EVALUATION AND COMPARISON OF THE SEALING ABILITY OF THREE DIFFERENT OBTURATION TECHNIQUES — LATERAL CONDENSATION, THERMOPLASTICISED GUTTAPERCHA, COLD FLOWABLE GUTTAPERCHA: AN IN VITRO STUDY

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Abstract

Aim: Evaluation and comparison of the sealing ability of three different obturation techniques - namely obturated by lateral condensation, using Thermoplasticised guttapercha, with Cold flowable guttapercha, with the help of a stereomicroscope at 40× magnification.

Materials and Methods: Thirty extracted lower first premolar teeth were selected. The canals were shaped with ProTaper rotary files. Irrigation was performed with 5% sodium hypochlorite and 17% EDTA. The teeth were then separated into three groups depending on the type of obturation technique. Group A (number=10)-obturated using the Lateral condensation technique with AHplus sealer, Group B (number=10)-obturated with injection-moldedthermoplasticized technique with AHplus sealer and Group C (number = 10) obturated using cold flowable guttapercha technique. The teeth were stored in 100% humidity for seven days at 37º Centrigade, the roots of the teeth were sectioned at three levels. These sections were then observed under a stereomicroscope at 40 × magnification and the images were analyzed for area of voids (AV) and frequency of voids.

Statistical Analysis Used and results: The data on the voids in the root canals of the teeth were subjected to the 'ANOVA' test using the treatments and sections as explanatory variables. The results indicate that the differences in the voids in the root canals of the tooth were significantly different for the treatments as well as the sections. The post hoc Tukey test indicates that the differences with the three groups were significantly different. Similarly, the apex and cervical sections were significantly different when the post hoc test was considered for the section pairs.

Conclusion: Thermoplasticised guttapercha exhibited the best adaptation with no of voids, as compared to the other two groups and the sealing was dense in all the three sections followed by the lateral condensation group and cold flowable guttapercha group.

Key Words Sealing ability; lateral condensation; thermoplasticisedguttapercha; cold flowable guttapercha, area of voids.

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INTRODUCTION

A key to successful endodontics and a major goal of contemporary root canal treatment is to seal the canal completely. Maintenance of the disinfected status reached by the chemical and / or mechanical cleaning, to prevent reinfection and percolation of bacterial substrates, allowing the periodontium to maintain its integrity and to achieve healing.[1-4] Ingle found that nearly 60% of endodontic failures were due to the incomplete obturation of the root canal system.[5] The most commonly used obturation technique is the cold lateral condensation technique. Voids, spreader tracts, incomplete fusion of the gutta-percha cones, and lack of surface adaptation are some of the drawbacks of this technique.[6] Thermoplasticised guttapercha technique is an injectable, heated guttapercha technique and has been found to be significantly superior to lateral condensation and has a better sealing to the three-dimensional root canal system. It has better adaptation to the canal wall than the lateral compaction method. Guttapercha and sealer enters the dentinal tubules in this technique.[7] Cold lateral condensation technique is a reliable cold filling system for root canals in which-gutta-percha and sealer is placed in root canal in a single application and it also has bioactivity for the healing process. The new root canal filling paste GuttaFlow (Coltene / Whaledent, Raiffeinsenstra, Germany) is a modification of this sealer. It contains gutta-percha particles as a filler. The manufacturer claims a better seal and good adaptability because of the increased flowability and the fact that this material expands slightly on setting.

MATERIALS AND METHODS

Thirty extracted human mandibular single-rooted teeth, with intact crowns, were collected for the study from the Department of Oral and Maxillofacial Surgery, Haldia Institute of Dental Sciences, after visual and radiographic examination. Teeth were disinfected, stored and handled as per the recommendations and guidelines laid down by Occupational Safety and Health Administration (OSHA) and Centers for Disease Control and Prevention (CDC). Teeth that were collected had been extracted for orthodontic reasons. The exclusion criteria from the study included those showing incompletely formed apex, evident root fracture, extreme calcifications, and extreme canal curvatures. The teeth were divided into three groups of 10 teeth each, using stratified randomization. The teeth were stored in distilled water during the entire study.

Canal preparation:

Conventional access cavities to the pulp chamber were prepared. The working length was defined to be 1 mm short of the apical foramen, determined by inserting a size #15 K-file into the canal until the tip of the file was just visible at the apical foramen. Patency of the canal was maintained throughout the procedure by passing a #10 K-file approximately 0.5 mm through the apex. Instrumentation of the canal was carried out with the help of ProTaper files. During preparation and between two successive file 2 ml of 5% sodium hypochlorite was used as an irrigant. All canals were prepared to F3 ProTaper file. The smear layer removal was done using 10 ml of 17% EDTA followed by 10 ml of 5% sodium hypochlorite. The final rinse was done with saline. The canals were then dried with paper points.

Obturation of the groups were done as follows:

Group A: Lateral condensation group

A standardized gutta-percha master point was selected and introduced into the root canal to full working length and was checked for "tugback criteria". "AH plus sealer", was mixed according to the manufacturer's directions and applied to the canal wall using file size #20, in a counter clockwise rotation.[8] The master cone was then coated with a sealer and introduced slowly into the root canal until the working length was reached. Lateral condensation was performed using standardized finger spreaders and gutta-percha point sizes of # 15, # 20, #25, and # 30.

Group B: Thermoplasticised guttapercha technique group (calamus)

The "Calamus system" was prepared according to the manufacturer's instructions (Calamus Operator's manual). Silver injection needles of 23 gauges were used for all obturations and a silicone stop was placed 2 – 5 mm from the working length. The AH-Plus sealer was placed into the canal using a file size #20 with counter clock wise rotation.[8] At the time of obturation, the injection of the thermoplasticized gutta-percha was performed twice. First, the needle was inserted in the apical direction until it bound to the canal wall, and the thermoplasticized gutta-percha, heated to 200 degree C in the delivery system, was injected. The needle was removed after injecting a few millimetres of gutta-percha near the tip of the preparation. The softened gutta-percha in the apical portion was then vertically condensed to the apex with a hand plugger dipped in alcohol, to avoid adherence to the hot gutta-percha. The remaining root canal was then back-filled in increments until the gutta-percha was observed in the cervical aspect of the root.

Group C: Cold flowable guttapercha technique group (gutta flow bioseal)

A standardized gutta-percha master point was selected and introduced into the root canal to full working length and was checked for tugback

Calamus

Gutta flow bioseal

Incubator

criteria."GuttaFlowBioseal" was then introduced into the canal, 3 mm short of the working length. The tip of the master point was coated with GuttaFlow Bioseal paste and introduced into the root canal and was taken to the working length, slowly and gently back and forth, twice, to ensure complete wetting of the point and the canal wall. Then the master point was permanently placed in the canal.

Access cavities in all the three groups after obturation were sealed with Cavit G.

Storage:

After obturation these specimens were stored at 37°C and 100% humidity for seven days in incubator to allow adequate time for the obturated materials to set. Each root was then sectioned at three equal levels. The thickness of the section was 2.5 mm. Sectioning was done with double-ended diamond disks at low speed, with water cooling.

The surfaces of the sections were labeled, digitally photographed, and measured at ×40 magnification, using a Stereomicroscope (Magnus).

RESULTS

The following parameters were recorded.

1. Number of sections with voids

2. Location of the voids (either in the filling core or along the root canal wall)

Results :

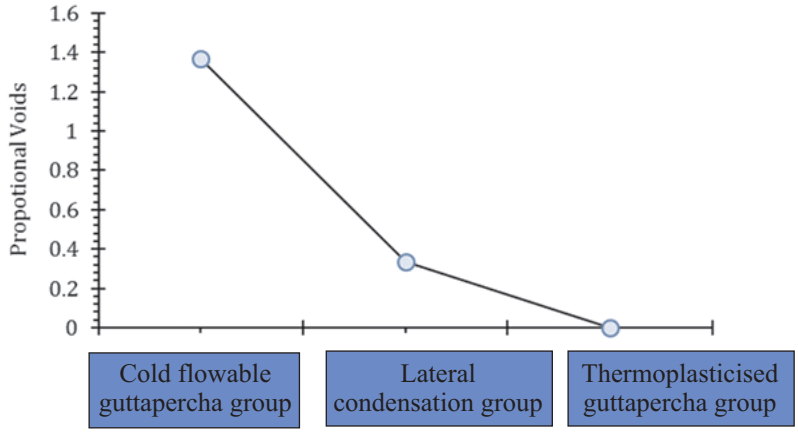
Table 1. The results of the ANOVA using the voids as response variables against the treatments and the sections as sources of variations. (n {total}= 90). The values in bold indicate significant difference.

Table 1

Source	DF	Sum of squares	Mean squares	F	Pr> F
Model	4	45.733	11.433	7.233	<0.0001
Treatment	2	30.467	15.233	9.637	0.000
Section	2	15.267	7.633	4.829	0.010
Error	85	134.367	1.581		
Total	89b	180.100			

Contrast	Difference	Standardized difference	Critical value	Pr> Diff
Thermoplasticisedvs				
Cold flowable	-1.367	-4.210	2.386	0.000
Thermoplasticisedvs				
Lateral condensation	-0.333	-1.027	2.386	0.562
Lateral condensation				
vs cold flowable	-1.033	-3.183	2.386	0.006
Tukey's d critical value:			3.374	

Contrast	Difference	Standardized difference	Critical value	Pr> Diff
Apex vs Cervical	-0.967	-2.978	2.386	0.010
Apex vs Middle	-0.733	-2.259	2.386	0.067
Middle vs Cervical	-0.233	-0.719	2.386	0.753
Tukey's d critical value:			3.374	



DISCUSSION

Teeth were divided into three groups. This assured that one had comparable groups with respect to tooth type and form (long / short and straight / curved). Only teeth with intact or restored crowns were used.[8] All the canals were prepared by single operator using crown down technique to reduce the variability.

The presence or absence of a smear layer plays an important role in the apical seal produced by various obturating techniques.[9] Studies have shown that the smear layer can serve as a reason for leakage of microorganisms and as a source for the growth and activity of bacteria, which remained entrapped in dentinal tubules.[10] Therefore, the root canals were irrigated with 5% sodium hypochlorite solution and 17% EDTA to remove the smear layer.

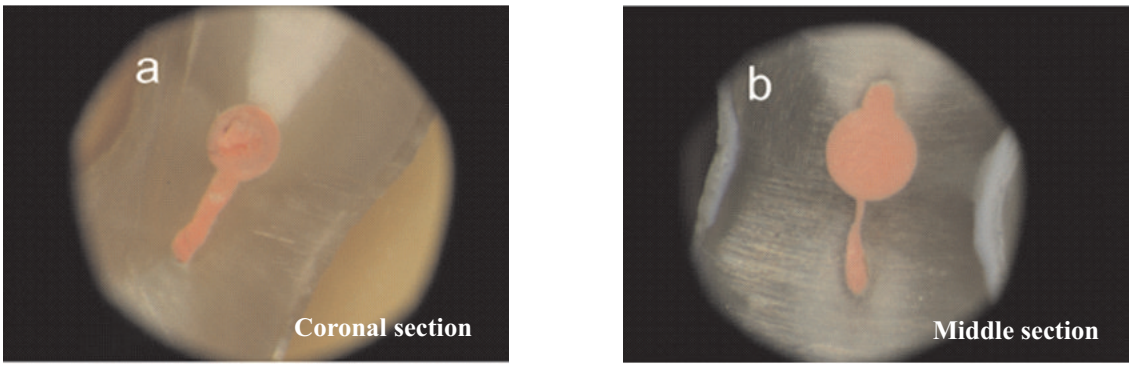
Lateral condensation had been used as it is widely and commonly practiced, and henceit served as a standard with which other techniques can be compared. [11-14]

GuttaFlow, a new root canal obturation material, is said to have good flowable properties at room temperature. It provides better sealing, has good adaptability because of its increased flow, and also it expands on setting and it also has bioactivity.

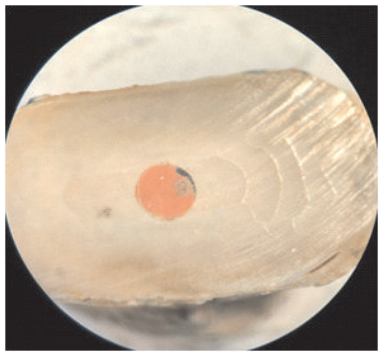
Sectioning of teeth was performed at predetermined distances from the apex. This was done to obtain comparable information at the specific root levels, for example, at mid root level. [8]

Stereomicroscopic examination was chosen for this study as it provides a three-dimensional view of the surface to be examined. It requires no pretreatment of the specimen (as in the Scanning Electron Microscopic Examination). It is associated with an image analysis software, which aids in eliminating human errors, in the interpretation of the parameters.

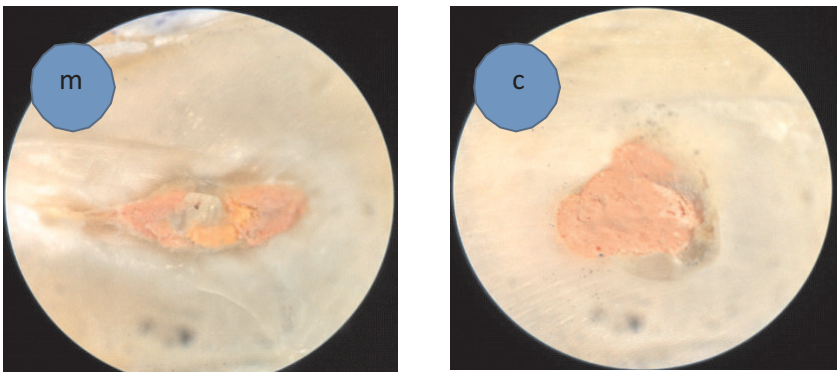
The areas of voids were calculated to quantify the sealing of the filling. The influence of this parameter on the leakage of the filling depended on



Calamus group under stereomicroscope
Coronal section(a) Middle section(b)



Coronal section of gutta flow bioseal under stereomicroscope



Coronal (c) and middle (m) sections of the lateral condensation group under stereomicroscope

the type ("through and through" or "dead end voids") and location of the voids (within the filling or at the canal wall).

Based on the results of this study, the thermoplasticised guttapercha group showed the lowest percentage of area of void (0.0%). Thus the adaptation to the root canal wall was complete. This was in agreement with the results reported by Monticelli et al. and ElAyouti et al. [15-16]

In the cold flowable guttapercha group, remarkably, a maximum number of voids were enclosed within the core of the filling material and surrounding the core, which was in accordance with other studies.

Lateral condensation exhibited good sealing. It was better than the gutta flowbioseal.

CONCLUSION

Thermoplasticised guttapercha technique exhibited the best sealing with no of voids, as compared to the other two groups and the sealing was dense in all the three sections.

The lateral condensation group had more voids when compared with the thermoplasticised guttapercha treated teeth and most of the voids were seen at the periphery. But this group had no voids at the apex. All the voids were at the cervical or at the middle sections. But the voids were much less than the previous group.

The cold flowable guttapercha group, although it showed most number of voids, these voids were remarkably enclosed within the material and around

the periphery. Thermoplasticised guttapercha exhibited a homogenous obturation with adaption followed by lateral condensation and cold flowable guttapercha group.

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