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Comparison of apical sealing ability of lateral compaction and single cone gutta percha techniques using different sealers: An *in vitro* study

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ABSTRACT

Aim: To compare apical sealing ability of lateral compaction and single cone gutta-percha techniques in root canals obturated using three different resin-based root canal sealers.
Material and method: Seventy single-rooted human premolars were endodontically treated using hand protapers. The samples were divided into three groups, that is, group I ($n = 20$): AH Plus sealer; group II ($n = 20$): MetaSEAL sealer and group III ($n = 20$): GuttaFlow2. On the basis of obturation technique, each group was further subdivided into two subgroups of 10 each: subgroup A: single cone and subgroup B: cold lateral condensation. All the specimens were immersed in methylene blue dye for 24 h, and then the teeth were sectioned longitudinally. Apical leakage was measured under a stereomicroscope. The data were subjected to statistical analysis using Kruskal–Wallis test and Mann–Whitney *U* test.
Results: Lateral condensation showed significantly less leakage than single cone technique could do. GuttaFlow2 showed the least apical leakage followed by MetaSEAL and then AH Plus. The difference between all the groups was statistically significant except between GuttaFlow2 and MetaSEAL.
Conclusions: The apical sealing ability of lateral condensation was better than the single cone technique. GuttaFlow2 showed superior sealing ability as compared to MetaSEAL and AH Plus in both lateral compaction and single cone technique.

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1. Introduction

The purpose of the root canal obturation is to provide a suitable seal of the canal space to prevent further ingress of tissue fluids, bacteria and their by-products.[1] Lateral compaction of cold gutta-percha is a commonly used technique owing to its simplicity and adaptability in most cases and is often used as a standard to compare new techniques. Even though warm vertical compaction is the standard technique used, but it is difficult to apply, requires longer time,[2] and may cause apical extrusion of gutta-percha.[3] Nowadays, there is an increasing demand for prompt and efficient obturation technique, which improves practice and causes less stress

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for patients and clinicians. With the widespread use of rotary NiTi instruments and matched-taper Gutta-percha cones, the single-cone obturation technique has become popular.[4]

The advent of contemporary root canal sealing systems that claim to create bonds along the sealer–gutta-percha interface via modifications of the sealer or the root filling material may also support the use of a single-cone obturation technique.[5]

Some of the new root canal filling systems have been recently developed such as MetaSEAL, AH Plus and GuttaFlow2 systems, which may encourage the practitioners to use the single-cone obturation technique.

Epoxy resin sealers are popular because of their reduced solubility, their apical seal and their micro-retention to root dentine.[6] AH Plus (Dentsply Maillefer, Ballaigues, Switzerland) is a silver-free epoxy-based sealer used in conjunction with gutta-percha in various root-filling techniques.

Gutta-flow (Coltene/Whaledent, Altstatten, Switzerland) is an alternative root-filling material recently introduced into the endodontic practice. It is a cold-flowable, self-curing material composed of gutta-percha powder, polydimethylsiloxane and silver particles. It has a better seal and good adaptability because of its high flowability and setting expansion.[7]

A self-adhesive, dual curable methacrylate resin-based sealer MetaSEAL (Parkell Inc., Farmington, NY) has recently been introduced commercially. The sealer purportedly bonds to thermoplastic root-filling materials as well as radicular dentine via the creation of hybrid layers in both substrates.

There are several methods for evaluating the apical sealing of root canal sealers, such as bacterial penetration,[8] fluid transport,[9] clarification,[10] penetration of radioisotopes,[11] electrochemical methods[12] and gas chromatography.[13] Dye penetration tests; however, seem to be the most widely used.[14]

Till date, no study has compared the sealing ability of these three sealers used with lateral and single-cone obturation techniques.

Hence the present study was formulated with the aim to evaluate and compare the apical sealing ability of lateral compaction and single cone gutta-percha techniques in root canals obturated using three different resin-based root canal sealers. The null hypothesis tested was that there is no difference in the apical seal of a root canal obturated with the two different techniques.

2. Methodology

Seventy, single rooted human mandibular premolars, were used in the study. The teeth having cracks, extensive carious lesions, immature apices and resorption were excluded. The teeth were decoronated using a diamond disc under water cooling, so as to obtain a final dimension of 14 mm. A size 15 K-type file was used to establish apical patency. When the tip of the file was visible flush with the apical foramen, its length was recorded; the working length was defined to be 1 mm less than the measured length. Biomechanical preparation of the canals was done using hand ProTaper instruments in a sequential order from S1 to F3. During preparation and between each instrument, 1 ml of 5.25% NaOCl was used as an irrigant. After the completion of canal preparation, all specimens received a flush of 5 ml of 5.25% NaOCl and 5 ml of 17% EDTA for 1 min to remove the smear layer followed by final rinse with 5 ml of distilled water.

The samples were divided into three groups based on the sealer used for obturation of the root canal, that is

Group I ($n = 20$): AH Plus sealer.

Group II ($n = 20$): MetaSEAL sealer.
Group III ($n = 20$): GuttaFlow2.

On the basis of obturation technique, each group was further subdivided into two subgroups of 10 each ($n = 10$):

Subgroup A ($n = 10$): single cone technique
An F3 ProTaper gutta-percha cone (Dentsply Maillefer) was selected, and its apical portion was adjusted as necessary with a scalpel blade until tugback was achieved. The gutta-percha point was coated with the required sealer and was seated at the working length. Excess gutta-percha was removed with a hot instrument.
Subgroup B ($n = 10$): cold lateral condensation
An ISO size 30 gutta-percha cone was trimmed to give tugback at working length. After the required sealer was placed in the canal, the master cone was coated with sealer and inserted slowly into the canal to the full working length. Lateral compaction with accessory gutta purcha cones was performed. A heated instrument was used to remove excess coronal gutta-percha.

The remaining 10 teeth served as positive ($n = 5$) and negative ($n = 5$) controls.

In the positive control group, biomechanical root canal preparation was done but the samples were not obturated. In the negative control group, biomechanical root canal preparation was done and the samples were obturated with only AH Plus sealer.

All the experimental and control teeth were stored at 37 °C and 100% relative humidity for 48 h to allow time for the sealer to set.

2.1. *Apical leakage test*

Apical leakage was estimated by dye penetration test. The root surfaces of all specimens were coated with two layers of nail varnish with the exception of the apical 2 mm. The root surfaces of the positive control group did not receive a coating of nail varnish whereas negative control teeth were entirely coated with two layers of nail varnish to prevent possible leakage. Specimens were then immersed in 2% methylene blue solution for 24 h at room temperature. After removing from the dye solution, the specimens were washed, and nail varnish was scraped away from the surface. The samples were then sectioned bucco-lingually in a longitudinal direction. The degree of leakage was determined from the root tip to the most coronal extent of leakage, which was evaluated under a 30× stereomicroscope (Olympus, Spectro Analytical Laboratory, Delhi, India) and the reading was measured in

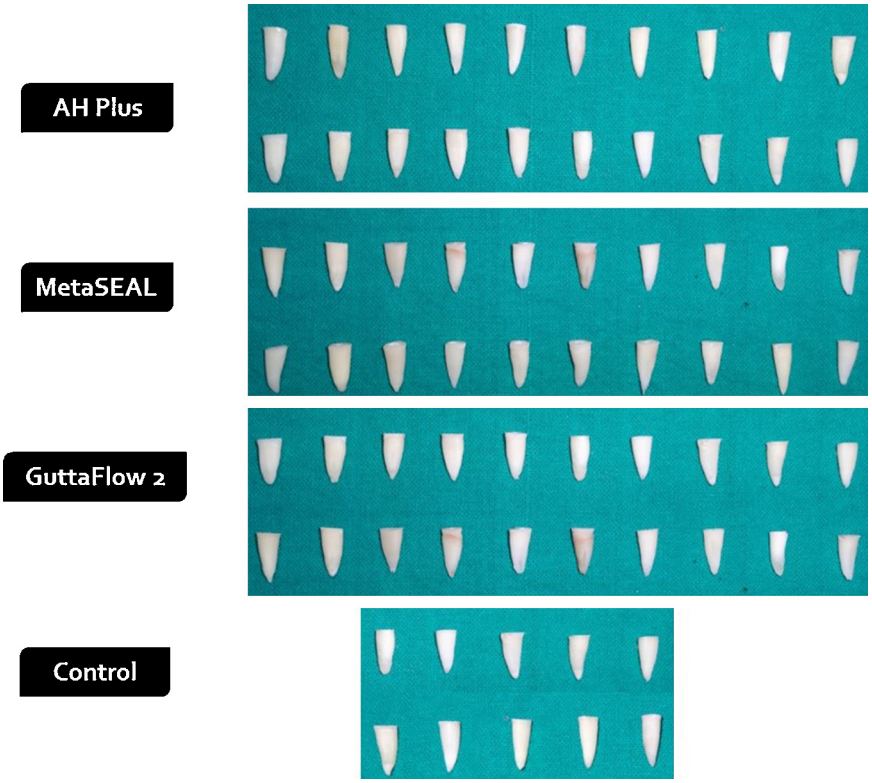


Fig. 1 – Samples after decoronation.

millimetre. The degree of dye penetration was recorded for both the walls of the section which showed relatively greater leakage and the mean was recorded.[10]

The data collected were subjected to statistical analysis using SPSS version 15.0 software (SPSS, Chicago, IL, USA). The level of significance was set at 0.05. Mann–Whitney test was used to check the significance between two groups and Kruskal–Wallis test to check the significance within the group (Fig. 1).

3. Results

Fig. 3 illustrates the leakage scores in all groups (excluding controls).

Excessive amount of dye leakage was seen in the positive control group, and no leakage was detected in a negative control group, which confirmed the functioning and reliability of the study. Fig. 2 shows images of samples showing dye leakage in various groups.

Mean, minimum, maximum and standard deviation of apical leakage of different sealers using two different techniques is given in Table 1.

Lateral condensation showed less leakage than single cone technique in all the three sealer groups, and the difference between them was statistically significant ($p < 0.05$).

Among the three sealers used in this study, GuttaFlow2 showed least leakage values and AH Plus maximum leakage values with both the obturation techniques and the data obtained was statistically significant ($p < 0.05$). However, MetaSEAL showed more leakage values than GuttaFlow2 but the difference was not statistically significant.

4. Discussion

In the present study, dye penetration tests were done as they are easy and fast methods and are common to gauge microleakage of root canal fillings.[15] Methylene blue was used in this study as the leakage marker as it has a low molecular weight and penetrates more deeply along the root-canal filling.[16] Some authors prefer to combine this technique with fluid filtration method[17] while some found bacterial test to offer a better approximation of clinical reality.[18] However, recently this apical microleakage evaluation model has been challenged.[19] According to Robberecht et al., the dye penetration methods provide a realistic imitation of clinical conditions.[20]

In the current study, the cold later compaction was used as a standard to which single-cone obturation technique was compared using three different sealers. The master gutta-percha coating technique was used in this study for sealer placement because of its ease of use and comparable seal to other placement techniques.[21]

In the present study, the null hypothesis was rejected as there was a difference in the apical seal of a root canal obturated by lateral compaction and single cone gutta-percha techniques.

According to the results of this study, the samples filled with single cone technique yielded significantly more leakage

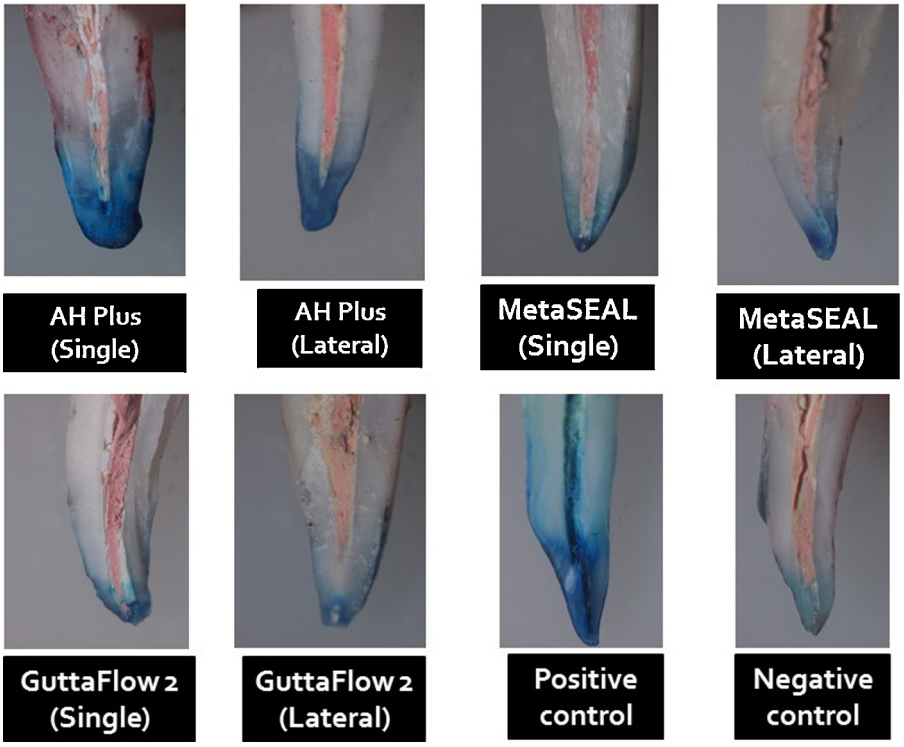


Fig. 2 – Images of samples showing dye leakage in various groups.

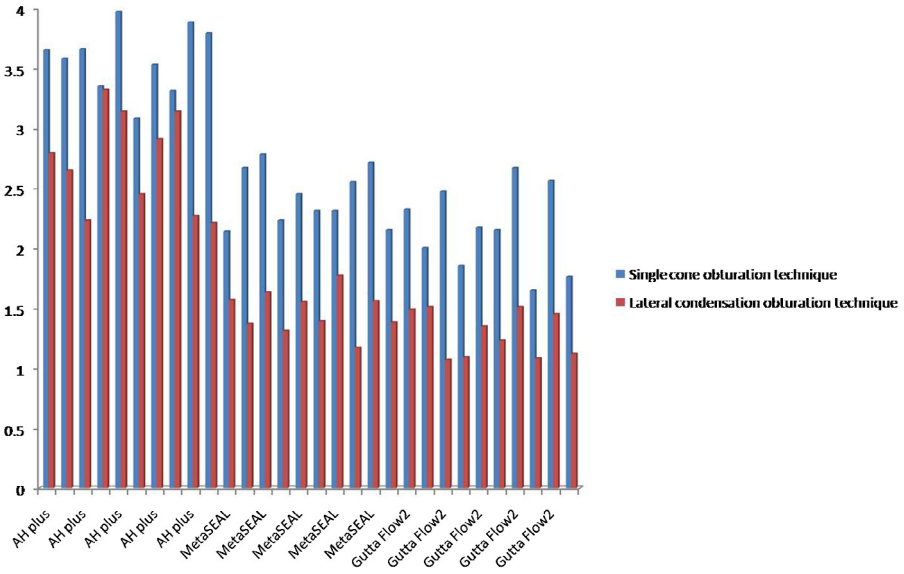


Fig. 3 – Bar diagram showing the distribution of leakage in various groups.

Table 1 – Mean, minimum, maximum and standard deviation of apical leakage of different sealers using two different techniques.

Groups	Single cone obturation technique			Lateral condensation obturation technique		
	Minimum	Maximum	Mean ± SD	Minimum	Maximum	Mean ± SD
AH Plus	3.08	3.97	3.58 ± 0.274	2.21	3.32	2.71 ± 0.412
MetaSEAL	2.14	2.78	2.43 ± 0.236	1.17	1.77	1.47 ± 0.176
GuttaFlow2	1.65	2.67	2.16 ± 0.347	1.07	1.56	1.29 ± 0.191

than the samples filled with lateral compaction technique. The result was in accordance with the studies done by Peak et al.[22] and Wu et al.[23] According to Wu et al.,[23] single cone technique was not compatible with canal irregularities at the coronal and middle thirds of the canal. Peak et al.[22] stated that the porosities in large volume of sealer, setting contraction and dissolution of the sealer have also contributed in more leakage in samples filled with single cone technique.

Zmener et al.[24] and Mokhles[25] reported similar finding in their studies but the difference between the two techniques were statistically not significant.

Contrary to this finding Inan et al.,[26] Ismail et al.[27] and Rajeswari et al.[28] in their study reported more leakage in samples obturated with lateral condensation technique than single cone obturation technique.

According to Inan et al.[26] and Ismail et al.,[27] the reason for more leakage in the samples obturated using lateral condensation technique could be due to the formation of a non-homogenous mass of gutta-percha that poorly replicates the prepared root canal space and does not adequately obturate simulated lateral canals. Additionally, Rajeswari et al.[28] found that lateral compaction technique leaves voids between cones that often are not filled with sealer and may provide a niche for bacteria to thrive.

Some authors[29–31] reported similar leakage with single cone and lateral condensation groups. According to them, in the case of the lateral compaction technique, the spreader penetration causes satisfactory obturation, and in the case of the single cone technique, the cones having the same taper with the rotary nickel titanium instruments provide good apical obturation.

Among the three sealers used in our study, GuttaFlow2 showed the least leakage followed by MetaSEAL and then AH Plus. The difference between all the groups was statistically significant except between GuttaFlow2 and MetaSEAL.

The most probable explanation for low mean leakage scores in GuttaFlow2 sealer would be the setting expansion ,[32,33] flowability[33] and lower solubility of this material.[34] The better sealing ability of GuttaFlow over AH Plus is also in accordance to the studies done by Savariz et al.,[35] Wu et al.,[36] and Bouillaguet et al.[37]

However, Monticelli et al.[38] and Flores et al.[39] found the sealing ability of AH Plus to be better than that of GuttaFlow. According to Monticelli et al.,[38] this could have been due to high-quality properties with epoxy resin-based sealers, including very low shrinkage while setting, long-term dimensional stability, flow, and long setting time. According to Flores et al.,[39] AH Plus sealer penetrates deeper into the surface micro irregularities.

In the present study, MetaSEAL showed good sealing ability than AH Plus. The reason could be because MetaSEAL is a resin-based endodontic sealer that uses 4-META to enhance dentinal penetration and hybridisation. Moreover, formation of secondary monoblock by MetaSEAL due its bonding to gutta percha, as well as root canal dentine could have resulted in better sealing of the canal when compared to AH Plus.

Contrary to this study, Van der Vyver et al.[40] and Belli et al.[41] reported statistically insignificant difference between the sealing ability of AH Plus and MetaSEAL.

In the present study, AH Plus showed maximum leakage. This could be because of the inadequate bonding between the sealer and the gutta-percha point, allowing fluid to flow at the interface.[42] Another reason could be the fast setting and subsequent polymerisation shrinkage of this sealer,[42] and low penetration ability of this sealer within the dentinal tubules,[43] and its hydrophobic property that prevents good adaptation of to the incompletely dried canal.

5. Conclusion

In the light of our findings, the null hypothesis was rejected as there was difference in the apical seal of a root canal obturated with two different techniques. Samples obturated with lateral condensation technique showed better sealing ability than single cone obturation technique. Among the sealers used, GuttaFlow2 showed superior sealing ability as compared to MetaSEAL and AH Plus in both techniques. However, further research is required to validate the findings of the present study.

Conflicts of interest

The authors have none to declare.

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