

MTA as an Apical Barrier in Teeth with Open Apices

Jasvir Kaur^{1*} Bharat Suneja² Sunaina Jodhka³ Amanpreet Singh⁴ Basil M. Mathew⁵

¹Reader, Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

²Professor and Head, Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

³Professor, Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

⁴Reader, Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

⁵Senior Lecturer, Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

ABSTRACT

Background: One-step apexification procedure using MTA has gained wide acceptance due to lessened visits and better patient compliance. This prospective study was designed to assess the outcome of apexification with MTA as an apical barrier using a simple method with hand pluggers.

Materials and Methods: 32 children having wide-open apices of anterior and posterior teeth indicated for root canal treatment were the study subjects. The teeth were clinically and radiographically assessed (presence of pain, sinus and the PAI score) and the findings recorded. In the first visit, access preparation was done and Ca(OH)₂ was packed within the canal. On the 2nd visit (one week later), MTA was placed in the apical area using customized hand pluggers. After a follow up period of one year, the teeth were reassessed and the findings compared with the initial findings.

Results: No patient reported with pain after the treatment was completed and during the follow up period. If sinus was present, it was not seen after 1 week of commencement of treatment. Radio graphically, the PAI scores dropped by highly significant levels after one year.

Conclusion: Both by clinical and radiographic criteria, apexification using MTA is a successful, predictable and a reproducible procedure. A simple method of placement employing hand pluggers, without use of carrier gun gives good results.

Keywords: MTA, wide open apices, apexification, calcium hydroxide.

INTRODUCTION

Patients with teeth that are incompletely developed or have open apices and are non-vital, offer dentists the most challenging treatment problem. Since it is necessary to seal the apex to gain endodontic success, it becomes physically impossible to obtain the objectives through ordinary procedures in the open apex cases.¹

Because endodontic obturation techniques rely on the presence of an apical stop so that an obturating material can be placed against it, it is essential to create an artificial apical barrier or to induce the closure of an apical foramen with calcified tissue.^{1,2}

Traditional apexification techniques involve the use of calcium hydroxide, which is filled in the root canal up to the apex.³ Evidence of the calcific barrier is checked for every six months. It might sometimes take more than one year for barrier to be apparent.³ Some of the inherent disadvantages of these techniques are decreased patient compliance (with multiple appointments in 6 – 24 months of treatment) and an increased risk of root fracture during the extended period because of thin roots, coupled with the increased incidence of traumatic root injuries, during this period.^{4, 5} Moreover concerns have been expressed about incomplete

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*Correspondence Dr. Jasvir Kaur.

Department of Periodontics, B.J.S. Dental College, Hospital & Research Institute, Ludhiana, India.

Email: Not Disclosed

apical hard tissue barrier because of vascular inclusions. Bacterial invasion may occur through such vascular tunnels^{1, 6,7} and might also result in extrusion of the sealer during obturation.⁵

In 1993, a new endodontic material, mineral trioxide aggregate (MTA) was developed by Torabinejad and co workers, primarily for the purpose of sealing accidental perforation of the root canal⁸. This biocompatible material provided a bacteria tight seal. Subsequently, the material was shown to be ideal as root-end-filling material and a material for use in pulp capping and pulpotomy cases.⁹ Later, MTA found its way into treatment of traumatized immature teeth with permanent necrosis (apexification), as some of the shortcomings of calcium hydroxide seemed to be overcome with the use of MTA. This material, when used in apexification showed fewer vascular inclusions with hard tissue formed than under calcium hydroxide. MTA formed a sort of an apical barrier, which provided a hermetic seal and against this barrier, the root canal material could be easily placed. This apical barrier technique is hence a replacement for apexification with calcium hydroxide.^{10, 11, 12}.

Even considering its other properties viz. sealing ability, biocompatibility, hard tissue induction potential and ability to set in presence of moisture, MTA is the material of choice for apical barrier technique.¹³ Nevertheless, the most important reason for favoring MTA over calcium hydroxide seems to be advantage of single step apexification. Not surprisingly there has been an increase in the use of MTA over $\text{Ca}(\text{OH})_2$ in the last 15 years. It has been reviewed in various studies^{14, 15} but there has been a dearth in literature regarding its usage over large no. of cases.¹

Also, armamentarium recommended for placing MTA at the desired level in the root canal is expensive, placement is somewhat cumbersome and techniques have an increased learning curve. Therefore, a simpler method has been used to facilitate placement of MTA in this study.

AIMS AND OBJECTIVES

Clinical and radiographic evaluation of the use of white MTA for a significant number of children with a follow up of one year.

To check the efficacy of the use of a simpler method of placement of MTA using hand pluggers without the use of a carrier gun.

MATERIAL AND METHODS

This study was carried out on patients attending the OPD of pedodontics department, BJS dental college and hospital, Ludhiana.

Inclusion criteria:

- Child less than 16 years of age
- Immature permanent root with more than half root length developed (ascertained radiographically)
- Non vital tooth requiring endodontic treatment
- Restorable tooth with no horizontal / vertical root fracture
- No active root resorption (inflammatory/ replacement)
- Fit and healthy patients, cooperative for treatment

Complete history and findings on the oral examination were recorded. All radiographs were scored using the periodontal index score. (PAI score).^{16, 17}

normal periodontal structure
small changes in bone structure
changes in bone structure with mineral loss
periodontitis with well-defined radiolucent area
severe periodontitis with exacerbating features

All treatment was carried out over three visits following a standardized protocol in rubber dam isolation under local anesthesia, whenever indicated.

On the first visit access opening and chemomechanical debridement was done. Working length determined by both radiographs and electronic apex locator. a thin paste of calcium hydroxide powder mixed with distilled water was placed in the canal for a period of one week.

In the second visit, $\text{Ca}(\text{OH})_2$ was removed using normal saline under rubber dam isolation. A finger or hand plugger which fit to 2 mm short of working length was selected or modified. In the circumstance of the plugger being loose in the canal, an 80 no.K file with tightly wound sterile cotton

Table 1: Summary of the patient record.

Patient No.	Age/ Sex	Tooth No.	Pain	Sinus	Initial PI Score	No. of Visits till MTA Placement	Adequacy of Seal	Extrusion of Material	Evaluation after one week		Recall Evaluation		
									Pain	Sinus	Pain	Sinus	PI Score
1	9/F	21	+	-	5	3	+	-	-	-	-	-	3
2	8/F	46	-	-	4	3	+	-	-	-	-	-	3
3	8/F	36	-	-	3	3	+	-	-	-	-	-	3
4	10/M	11	+	+	5	3	+	+	-	-	-	-	4
5	8/F	11	+	-	4	3	+	-	-	-	-	-	4
6	7/F	21	-	-	4	3	+	-	-	-	-	-	3
7	8/M	11	-	-	4	3	+	-	-	-	-	-	2
8	9/M	21	+	-	4	3	+	-	-	-	-	-	2
9	12/M	45	+	+	4	3	+	-	-	-	-	-	3
10	8/M	11	-	-	4	3	+	-	-	-	-	-	2
11	9/M	21	+	-	3	3	+	-	-	-	-	-	3
12	9/F	11	-	-	4	3	+	-	-	-	-	-	2
13	10/M	21	-	-	4	3	+	-	-	-	-	-	4
14	8/M	11	-	-	5	3	+	+	-	-	-	-	2
15	8/M	26	-	-	4	3	+	-	-	-	-	-	2
16	9/M	21	-	-	5	3	+	-	-	-	-	-	4
17	8/M	46	-	-	3	3	+	-	-	-	-	-	2
18	8/M	11	+	+	4	3	+	-	-	-	-	-	2
19	9/F	36	+	-	3	3	+	-	-	-	-	-	2
20	9/M	21	-	-	4	3	+	+	-	-	-	-	2
21	9/F	36	-	-	3	3	+	-	-	-	-	-	3
22	8/M	46	-	-	5	3	+	-	-	-	-	-	2
23	8/M	47	-	+	4	3	+	-	-	-	-	-	4
24	9/M	11	+	-	4	3	+	+	-	-	-	-	3
25	9/M	21	-	-	4	3	+	-	-	-	-	-	2
26	10/M	21	-	-	5	3	+	-	-	-	-	-	3
27	9/F	21	-	-	5	3	+	+	-	-	-	-	2
28	9/M	11	-	+	4	3	+	-	-	-	-	-	2
29	8/M	36	+	-	4	3	+	-	-	-	-	-	3
30	11/M	21	-	-	2	3	+	-	-	-	-	-	1
31	10/M	11	-	-	2	3	+	-	-	-	-	-	1
32	8/M	21	-	-	2	3	+	-	-	-	-	-	1

Table 2: Change in the PAI scores after the follow up period.

Initial score 5 (7)		Initial score 4 (17)		Initial score 3 (5)		Initial score 2 (3)	
Remained same	0	Remained same	3	Remained same	3	Remained same	0
Reduced from 5 to 4	2	Reduced from 4 to 3	5	Reduced from 3 to 2	2	Reduced from 2 to 1	3
Reduced from 5 to 3	3	Reduced from 4 to 2	9	Reduced from 3 to 1	0		
Reduced from 5 to 2	2	Reduced from 4 to 1	0				
Reduced from 5 to 1	0						

Table 3: Comparison of initial and final PAI score.

• Score	PI	Initial	Final
Score 1		-	3 (9.4%)
Score 2		3 (9.4%)	14 (43.8%)
Score 3		5 (15.6%)	10 (31.3%)
Score 4		17 (53.1%)	5 (15.6%)
Score 5		7 (21.9%)	-
Total		32	32
Range		2 - 5	1 - 4
Mean $\pm$ SD		3.88 $\pm$ 0.87	2.53 $\pm$ 0.88
Median		4	2
Initial vs Final		Z value = 4.552; p < 0.001; Highly significant	

fibrils was used, the cotton fibrils wound to the file was moistened with sterile water and the fit inside the canal was checked. MTA powder was then mixed with dispensed sterile water and carried into the canal in a workable consistency Using an 80 no. K file, rotating the file working length in an anticlockwise direction. The previously selected custom made plugger or wound K-file was used to compact their initial increment. A radiograph was taken to ascertain the placement of the initial increment. If found satisfactory, another increment was used. A minimum of 4- 5 mm thickness of the material was then verified radiographically. A moist cotton pellet was left in the canal and temporarily sealed

In the next visit, the rest of the root canal was obturated with guttapercha or a post inserted in the canal. (whatever was the clinical requirement) After the follow up period, the patients were clinically examined and radiographs were taken. The radiographs were scored using the PAI index. All the findings were tabulated and statistically analyzed.

RESULTS

32 patients were recruited in the study out of which 9 (28.1%) were females and 23 (72.9%) were males. The mean age of the patients was 8.81 years. A brief summary of all the patients, with initial findings, initial PAI scores and those after the follow up period of one year are described in table 1.

The technique described for apexification was used for a total of 22 maxillary incisors, 9 mandibular molars and 1 mandibular premolar. 10 patients (31.3%) had presented with the chief complaint of pain in the associated tooth. On clinical examination 5 patients (15.6%) presented with the sign of a patent sinus with the associated tooth.

Treatment was completed predictably in 3 visits in all cases. Radiographically, a satisfactory apical seal was seen in all cases. The seal was described as satisfactory if MTA was adhering to the walls of the root canal at the desired length and was radiographically at least 4-5 mm thick. MTA had been pushed out of the apex in 3 cases.

None of the patients reported with clinical discomfort or pain after the treatment was completed and during the follow up period. In the cases where sinus if present, it was not seen after 1 week of commencement of treatment.

The periodontal index score reduced in the follow up period in 26 out of 32 cases. It remained the same in 6 out of 32 cases. It reduced by 1 score in 12 out of 26 cases, by 2 score in 11 cases and by 3 score in 3 cases. Table 2 describes the change in PAI scores in all cases over the follow up period. Table 3 shows that the range of PAI scores changed from 2-5 to 1-4 in the follow up period and the mean score changed from 3.88 $\pm$ 0.87 to 2.53 $\pm$ 0.88. Maximum no. cases had presented with an initial score of 4 while at the end of the follow up period

score 2 could be assigned to the maximum number of cases.

Wilcoxon signed rank test was applied while comparing the initial and final score and there was statistically a highly significant difference between them ($p < 0.001$) (table 3).

DISCUSSION

An ideal material to be used for creating an apical seal should seal pathways of communication between the root canal system and its surrounding tissues. It is challenging to obtain the objective in infected root canals in open apices. MTA has been shown to be a suitable material with highest amount of hard tissue formation and lowest level of inflammation.¹⁸ It has been reviewed in various studies but there has been a dearth in literature regarding its usage over long term¹⁹. Only clinical reports describing solitary cases or a group of cases have been tabulated. A long-term evaluation of the serviceability of MTA incorporating significant number of cases has not extensively been undertaken. Furthermore, the studies mainly include anterior teeth chosen for apexification (reason could be frequent trauma incurred by anterior teeth). In a functional pediatric dental practice cases of posterior teeth with non-vital pulp and immature roots are occasionally encountered. The cause for such clinical situation is mainly dental caries. Keeping the above consideration in mind, in the present study a total of 32 patients were recruited who presented with the clinical finding of an infected, non-vital, anterior or posterior tooth with open apices.

The technique used in the present study for the placement of MTA employed the use of a finger or hand plugger which was selected or modified. With this simple technique the material was successfully placed desired level within the confines of the root canal cemental limit²⁰. The teeth selected in the study had open apices, which could be convergent, parallel or divergent depending upon the stage of root development. The plugger selected for carrying the increment compaction had to be snugly fitting in the apical area in order to prevent under and over filling of MTA. Compaction is required to decrease the voids and micro channels in the material.²

Ultrasonics has also been used for placement of MTA in a few studies. It is a matter of debate amongst the investigators and it has been shown that after 90 days no significant difference was observed in the placement of MTA with/without the use of ultrasonics.¹²

In the present study a 4-5mm thickness of MTA was required radiographically as criteria for obtaining an adequate seal. In one study no significant difference has been reported between 1mm, 2mm, 3mm thickness of MTA.¹³ On the other hand another investigation demonstrated that only a 5mm thickness adequately prevents bacterial penetration.¹²

Recently, however a biologically based treatment called regenerative endodontic treatment was introduced which claims to be superior to apexification as it overcame the greatest drawback of apexification i.e. inability to cause root development. This approach is based upon presence of osteo/odontoprogenitor stem cells in the apical papilla that are resistant to the infection and necrosis caused by the proximity to the periodontal blood supply. The earlier studies were so successful that this treatment modality pointed towards the end of the apexification procedure. But as research progressed, the drawbacks also surfaced. Some of the drawbacks reported are i) discolouration-due to use of antibiotic paste, monocycline being the main culprit, ii) treatment period, iii) poor root development and iv) root canal calcification. Therefore in the light of present evidence based knowledge the use of MTA for apexification remains to be a reliable and sturdy option.²³

A draining sinus was seen associated with 5 cases undertaken in this study. The sinus healed in all cases after one week of placement of Ca(OH)_2 . This finding can be attributed to the strong antibacterial effect of Ca(OH)_2 . Therefore it is routinely recommended that Ca(OH)_2 be used as an intracanal medicament for at least one week before the placement of MTA⁶. The fact that sinus did not reappear in any of the cases during the follow-up period points towards the antibacterial properties of MTA. MTA has also been extensively evaluated for its antibacterial and antifungal properties against no. of microbes viz. *Staph. Aureus*, *Enterococcus faecalis*, *Pseudomonas auregnosa*, *Candida albicans*, although some reports have been

conflicting. Largely the literature shows that MTA has antibacterial and antifungal affect.²¹

Radiographically, the PAI index is one of the most validated recommendation in endodontics. It rates the periapical status and its change over a period of time indicates a healing or a non-healing lesion. In this study the PAI score reduced in most of the cases. Overall, in the entire sample it reduced statistically up to highly significant levels. Therefore radiographic evidence strongly supports the use of MTA as an apexification material. Recently published literature also indicates that MTA demonstrates good success and an effective option for apexification^{24, 25}. A recent meta analysis and systematic review also concludes that the shorter treatment time with MTA may translate into higher overall success rates because of better patient compliance²⁶. moreover, it is considered to be more effective in terms of apical closure end of the root canal as compared to calcium hydroxide in immature permanent teeth.²⁷

The success rate is similar to other studies where a messings gun was used to carry MTA to the apical area. This study undertook an easier, cheaper, readily available method of MTA placement.

CONCLUSION

Therefore, both by clinical and radiographic criteria, apexification using MTA seems to be a highly successful, predictable and a reproducible procedure. The present study has also shown that the simple technique of using hand pluggers for placement of MTA has no bearing on the clinical success rate.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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