregate (MTA)-based sealers have been introduced in order to achieve biologic properties and a proper seal with MTA. One of these sealers is Endoseal MTA (Wonchu,Korea) which is presented as premixed syringe. This sealer has good sealing ability, bactericidal effect, and biocompatibility with low solubility and low setting expansion.

Stereo electron microscope (SEM) device which allows ultrastructural analysis interface between filling material/dentin wall and this method enables the evaluation of the presence of gaps.

Hence a study was devised to evaluate the dentinal wall adaptation ability of the two recently introduced silicate based root-canal sealers using stereomicroscope.

Materials and Methods

The *in-vitro* stereomicroscopic study was conducted to evaluate effectiveness of dentinal wall adaptation ability of different root canal sealers. A total of 24 single rooted extracted human teeth with a single root canal were selected.

Inclusion Criteria: Single-rooted extracted human permanent teeth with a single root canal were included in this study.

Exclusion Criteria: Preoperative radiographs were taken and radiographs were screened and teeth were excluded if any of the following were noted:

- If the curvature was greater than 5 degrees,
- If a root fracture was evident,
- If the apex was incompletely formed or larger than a #25 K-type file,
- If any bifurcating canals, fins, ribbon-shaped canal, or extreme calcifications could be seen.

The teeth were stored in 1% sodium hypochlorite (NaOCL) solution, for three days to remove organic debris and then they were stored in distilled water. The crowns were removed at the cement-enamel junction using a high-speed fissure bur. Access preparation was done using an endo-access bur (Dentsply Maillefer, USA) and a barbed broach (Dentaire, SA) was used to remove the pulp. Then, a no.10 - K-file (Mani, Japan) was introduced into the canal and was pushed towards apical part until the tip of the instrument was just visible at the apical foramen. This length of the file was recorded and then after subtracting 1mm from the recorded length, working length of the root canal was determined.

The canal was cleaned and shaped with Protaper F3 (Dentsply). After each instrument was used, the canals were irrigated with 2ml of 5% NaOCl and 2ml of 15% solution of EDTA (Dental Source, North Hollywood CA, USA). The irrigating solutions were delivered through a 25-gauge needle which was placed as far as possible into the canal without allowing the needle to touch the canal walls. The total amount of irrigant used in each canal was 30 ml, on completion of the instrumentation process, a 10 no. K-file (Mani, Japan) was passed 1mm through the apical foramen to remove any dentinal plugs and to ensure that the foramen was patent for dye penetration.

After drying the canals with paper points, matching gutta-percha cones (Dentsply, China) were selected as master points. The fit of each master point was assessed by radiographs to determine whether the point was fully seated to the working length. The teeth were randomly selected and divided into two groups of 30 teeth each. The sealers used were as follows-

Group 1: Endo Seal MTA

Group 2: Bioceramic sealer Hiflow

Single cone obturation technique was employed in both groups. Radiographs were taken to evaluate the obturation. Obturation was considered to be optimum when no voids were present in the radiograph. If the voids appeared in the radiograph, re-obturation was done.

The access cavities were sealed with Cavit G (3M ESPE, Germany) up-to 2 mm and the teeth were placed in a Humidifier (ICU Safe, Sanyo, Japan) for 1 week with 100% humidity at 37˚C to ensure that the sealer set in an environment that simulate the clinical situation in which they are designed to be used.

The experimental samples were sectioned longitudinally by means of a low-speed circular diamond saw (Confident, India) in a path roughly parallel to the axis of the tooth and through the apex with a coolant. After sectioning, the samples were studied under a stereomicroscope (500X &1000X Magnification, Carl Ziess). The gaps between the root canal sealer and canal walls were detected and measured in coronal, middle, and apical thirds. For each section, the highest value among the detected gap formations was taken into account and recorded. The gap sizes were recorded in millimicron (μm).

Statistical Analysis

The obtained results of experimental groups were compared by using Mann-Whitney U-test. In every group, three root sections were compared with each other by using Freidman and Wilcoxon tests.

Results

Table 1: The minimum and maximum gap size values, mean values, and standard deviations for Groups 1 and 2

Section C-M-A	Group	n	Minimum dap size (pm)	Maximum gap size (pm)	Mean (pm)	SD (pm)	P
C	1	12	4.32	330.21	95.54	93.64	0.63
	2	12	41.27	188.64	88.45*	43.61	
M	1	12	5.06	442.21	106.13*	116.26	0.31
	2	12	30.16	494.42	138.14*	130.18	
A	1	12	20.78	463.63	190.22*	161.67	0.71
	2	12	20.05	657.81	226.85*	184.06	
Mean	1	12	10.05	412.01	130.49	99.15	0.51
	2	12	30.49	446.95	151.15	92.67	

The statistical analysis showed no significant difference between two sealers in terms of gap formation ($P > 0.05$). The maximum and minimum gap size values in each section, mean values, and standard deviations for both groups are shown in Table 1. In Group 1, no difference was found between apical, middle, and coronal thirds of the root canals ($P > 0.05$). In Group 2, apical thirds demonstrated a high amount of gap formation when compared to coronal thirds ($P = 0.028$). The middle thirds did not show any significant difference when compared to coronal and apical thirds.

Discussion

The selection of sealers is dependent on its capacity to create a comprehensive seal but it must also be well accepted by peri-radicular tissues and be comparatively easy to manipulate so that its optimum physical and biological properties can be

clinically achieved. In principle the core material should push the less viscous into unreachable areas such as canal anastomosis, apical delta and into irregularities produced through canal preparation.[5] The sealing ability of various root canal filling materials and root canal sealers have been studied and it has been found that dissimilar constituents seal the canal to different extents [6] Preventing contaminationor recontamination of the root canal system after completion of endodontic therapy is still a challenge for the dental professional. In the absence of impermeable sealing of the root canal system, failure of endodontic therapy may ensue [7].
The single-cone technique is a viable obturation option in NSRCT when using a tricalcium silicate sealer [8].
The SC technique with calcium silicate sealers is considered less sensitive and has shown equivalent or superior sealing ability compared to the CW technique [9, 11]. There have been conflicting results regarding the quality of root canal filling based on various obturation techniques and sealer materials [9, 12, 13]. Compared to the CW technique, the SC technique generally allows for more sealer and less GP. It is advantageous to obturate teeth with irregular root canals; however, porosity may occur when large volumes of sealers are applied.
Adhesion of root canal sealer to root dentin is a basic requirement of any root filling material 14. Degree of adhesion depends on a multitude of interacting factors, including the surface energy and cleanliness of dentin, and the adhesive's (sealer) surface tension and wetting ability [15]. Clinically, the critical root filling area that is susceptible to bacterial leakage is located at the sealer-dentin interface [16]. In this study, more gaps were observed at the apical level of all sealer types than at the coronal level. This observation was consistent with those of other studies [17, 18]. The discrepancy between the apical and coronal levels might be accounted for by the lower density and diameter of dentinal tubules found at the apical level, resulting in lower sealer penetration [19]. Moreover, difficulty in removing the smear layer at the apical third might act as a physical barrier which interfered with sealer adaptation to root canal dentin [20].
Amoroso-silva *et al.*, Sevimay *et al*. which stated that AH plus sealer was the best sealer regarding adaptability on dentin surface when compared with other sealers. This can be explained by the fact that epoxy resin present in AH Plus can react with the amine group of the collagen network and create a covalent bond between sealer and dentin [21]. On the other hand Zhang *et al*. [22] stated that AH plus sealer was equivalent in adaptability to the bioceramic sealer. Which can be due to the alkaline nature of many bioceramic by-products has been reported to denature dentinal collagen fibers, which then facilitated the penetration of sealers into the dentinal tubules [23].
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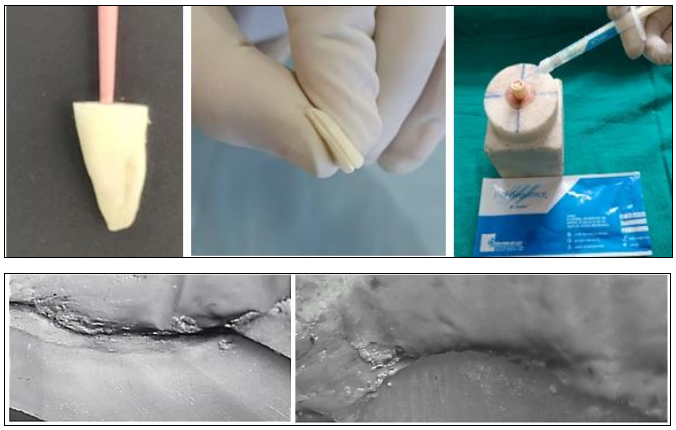
Although number of studies have obtained favorable results with these calcium silicate-based sealers further long-term studies both *in vitro* and *in vivo* with more variables are required to verify same.



These calcium silicate-based sealers further long-term studies both *in vitro* and *in vivo* with more variables are required to verify same

Conclusion

Within limitations of our study both bioceramic hiflow sealers and endosequence MTA showed a similar amount of gap formation in all sections of the root canal. Results of the present study should be interpreted with caution, and need to be investigated further.

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