

Evaluation of Extrusion and Apical Seal of Thermafil™ Obturation with and without MTA as an Apical Barrier in Comparison with Lateral Condensation Technique: An *In Vitro* Study

Ajay S Rao¹, Rinku Mathur², Nimisha C Shah³, Rajeshkrishna Malge⁴, Sharanpriya Sathnoorkar⁵, T Chandrasekhar⁶

ABSTRACT

Aim and objective: This study aimed to compare the apical sealing ability and periapical extrusion in the Thermafil™ obturation technique, with and without an apical barrier of MTA, with lateral condensation technique.

Materials and methods: Sixty freshly extracted human central incisors were instrumented with the crown down technique and divided into three experimental groups. Group I: lateral condensation technique obturation, group II: Thermafil obturation (DENTSPLY Tulsa), and group III: this group was obturated into two parts; first MTA (ProRoot) was placed in apical 3 mm and later the remaining canal was obturated with Thermafil™ obturation technique (DENTSPLY Tulsa). AH Plus sealer was used in all the groups. Specimens of all the groups were layered with nail paint excluding the apical 3 mm. Twenty-four hours later, all the teeth were suspended in Black India ink for 48 hours. Finally, all the teeth were decalcified, rendered transparent and linear dye leakage and periapical extrusion was measured using ×60 magnification of stereomicroscope with an in-built ruler.

Results: A Chi-square test done to evaluate periapical extrusion showed there was a significant difference found among all the groups ($p < 0.05$), whereas in case of linear apical dye leakage using a Student's *t* test showed there was no significant difference among all the groups ($p > 0.05$).

Conclusion: Despite showing apical leakage, the thermo-plasticized gutta-percha obturation technique can be advantageous when used with MTA as an apical barrier since there is no scope for apical extrusion along with the benefit of three-dimensional obturation of the root canal system when compared with the lateral condensation technique.

Keywords: Lateral condensation technique, MTA apical barrier, Thermafil obturation.

International Journal of Clinical Pediatric Dentistry (2020): 10.5005/jp-journals-10005-1865

INTRODUCTION

The prime purpose of root canal therapy is complete debridement of the pulp and three dimensional sealing of the whole root canal system.¹ Although numerous techniques have been introduced for obturation, cold lateral condensation is an established standard technique.² In 1978, Ben Johnson introduced the Thermafil obturation technique using flexible metal carriers coated with α -phase gutta-percha (Tulsa Dental Products, Tulsa, OK). The benefit of this technique was the flow of the thermo-plasticized gutta-percha into lateral and accessory canals offering the three-dimensional obturation of the root canal system.³ But it caused a considerably more apical extrusion in contrast with the lateral condensation technique.⁴

A range of techniques have been advised using different materials to produce a firm apical barrier so that the remaining canal can be obturated without the fear of periapical extrusion of gutta-percha and sealer or both reducing the microleakage to a certain extent at the same time, e.g.; (1) Tricalcium phosphate,⁵ (2) Freeze-dried (lyophilized) cortical bone,⁶ (3) Dentin chip apical filling,⁷ but Holland et al.⁸ found that if the dentin chips are infected, they can hamper the repair, (4) Calcium hydroxide apical filling,⁹ but Pitts et al.¹⁰ found that calcium hydroxide resorbs away from the apex faster than do dentin chips.

MTA is bioactive material that does not irritate periapical tissues and it stimulates the regeneration of cementum-like tissue and the PDLs.¹¹ Studies have proven that MTA induces apexogenesis by

^{1,3}Department of Conservative Dentistry and Endodontics, KM Shah Dental College and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat, India

²Department of Pediatric and Preventive Dentistry, RUHS College of Dental Sciences, Jaipur, Rajasthan, India

⁴Department of Pedodontics, ESIC Dental College, Kalaburgi, Karnataka, India

^{5,6}Department of Conservative Dentistry and Endodontics, ESIC Dental College, Kalaburgi, Karnataka, India

Corresponding Author: Ajay S Rao, Department of Conservative Dentistry and Endodontics, KM Shah Dental College and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat, India, Phone: +91 8385017307, e-mail: drajayinendo@gmail.com

How to cite this article: Rao AS, Mathur R, Shah NC, et al. Evaluation of Extrusion and Apical Seal of Thermafil™ Obturation with and without MTA as an Apical Barrier in Comparison with Lateral Condensation Technique: An *In Vitro* Study. *Int J Clin Pediatr Dent* 2020;13(S-1):S40–S44.

Source of support: Nil

Conflict of interest: None

stimulating the mesenchymal stem cells from the apical papilla to encourage complete root formation in open apices.^{12,13}

So if MTA can induce closure of the immature apex, creating an apical 3-mm apical barrier in mature apices could be another rational application of this material.

AIM AND OBJECTIVE

This *in vitro* study aims to create a tight apical barrier of MTA in apical 3 mm of root canal against which the rest of the canal will be obturated three-dimensionally with Thermafil obturation technique to prevent apical extrusion of sealer and gutta-percha, and microleakage (to a certain extent) and to compare this technique with the gold standard lateral condensation technique and conventional Thermafil obturation technique.

MATERIALS AND METHODS

Method of Collection of the Sample

Sixty freshly extracted maxillary central incisors were selected; superficial debris was removed from roots with the ultrasonic unit and stored in 0.1% thymol solution until used for the study.

Preparation of the Sample

Preparation of Specimens

After access cavity preparation, the canal length was determined visually by passing a size # 15 K file into the canal until it was flush with the root surface at the apical foramen. Working length was established by subtracting 0.5 mm from this length.

Canal Instrumentation

Periapical radiographs from a proximal and buccolingual were acquired with different files in all the canals to verify the canal length. All canals were instrumented up to ProTaper rotary finishing file no. F-5 using the crown-down technique. A 3% sodium hypochlorite solution was used for copious irrigation of the canals between usages of each instrument throughout the procedure with a 27-gauge syringe. Prepared specimens were irrigated and dried with paper points and checked for patency.

The prepared samples were randomly divided into three groups of 20 samples each ($N = 20$).

Group I—Control group—To be obturated with the Standard Lateral condensation technique using the AH Plus sealer and gutta-percha cones.

Group I—To be obturated with the Conventional Thermafil™ Obturation technique with AH Plus sealer.

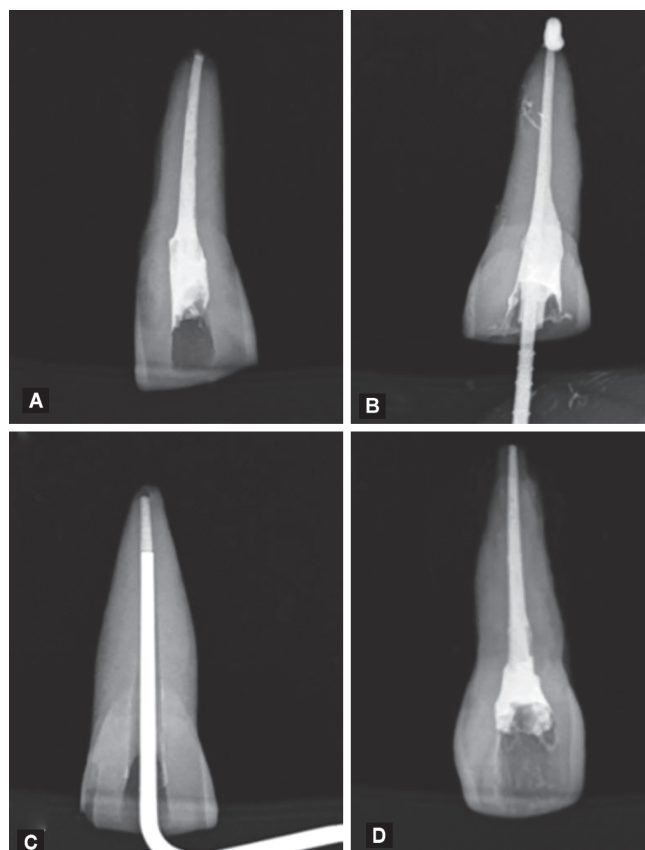
Group III—The root canals of this group was obturated in two parts:

At first, the MTA was placed in apical 3 mm and was allowed to set in moisture and after that, the remaining canal was to be obturated with the Thermafil obturation technique.

Group I: In this group, the canals were obturated by lateral condensation technique and confirmed with a radiograph (Fig. 1A).

Group II: The canals of the Thermafil group were obturated as per the manufacturer's instructions. A Thermafil obturator was selected (coinciding with the size of the verifier). The AH Plus sealer was then applied to the canal with sterile paper points. The obturator was heated in the Thermaprep Oven (*Dentsply, Maillefer*) for 17 seconds and then placed in the canal. The shaft was cut off with a carbide bur in a high-speed handpiece. The obturation was confirmed with a radiograph (Fig. 1B).

Group III: The canals of this group were obturated in two parts—Firstly, an apical plug of 3 mm of MTA (ProRoot) was placed in the canal. A hand pluggers of no. 50 was inserted into the canal and checked radiographically for its position from the apex. MTA (ProRoot) was mixed as per the recommendations by the manufacturer and was carried into the canal with the help of an appropriate amalgam carrier and was plugged in the apical 3 mm with the help of no. 50 hand pluggers (Fig. 1C).



Figs 1A to D: (A) Group I: Obturated by lateral condensation technique with AH Plus sealer and confirmed with a radiograph; (B) Group II: Obturated by Thermafil obturation technique with AH Plus sealer and confirmed with a radiograph; (C) Group III: Placement of MTA in the apical third with the help of a Hand pluggers confirmed with a radiograph; (D) Group III: Rest of the canal obturated with Thermafil obturation technique with AH Plus sealer and confirmed with a radiograph

After filling the apical 3 mm with MTA, the remaining canal was obturated with the Thermafil obturation technique after applying AH Plus sealer on the canal walls. The obturation was confirmed with a radiograph (Fig. 1D).

All the samples were stored in moisture for 48 hours. The samples were allowed to be dried and the root was painted with two layers of nail paint excluding the apical 3 mm. Samples were placed in Black India ink for 48 hours at room temperature after which they were thoroughly washed under tap water and dried. The nail varnish was carefully removed with the help of a Lecron carver. The samples then were kept in 5% nitric acid solution for demineralization of cementum and dentin of the root.

After verifying the absolute demineralization by the radiographs, the samples were placed in increasing percentage of ethyl alcohol, 2 hours in each solution, for complete dehydration. First in 75%, then in 85%, and finally in 95% of ethyl alcohol. After dehydration, the samples were kept in methyl salicylate for clearing. Linear apical dye penetration was calculated using a Stereo zoom Microscope at $\times 60$ magnification with an in-built gauging ruler.

RESULTS

Statistical Analysis

The occurrence of extrusion of sealer and/or obturating material was evaluated by means of a Chi-square test and linear dye leakage with a Student's *t*-test.

Extrusion

Extrusion Measurement Criteria

The apex was observed with a Stereo zoom microscope and the observations recorded using the following parameters:

0 Rating—No sealer and/or obturating material at the apical foramen.

1 Rating—Sealer and/or obturating material at the apical foramen.

2 Rating—Sealer and/or obturating material beyond the apical foramen.

The percentage of canals with extruded sealer and/or gutta-percha in each technique is given in Table 1. There was a significant difference noticed between groups II and III.

Table 1: Incidence (%) of apical extrusion between conventional thermafil and thermafil plus MTA techniques

Rating	Lateral condensation (group I)	Conventional thermafil (group II)	Thermafil with MTA apical plug (group III)
0	30	05	0
1	40	20	0
2	30	75	0

Table 2: Mean leakage values of test groups

Group	Mean dye leakage (mm) ± standard deviation
Lateral condensation (group I)	1.94
Conventional thermafil (group II)	1.46
Thermafil with MTA plug (group III)	1.82

Apical Leakage

Microleakage was observed and measured using a stereo zoom microscope with an in-built ruler in it. The mean leakage values and standard deviation (SD) values for all the techniques are shown in Table 2. A “Student’s t” test showed that there was no significant difference between groups I, II, and III ($p > 0.05$).

DISCUSSION

Analysis of the Results

Microleakage

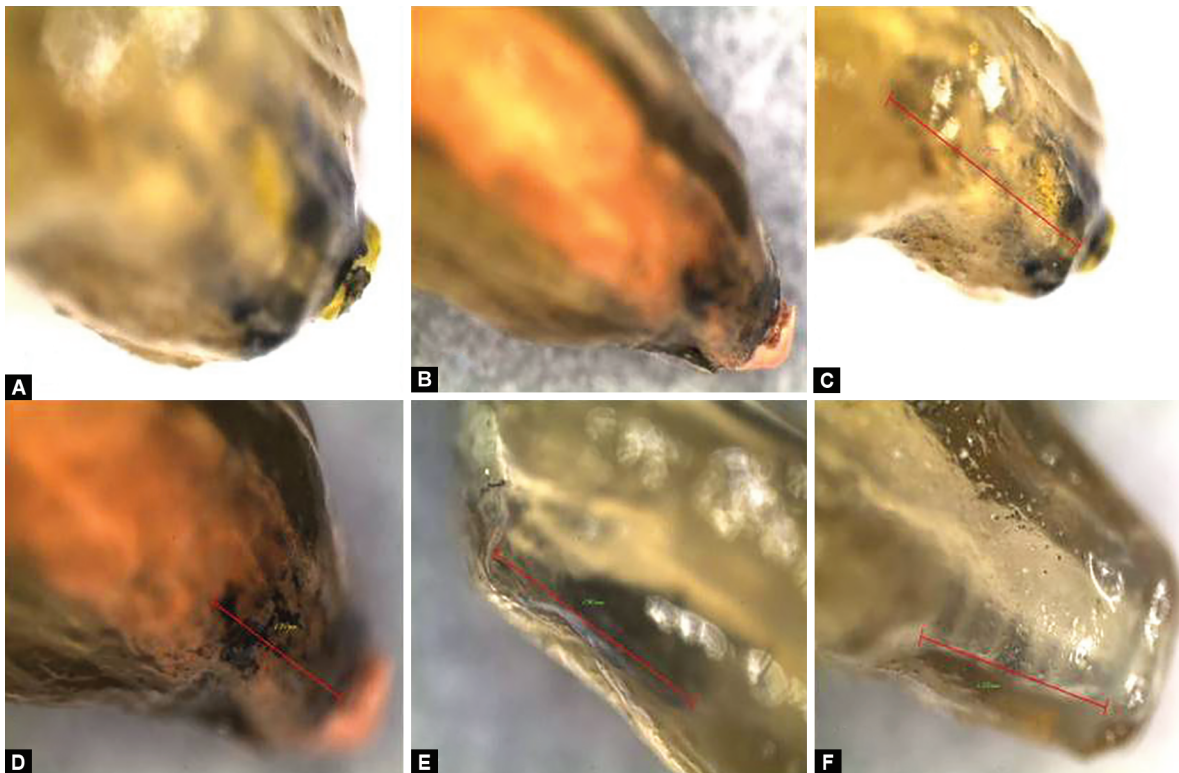
Results of the microleakage study in this experiment showed similar results with no significant difference among all the groups I, II, and III ($p > 0.05$) (Figs 2A to F).

Previous studies on microleakage, comparing the lateral condensation and thermo-plasticized gutta-percha, are inconsistent or contradictory because some of these studies have shown cold lateral compaction superior,¹⁴ whereas few studies showed that warm gutta-percha obturation techniques demonstrate better sealing properties than that of lateral condensation technique.^{4,15,16}

In an *in vitro* study, the sealing ability of the lateral condensation technique was specifically compared with the Thermafil obturation technique; yet, no significant difference was found between both the techniques.¹⁷ In the present study, also there was no significant difference found between groups I and II ($p > 0.05$).

Group III, where MTA was used as an apical plug, also displayed microleakage. The occurrence of microleakage with MTA in this study could be attributed to many factors such as:

- **Intracanal delivery technique:** Many investigations showed that a combination of hand and ultrasonic placement gave a



Figs 2A to F: (A) Periapical extrusion in group I; (B) Periapical extrusion in group II; (C) Microleakage in group I; (D) Microleakage in group II; (E and F) Microleakage in group III

compact filling of MTA over a manual condensation technique.¹⁸ In the present study, only hand condensation was used.

- **The thickness of the apical MTA plug:** One study using MTA as an apical plug in the thickness of 2, 3, and 5 mm showed that 5 mm thick plugs allowed less leakage, whereas 2 and 3 mm plugs showed a similar amount of leakage.¹⁹ In the present study, a 3-mm thick MTA plug was used.
- **Absence of the sealer around the MTA plug:** Because there was no any sealer applied in the apical 3 mm of the canal before plugging MTA, there was always a microscopic gap existing between the MTA and root canal wall, and this gap allowed the dye to flow inside through the apical foramen.
- **The direction of placement of MTA (Orthograde/Retrograde):** When used as an orthograde filling material (as a perforation repair material), a study suggested that ProRoot MTA displayed more microleakage than laterally condensed as well thermo-plasticized gutta-percha.²⁰
- **Type of the dye:** The literature shows that microleakage studies of MTA with Black India ink have often demonstrated the inferiority of MTA compared with other materials. When tested with Black India ink, the White MTA (ProRoot) showed poorer results than super EBA and Geristore.²¹
- **The type of MTA (WMTA/GMTA):** In a dye leakage study comparing White MTA (WMTA) and Gray MTA (GMTA) as an apical barrier, the latter showed significantly less leakage.¹⁹

It is well known that irrespective of the obturation technique employed, microleakage still remains an inevitable phenomenon and by far, none of the obturation techniques have been shown to stop the microleakage absolutely. The mean dye leakage in group III of this study was 1.82, but it can be overlooked if we simulate the same situation in the clinical scenario. Because the harmful effects due to microleakage can be counteracted by the antimicrobial properties of MTA.

Periapical Extrusion and Dye Leakage

In this study, MTA showed great promise in our experiment in the prevention of apical extrusion of gutta-percha and sealer (group III). The result showed that periapical extrusion was seen in both groups I and II except group III (Table 1). In group I, 30% of specimens showed periapical extrusion of gutta-percha and sealer beyond the apical foramen whereas, in group III, this finding was observed with a very high percentage of specimens, i.e., 75%.

This shows that periapical extrusion is more likely to occur in the Thermafil obturation than the lateral condensation (Figs 2A and B). To support this, the literature also suggests that several *in vitro* studies concluded the increased incidence of periapical extrusion related to thermo-plasticized gutta-percha obturation techniques.⁴

One meta-analysis study comparing the lateral condensation technique with thermo-plasticized gutta-percha techniques demonstrated that a greater incidence of overextension was seen in the warm gutta-percha group.²²

Even if the periapical extrusion was seen in the Thermafil obturation group (group II) we cannot ignore the fact that this technique had the advantage of obturating the whole root canal system three-dimensionally (e.g., Fig. 1B shows obturation of lateral canal) and that makes this technique still very versatile and better than the other techniques. And if it is used with an apical barrier of material like MTA, it can give the most desirable results because

microleakage, which is something that is unavoidable, will be counteracted by the superior properties of MTA.

CONCLUSION

According to this study, it is advantageous to use MTA along with ThermaFil Obturation for a better sealing as well as three-dimensional obturation of the root canal system.

REFERENCES

1. Ingle JI, Bakland LK. Endodontics. 6th ed., ch. 11. 2008. pp. 571–668.
2. Weine FS. Endodontic therapy. St. Louis: Mosby; 2004.
3. Johnson B. A new gutta-percha technique. JOE 1978;4(6):185–188. DOI: 10.1016/S0099-2399(78)80173-3.
4. Gilhooly RMP, Hayes SJ, Bryant ST, et al. Comparison of lateral condensation and thermo mechanically compacted warm a-phase gutta-percha with a single cone for obturating curved root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91(4):89–94. DOI: 10.1067/moe.2001.110416.
5. Coviello J, Brilliant JD. A preliminary clinical study on the use of tricalcium phosphate as an apical barrier. J Endod 1979;5(6):6–13. DOI: 10.1016/S0099-2399(79)80141-7.
6. Rossmeisel R, Reader A, Melfi R. A study of freeze-dried cortical bone used as an apical barrier in monkey teeth. J Endod 1982;8(5):219–226. DOI: 10.1016/S0099-2399(82)80358-0.
7. El Deeb ME, Thuc-Quyen NT, Jensen JR. The dentinal plug: its effect on confining substances to the canal and on the apical seal. JOE 1983;9:355–359.
8. Holland R, De Souza V, Nery MJ, et al. Tissue reaction following apical plugging of the root canal with infected dentin chips. Oral Surg 1980;49(4):366. DOI: 10.1016/0030-4220(80)90149-8.
9. Weisenseel Jr J, Hicks M, Pelleu Jr G. Calcium hydroxide as an apical barrier. JOE 1987;13(1):1–5. DOI: 10.1016/S0099-2399(87)80084-5.
10. Pitts DL, Jones JE, Oswald RJ. A histological comparison of calcium hydroxide plug and dentin plug used for the control of gutta-percha root canal filling material. JOE 1984;10(7):283. DOI: 10.1016/S0099-2399(84)80180-6.
11. Pitt Ford TR, Torabinejad M, McKendry DJ, et al. Use of mineral trioxide aggregate for repair of furcal perforations. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79(6):756–763. DOI: 10.1016/S1079-2104(05)80313-0.
12. Fellipe WT, Fellipe MCS, Rocha MJC. The effect of mineral trioxide aggregate on the apexification and periapical healing of teeth with incomplete root formation.
13. Huang GTJ, Sonoyama W, Liu Y, et al. The hidden treasure in apical papilla: the role in pulp/dentin regeneration and bioroot engineering. J Endod 2008;34(6):645–651. DOI: 10.1016/j.joen.2008.03.001.
14. Mann SR, McWalter GM. Evaluation of apical seal and placement control in straight and curved canals obturated by laterally condensed and thermo-plasticized gutta-percha. JOE 1987;13(1):10–17.
15. Sahli C-C, Berastegui E, Brau-Aguade E. Apical sealing using two thermo plasticized gutta-percha techniques compared with lateral condensation. JOE 1997;23(10):630–638.
16. Michanowicz A, Czonstkowsky M. Sealing properties of an injection thermo-plasticized low temperature gutta-percha: a preliminary study. JOE 1984;10(12):563–566.
17. Abarca AM, Bustos A, Navia M. A comparison of apical sealing and extrusion between Thermafil and lateral condensation techniques. JOE 2001;27(11):670–672. DOI: 10.1097/00004770-200111000-00004.
18. Yeung P, Liewehr FR, Moon PC. A quantitative comparison of the fill density of MTA produced by two placement techniques. J Endod 2006;32(5):456–459. DOI: 10.1016/j.joen.2005.08.008.

19. Matt G, Thorpe J, Strother J, et al. Comparative study of white and gray mineral trioxide aggregate (MTA) simulating a one-or two-step apical barrier technique. *J Endod* 2004;30(12):876–879. DOI: 10.1097/01.don.0000136213.93171.45.
20. Hamad HA, Tordik PA, McClanahan SB. Furcation perforation repair comparing gray and white MTA: a dye extraction study. *J Endod* 2006;32(4):337–340. DOI: 10.1016/j.joen.2005.10.002.
21. Pichardo MR, George SW, Bergeron BE, et al. Apical leakage of root-end placed super EBA, MTA, and Geristore restorations in human teeth previously stored in 10% formalin. *J Endod* 2006;32(10):956–959. DOI: 10.1016/j.joen.2006.07.011.
22. Peng L, Ye L, Tan H, et al. Outcome of root canal obturation by warm gutta-percha versus cold lateral condensation: a meta-analysis. *J Endod* 2007;33(2):106–109. DOI: 10.1016/j.joen.2006.09.010.