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# ASSESSMENT OF MARGINAL ADAPTATION OF AH PLUS VERSUS TOTAL FILL BC ROOT CANAL SEALERS WITH TWO DIFFERENT OBTURATION TECHNIQUES USING SEM (AN INVITRO STUDY)

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## *ABSTRACT*

Aim: This *in vitro study* assessed and compared two different root canal sealers with two different obturation techniques in terms of marginal adaptation using SEM

Materials and Methods: Sixty extracted single-rooted lower premolar teeth with closed apices were collected. samples were then de-coronated, and chemo-mechanical preparation were performed. The samples were then equally divided into four main groups ( $n$ = 15 ) according to the root canal sealer and the obturation technique used. Group A: teeth were obturated by cold lateral condensation technique with AH-plus sealer. Group B: teeth were obturated by single cone obturation technique with AH Plus sealer. Group C: teeth were obturated by cold lateral condensation technique with Total fill BC root canal sealer. Group D: teeth were obturated by single cone obturation technique with Total fill BC root canal sealer. Specimens were then transversely sectioned. Marginal adaptation to the dentin of root canals was assessed at coronal, middle & apical thirds with the aid of scanning electron microscopy (SEM). Then, marginal gap scores were assessed.

Result: The data were statistically analyzed by Two-way ANOVA and Three-way ANOVA tests to test the interactions between different variables. The lowest marginal gap value was observed in Group C while the highest marginal gap value was observed in Group B. Coronal thirds revealed superior marginal adaptation in comparison with middle and apical thirds within the different groups.

Conclusions: Within the limitation of this study, bio-ceramic sealers are reliable and promising root canal sealers that markedly improve the marginal adaptation. Moreover, obturation techniques also had an impact on the marginal adaptation of the root canal sealer to the dentin walls of the root canal. Cold lateral compaction technique is considered a reliable technique that improves the adaptation to the root canal dentin walls.

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## INTRODUCTION

The ultimate purpose of root canal obturation is to form a tight barrier to protect the apical tissue against various bacteria and their toxins. Moreover, its mandatory to guide all the efforts for prevention of reinfection[1]. Combination of a core material like Gutta-percha and root canal sealers are commonly used to achieve these goals. The main purposes of root canal sealers are to block off patent accessory canals and the voids. Also, creating a bond between gutta percha and root canal dentin to prevent leakage[2]. Leakage is considered an important reason for the clinical failure of root canal treatment. Therefore, leakage studies still of great importance for determining factors affecting the sealing properties and therefore the improve the prognosis of the endodontic therapy[3]. AH Plus is an epoxide-amine resin based root canal sealer characterized by superior working consistency and because it is slightly thixotropic, it flows better under pressure. Moreover, AH-Plus is heat tolerant and the setting reaction is not adversely affected during thermoplastic obturation. The small filter size and film thickness combined with the its high flow rate allow for superior adaptation to the entire root canal system[4]. The new era of root canal sealers have been introduced into the market based on calcium silicate as MTA Fill-apex, Ceraseal, Total Fill BC, and the recently introduced AH-Plus BC. Bioceramics form hydroxy apatite during setting reaction and superiorly chemically bond the sealer with the root canal dentinal walls[5]. Cold lateral compaction technique of obturation is commonly used by some clinicians throughout the world to fill the root canals due to its simplicity, cost effective and adaptability to most cases. It is considered the standard obturation technique for the assessment and evaluation of other different techniques of obturation[6]. The single cone obturation technique is usually used due to its ease of use, shorter time of technique and good adaptation to the dentinal walls in comparison with the cold lateral compaction technique[7].

## MATERIALS AND METHODS

### 1. Teeth selection

Sixty recently extracted single-rooted lower premolar teeth were collected. The samples were then examined using stereomicroscope and radiographically from buccal and proximal views to confirm the following criteria:

***Inclusion criteria:***

- Teeth with intact roots and mature apices.
- Teeth with straight single root canal.
- Roots without signs of cracks or fracture or caries &external resorption.
- No evidence of calcification or internal resorption in the root canals.
- Teeth have no previous root canal treatment.

***Exclusion criteria:***

- Teeth with rapid apical curvature .
- Teeth with more than one root canals.
- Teeth with previous root canal treatment.
- Teeth with evidence of root caries, cracks or fractures.
- Teeth with any abnormalities as internal, external resorption or root canal calcification.
- Teeth with incompletely formed root (open apices).

### 2. Preparation of teeth:

The samples were properly washed off debris & remnants and then stored in normal saline solution (0.9% NaCl). All the specimens was decapitated at the (CEJ) using diamond disk in a low-speed hand piece under constant water cooling and the length of all roots was standardized to be 17mm.

### 3. Root canal instrumentation:

The canal patency was performed with K file #10 and the canal length was measured when the

#10 k-file tip is just apparent from the AF. WL was then identified by subtracting 1mm. Mechanical preparation was performed in a crown down manner using rotary Pro-Taper Next file system up to X3. In between the files the irrigation was performed with NaOCl 2.6% & EDTA 17%. Finally the canals were flushed with 2 ml NaOCl (2.6%) followed by 2 ml (EDTA, 17%) for to remove the smear layer and then rinsing with saline %ml followed by paper point dryness of the root canals.

**4. Sample grouping:**

The selected specimens (n= 60) were equally divided into four main groups(15 each) according to obturation technique and the type of root canal sealer.

**Group A: C**old lateral condensation technique & AH-Plus sealer.

**Group B:** Single cone obturation technique & AH-Plus sealer.

**Group C:** Cold lateral condensation technique & Total-fill BC sealer.

**Group D:** Single cone obturation technique & Total-fill BC sealer.

**5. Root canal obturation :**

***Group A : Cold lateral condensation technique & AH-Plus sealer:***

Root canals were filled using cold lateral condensation technique with gutta-percha points (# 30/0.02 ) and AH-Plus RC sealer. The master cone was precisely selected visually and radiographically to fit to the full WL. The AH Plus sealer was supplied in two tubes, equal volume units(1:1) of paste base and the catalyst were mixed on glass slab using plastic spatula to a homo-geneous consistency after mixing the sealer put onto a mixing pad.

The canal walls were coated with sealer where, the sealer was added on the master cone which moved vertically up and down inside the canal to ensure full coating of the canal wall by the sealer.

The cone was then removed from the canal and reloaded with the sealer and permanently seated. A spreader of a suitable size(#25) was introduced to within 2 mm shorter than working length then auxiliary cones (#25, 0.02 taper) placed in spaces developed by the spreader. The procedure was repeated, and the root canals were adequately filled when the spreader no longer penetrated beyond the coronal 2 mm of the canal .

***Group B : Single cone obturation technique & AH-Plus sealer:***

Root canals were filled using single cone obturation technique by proper selection of gutta percha master cone (ProTaper Next gutta percha) corresponding to the same size as the master apical file (X3) and AH plus resin root canal sealer.

Prior to obturation, ProTaper next gutta-percha size X3 fitness was checked radiographically & for tug-back to the full WL of root canal. AH-plus sealer base and the catalyst were mixed till forming a mix with homogenous consistency. The mixed sealer was introduced into the canal through the sealer coating the MC to the full WL.

***Group C : Cold lateral condensation technique & Total-fill BC sealer:***

Root canals were filled using cold lateral condensation technique with gutta-percha points (# 30/0.02 ) and Total-fill bioceramic sealer. The sealer used with this group was Total fill Bioceramic sealer, this sealer was supplied in a premixed injectable syringe with disposable tips . The syringe cap was removed from the syringe. Then, a disposable tip was securely attached with a clockwise twist to the hub of the syringe.

The sealer was injected into the canals by disposable Intra canal tips as recommended by the manufacturer in which an adequate amount of the material was gently and smoothly dispensed by compressing the plunger of the syringe. The material was dispensed while withdrawing the disposable

tip avoiding the formation of air bubbles. Sealer coating the MC and then placed into root canal by a slow up and down action against the canal walls; this ensured the complete coating of the canal walls with sealer. The cone was then removed from the canal and reloaded with the sealer and permanently seated into the canal. Cold lateral condensation utilizing spreader and adding accessory cone was done as illustrated previously.

***Group D : Single cone obturation technique & Total-fill BC sealer:***

Root canals were filled with ProTaper Next GP (X3) & Total fill BC sealer by the single-cone obturation technique.

Prior to obturation, ProTaper next gutta-percha size X3 fitness was checked radiographically & for tug-back to the full working length of root canal.

Total fill BC root canal sealer was introduced directly into the canal according to the manufacturer's directions through a disposable tip attached to a premixed syringe. The canal walls were coated with sealer where, and the master cone moved vertically up and down inside the canal to ensure full coating of the canal wall by the sealer.

In all tested specimens, the remaining excess of the GP was cut off using hot condenser and the canal orifices were sealed with a glass ionomer. A radiograph was taken for confirmation of proper condensation and absence of any voids.

Each root specimens were stored in gauze dampened with sterile saline and enclosed in sealed tube at room temperature for 1 week for proper sealer setting.

**6. Scanning electron microscopic evaluation:**

After 7 days; every sample was transversely sectioned cervical, middle, and apical thirds at 3, 6, and 9 mm from the apex. All the samples were dehydrated by increasing concentrations of ethyl alcohol (30%, 50%,70%, 90%, and 100%). Then the specimen were mounted in aluminum stubs, gold coated with sputtering system under vacuum desiccation, and properly examined under scanning electron microscope(SEM) .

Photomicrographs were taken at a magnification power of ×2000. Then, the internal gaps (width) in-between the obturating material and the dentinal walls at three randomly selected points in each root specimen and at three different levels (apical, middle, and coronal) were measured in micrometer(micron) using imaging tool in software of electron microscope to evaluate adaptability of tested root canal sealers.

SEM images of each sample analyzed using image tool 3.00 used for measuring gaps area, width, and length to evaluate adaptability of tested root canal sealers.

**RESULTS**

The interactions between different variables were tested through Two-way ANOVA and Three-way ANOVA tests.

Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows. The significance level was set at $P \leq 0.05$.

**1. Effect of thirds:**

Coronal third revealed better marginal adaptation when compared to middle and apical thirds in the different groups.

The highest marginal gap was seen in Group B while Group C showed the least marginal gap.

**2. Effect of obturation technique:**

No statistically significant differences was found between (Cold lateral compaction) and (Single cone) groups ( $p = 0.603$ ).

The highest mean value was revealed in (Single cone), while least mean value was seen in (Cold lateral compaction).

TABLE (1): The mean, standard deviation (SD) values of marginal adaptation of all groups.

| Var. | Marginal adaptation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group A AH Plus &ISO GP by Cold lateral compaction | | Group B AH Plus &ProTaper Next GP by Single cone technique | | Group C BC&ISO GP by cold lateral compaction | | Group D BC &ProTaper Next GP by Single cone technique | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **Coronal** | 2.20 | 0.20 | 2.40 | 0.30 | 1.70 | 0.17 | 2.00 | 0.10 |
| **Middle** | 3.44 | 0.15 | 3.48 | 0.29 | 2.21 | 0.50 | 2.27 | 0.05 |
| **Apical** | 3.50 | 0.10 | 3.62 | 0.16 | 2.24 | 0.04 | 2.30 | 0.18 |
| ***p-value*** | **<0.001*** | | **0.001*** | | **0.023*** | | **0.011*** | |

***; significant (p<0.05)** **ns; non-significant (p>0.05)***

TABLE (2): The mean, standard deviation (SD) values of marginal adaptation of different groups.

| Var. | Marginal adaptation | | | | p-value |
|---|---|---|---|---|---|
| | AH plus sealer | | BC sealer | | |
| | Mean | SD | Mean | SD | |
| **Cold lateral compaction** | 3.05 | 0.64 | 2.05 | 0.38 | <0.001* |
| **Single cone technique** | 3.17 | 0.61 | 2.19 | 0.18 | <0.001* |
| ***p-value*** | **0.603ns** | | **0.212ns** | | |

***; significant (p<0.05)** **ns; non-significant (p>0.05)***

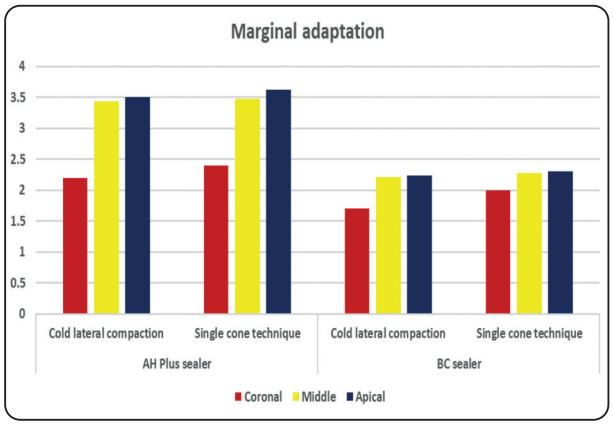


Fig. (1): Bar chart representing effect of thirds on marginal adaptation for different groups

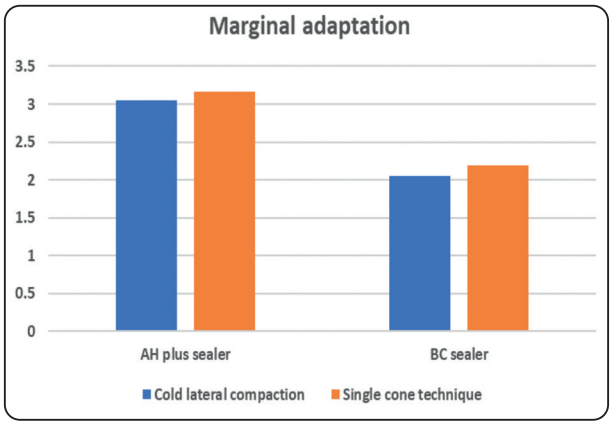


Fig. (2): Bar chart representing marginal adaptation for different groups (A)

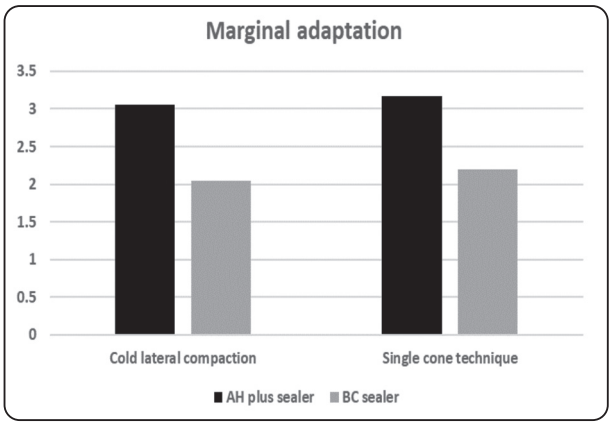


Fig. (3): Bar chart representing marginal adaptation for different groups(B)

**3. Effect of sealer:**

A statistically significant difference was found between (AH-plus sealer) & (Total-fill BC sealer) groups ( $p < 0.001$).

The highest mean value was revealed in (AH plus sealer), while the least mean value was found in (Total-fill BC sealer).

## DISCUSSION

The ultimate goals for endodontic treatment are a prevention and elimination of the pulpal/periradicular pathosis and to preserve the natural dentition when affected by pathosis .[8] The main goal of obturation technique is to perform an adequate 3D seal, thus preventing the reinfection of the root canal system and promote healing with healthy condition for the surrounding periapical tissues[9]. Any defect in obturation is considered the most common cause of failure in endodontics. Various obturating techniques and materials have been advanced to increase the success rate of root canal treatment[10]

The main purpose of our study was directed to assess and compare the marginal adaptation of AH-Plus (resin-based root canal sealer) versus Total-fill BC (Bio ceramic-based sealer) to root canals (different root canal sections) that obturated with two obturation techniques (Lateral condensation and single cone techniques) using scanning electron microscope (SEM).

Root canal sealer has a great importance, because a sealing material is essential to adhere the GP to the root canal dentin walls and to seal the lateral and accessory canals, void, and dentinal irregularities.[11]therefore enhancing the adaptation of the root canal obturation materials at the dentin-material interface[12]

AH-plus, one of the most commonly used epoxy resin-based root canal sealers has gained its popularity due to its tight sealing capabilities in terms of low shrinkage, low leakage and an extraordinarily high adhesion to root canal dentin. Moreover, its superior radiopacity and biocompatibility when compared to other root canal sealers.[13]

The Total fill BC sealer is water-based sealer it has good antibacterial activity, excellent sealing ability and bond strength, good flowability, low shrinkage, and insoluble properties[14]. It has fine particle size, it consumes moisture in dentinal tubule to harden and set. Moreover, BC sealer is anti-bacterial during setting due to its high alkaline pH and unlike traditional sealers, it exhibits zero shrinkage. [15]

Cold lateral obturation technique (CL) is a widely used technique, but it gives poor compaction of GP core material to the walls of the root canal dentine canal, non-homogenous, within the cones had gaps.[16]But, this technique is still the used for comparison purposes in many studies of new obturation systems.[17]

With the advancement of the rotary instrumentation systems, the single cone (SC) has been greatly used.[18]This technique uses larger master cone that to the highest degree match the geometry of the nickel–titanium (NiTi) rotary systems. When the root canal is prepared by rotary instruments, gutta-percha point is used without accessory points[19] This technique accelerates the root canal filling with minimum application of pressure on the canal walls.

[20]The most important disadvantages of SC appear when the cone was not adaptable with canal irregularities at the root canal's coronal and middle thirds. Consequently, sealer accumulates in these areas and also more sealer will be required resulting in poor marginal adaptation, porosities, setting contraction, and dissolution of the sealer[21]

In this study regardless of the obturation techniques , the greatest marginal adaptation was revealed by Total Fill BC root canal sealer followed by AH plus resin based sealer. This may be due to the alkalinity of the calcium-silicate sealant moisturizing ingredients that have been stated to degenerate the collagenous element of the intermediate dentin, that may then promote the infiltration of the plugs into the dentinal tubules.[22] . Also, the BC is hydrophilic, and has a small contact angle which allows the sealant to easily cap the channel wall improving the degree of adaptation[23]. Moreover, the exceptionally-fine particle size and proper premixed texture may have improved its infiltration capabilities into the dentinal tubules providing better adaptation and adhesion to the root canal dentinal walls.[24]

Regardless of the tested sealer used, the better marginal adaptation was revealed by (CL) condensation technique of obturation, followed by (SC) obturation technique. The most important disadvantages of SC appear when the cone was not adaptable with canal irregularities at the coronal & middle thirds of the canal. Consequently, sealer accumulates in these areas and also more sealer will be required resulting in poor marginal adaptation, porosities, setting contraction, and dissolution of the sealer.

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