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Contents

Editorial

- ▶ DNA Sequencing: From Medicine to Personalized Medicine 5-7
Dr. DM Arifur Rahman, Dr. Fahim Uddin Ahmad, Dr. Md. Matiur Rahman

Original Article

- ▶ Comparison of Serum Uric Acid Concentrations in Patients with Lichen Planus and other Dermatoses 9-15
Dr. Farah Safa Huq, Dr. Mohammed Saiful Islam Bhuiyan, Dr. Emily Akter, Dr. Khyrun Nahar Shaila
- ▶ COVID-19 and Online Medical Education Perspective; A Study in TMSS Medical College 17-23
Dr. Mst. Nadira Parvin, Dr. Md. Matiur Rahman, Professor Dr. Md. Anup Rahman Chowdhury
- ▶ Assessment of Clinical Characteristics and FNAC Findings of Different Thyroid Lesions in a group of Bangladeshi patients 25-29
Dr. Mehdi Ashik Chowdhury, Dr. DM Arifur Rahman, Dr. A K M Maruf Raza, Dr. Syeda Noorjahan Karim, Dr. Md. Neaz Nowsher, Dr. Zerin Shabnam Rahman, Dr. Mohammad Mahabubul Hoque
- ▶ Efficacy of Mineral Trioxide Aggregate and Calcium Hydroxide as Root Canal Sealer in Non-vital Permanent Tooth 31-37
Dr. Mst. Dilruba Khatun, Dr. Evan-E-Alam Emtakamul Haque, Dr. Musfiqa Aman, Dr. Mostofa Mohammad Ekramul Hasan, Dr. Md. Rakibul Hassan Khan, Professor Dr. Md. Shamsul Alam
- ▶ Clinical Profile of 306 Patients with Chronic Low Back Pain in a Tertiary Care Hospital 39-42
Dr. Ferdousur Rahman Al-Mahmud, Dr. Muhammad Alamgir Mandal, Dr. Mst. Shamina Khatun, Dr. Mohammad Azizur Rahman

Case Report

- ▶ Benign intra-renal lipoma in two years old girl 43-45
Dr. Md. Mofazzal Sharif, Dr. DM Arifur Rahman
- ▶ Sigmoid mesocolon cyst : Case report 46-48
Professor Dr. Md. Rezaul Islam, Dr. A.H.M Shahnewaz Shoubho
- ▶ Abnormal Extension of Sacral Hiatus- A Case Report 49-51
Dr. Rawshon Ara Naznin, Dr. Md. Moniruzzaman, Dr. Afsana Khanam, Dr. Maskura Benzir, Dr. Taslima Akter



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*Original Article***Efficacy of Mineral Trioxide Aggregate and Calcium Hydroxide as Root Canal Sealer in Non-vital Permanent Tooth**Khatun MD^{1*}, Haque EEAE², Aman M³, Hasan MME⁴, Khan MRH⁵, Alam MS⁶

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Corresponding Author*Abstract**

Introduction: The bacteria impervious seal that is essential for success of root canal treatment which is provided by the root canal sealer and filler. In this respect, the choice of a sealer will influence the outcome of endodontic therapy. Calcium hydroxide has been widely used as an endodontic sealer, but recently Mineral Trioxide Aggregate (MTA) is a MTA based sealer introduce which has good sealing capacity. **Objective:** To observe the Efficacy of Mineral Trioxide Aggregate (MTA) and Calcium Hydroxide as a Root Canal Sealer in Non-vital Permanent Tooth With or Without Periapical Lesion. **Materials and Methods:** In this randomized clinical study total 100 tooth were taken and divided into two group: Group A-Mineral Trioxide Aggregate (MTA) and Group B-Calcium Hydroxide. Data were compiled and analyzed by computer based software SPSS version 22 and result were presented in tabulated form. **Results:** In the present study pain, tenderness on percussion and size of the lesion in both groups were evaluated at baseline, 3 and 6 months interval after completion of the treatment. Data were expressed in number and percentage. Statistical analysis was done by Chi-square test. The test of significance was calculated and p values < 0.05 was accepted as level of significance. **Conclusion:** It can be concluded that Mineral Trioxide Aggregate (MTA) is more effective in reducing the size of the periapical lesion than that of Calcium Hydroxide sealer. However, the clinical sign and symptoms, both materials showed almost equally effectiveness in reducing pain and tenderness.

Key word: Root canal sealer, Mineral Trioxide Aggregate (MTA), Calcium Hydroxide, Non vital tooth.

Introduction

The ultimate goal of endodontic therapy should be to return the individual teeth to a state of health and function. Root canal treatment is an effective, less invasive treatment modality for infective tooth and salvaging it from extraction. Success in endodontic treatment is originally based on the triad of debridement, thorough disinfection and obturation, with all aspects equally important. The bacteria impervious seal that is essential for success is provided by the root canal sealer and filler. Innumerable root canal sealers are time tested with definitive success rates.¹ sealers are categorized according to their main chemical constituents; zinc oxide eugenol, calcium hydroxide, resin and bioceramic based, glass ionomer and MTA based endodontic sealer.

Calcium hydroxide has been widely used in the treatment of various pathologic conditions in teeth. It is believed to aid in the production of secondary dentin, the induction of apical closure of immature teeth, and the healing of periapical lesions. Calcium hydroxide is commonly used as an inter-appointment root canal dressing because of its effectiveness in disinfecting the root canal system before permanent filling.² The alkaline pH of calcium hydroxide neutralizes lactic acid from osteoclasts and prevents dissolution of mineralized components of teeth. This pH also activates alkaline phosphates that play an important role in hard tissue formation.³ Calcium Hydroxide demonstrated stronger antibacterial activity after 7 days than 24 hrs.⁴

Another well known material is Mineral Trioxide Aggregate (MTA) which has good sealing capacity.⁵ This mineral trioxide aggregate (MTA) is now incorporated into root canal sealer which causes all properties of MTA are available in this sealer. MTA is a relatively new MTA-based root canal filling material, has a similar composition to MTA except from the addition of natural resin and nanoparticulate silica.⁶ Mineral trioxide aggregate (MTA) based sealers which have the predilection toward mineralization along with all the viable properties of orthodox sealer.⁷ According to its manufacturer, it exhibits high radio opacity, low solubility, biocompatibility, excellent flowing and stimulate bone to deposit on the Periapical area.⁸

MTA Angelus was recently shown to inhibit a diversity of aerobic and facultative microorganisms, including *E. faecalis* by agar diffusion method. Since MTA is rich in oxides. Subsequent to reaction with water on oxygen-rich environments, these compounds might generate reactive oxygen species (ROS), such as hydroxyl and hydroperoxyl radicals which exhibit antimicrobial activity.⁹ Although the manufacturer claims that MTA provide a good seal due the expansion during setting, there are limited independent publications about the physicochemical properties and the possibility to use, in clinical practice. Under the experimental conditions of the current *ex vivo* experiment, the results demonstrated that MTA has the potential to capitalize on the biological and sealing characteristics of MTA and, at the same time, improve its flow rate and manipulation characteristics.¹⁰ The tissue recovery and the lack of inflammatory response are optimized by the use of MTA and disalisylate resin. The product is eugenol free and will not interfere with adhesive procedure inside the root canal. Also, it does not cause discoloration of the tooth structure.¹¹

Materials and Methods

The study design was randomized clinical trial study. This comparative experimental study was performed from January, 2016 to December, 2016 in Department of Conservative Dentistry and Endodontics, Bangabandhu Sheikh Mujib Medical University, Dhaka-1000, Bangladesh. A total of 100 sample sizes were taken.

Selection criteria

Inclusion criteria

Single rooted non vital symptomatic tooth with or without periapical lesion.

Exclusion criteria

1. Large internal and external resorption.
2. Periodontal disease (3 degree mobility)
3. Patient with systemic disease.
4. Non restorable tooth.

Outcome Variables

Clinical evaluation

1. Pain: Pain assessment was performed according to VAS (Visual Analogue Scale) system proposed by Langer and Sheppers in 1985. According to this method, VAS is a 10 cm long horizontal line with points labeled 0 as no pain, 1-3 as mild pain, 4-6 as moderate pain, 7-10 as severe pain.
2. a) Tenderness on palpation: The apical area of the tooth was palpated with gentle finger pressure.
b) Tenderness on percussion: Percussion of tooth was performed by gentle tapping with gloved finger or blunt handle of mouth mirror on the offending tooth. Degree of response to percussion is directly proportional to degree of inflammation.

Radiological evaluation

1. Periodontal status: It was measured by the formation of lamina dura radiographically. All the radiograph will be taken by parallax view so that there was no change of size of the object or no change of angulation.
2. Periapical lesion: Diameter of the lesion was measured with a mili-metrical ruler radiographically.

Study Procedure

An individual patient's data, including case history, clinical and radiological assessment, treatment plan and periodic follow-up of the patients was recorded. Diagnosis of symptomatic necrosed anterior teeth was confirmed by pulp sensitivity test applying heat and cold method, and examination of pre-operative peri-apical radiograph was done for assessment of peri-apical lesion cases.

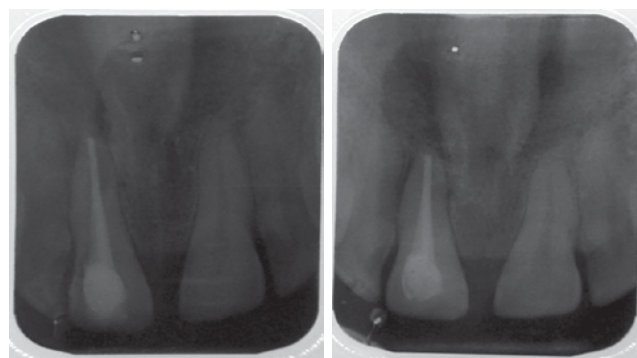
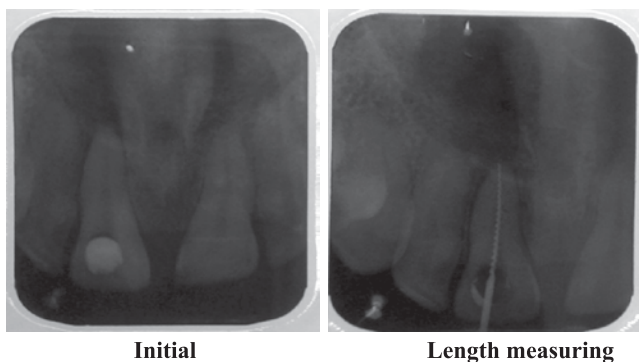
Tooth Preparation

Mouth preparation was done by scaling, polishing or curettage. After tooth preparation (if necessary) and proper isolation, A straight line access cavity was prepared and removed coronal necrosed tissue remnants. After negotiation, the canal patency was checked and the working length (Grossman formula) was determined. Biomechanical preparation of the canal was done by standardized technique and irrigation of the root canal was done by 2.5% NaOCl and EDTA. Finally, the smear layer was removed with liquid EDTA and then 2% Chlorhexidine was used. Drying of the canal was done with absorbent paper points. Placement of calcium hydroxide dressing for seven days and intermediate restoration was done by zinc-oxide eugenol cement. Removal of intermediate restoration and calcium hydroxide dressing and drying of the root canal was done. A master cone (gutta-percha point) was selected. The canal was obturated with Mineral Trioxide Aggregate (MTA) in group I and Calcium Hydroxide in group II as a root canal sealer. Access opening was finally sealed with a glass-ionomer or light cure composite filling material. The patient was later advised to report for any immediate complication.

The patient was recalled for clinical and radiographic evaluations at base line, after 3 and 6 months interval. Collected data will be analyzed using Statistical Package for social Science (SPSS) version 22. A p-value of <0.05 was considered significant.

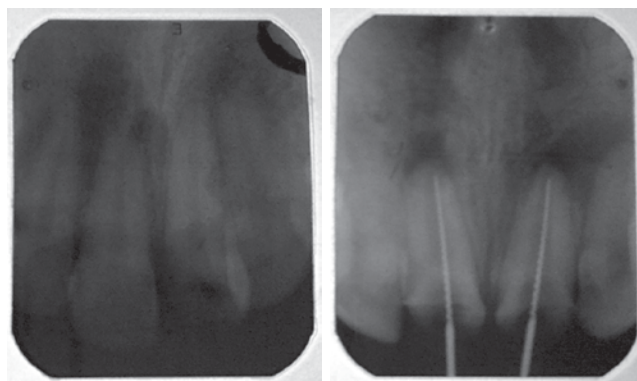
Radiological Evaluation-

Case-1 – Mineral Trioxide Aggregate (MTA)



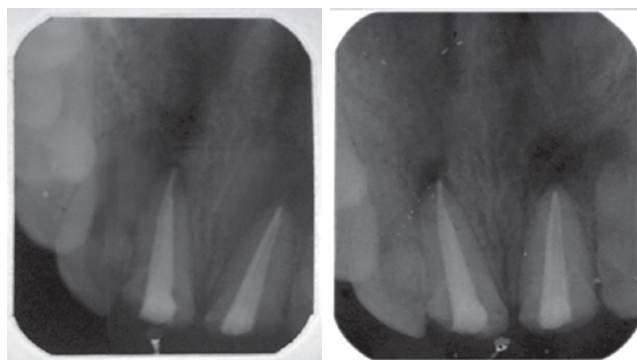
After obturation
Case-2 – Calcium Hydroxide

Follow-up after six month



Initial

Length measuring



After obturation

Follow-up after six month

Results

In the present study pain and tenderness on percussion in both groups were evaluated at baseline, 3 and 6 months interval after completion of the treatment. After 6 month in each group, 98% of MTA treated teeth and 88% of Calcium Hydroxide treated teeth showed no pain and tenderness on percussion. The differences between MTA and Calcium Hydroxide treated groups were not statistically significant ($p>0.05$). Results of this study are shown in table.

Table I: Comparison of pain level (VAS score) between two groups (n= 50 teeth in each group).

Evaluation period	Group I (MTA)		Group II (Calcium Hydroxide)		P value
	(n=50 teeth)		(n=50 teeth)		
	No.	%	No.	%	
Baseline					
No pain	40	80%	35	70%	0.684 ^{ns}
Mild pain	10	20%	15	30%	
Moderate pain	0	0.0%	0	0.0%	
Severe pain	0	0.0%	0	0.0%	
After 3 months					
No pain	48	96%	44	88%	0.297 ^{ns}
Mild pain	2	4%	6	12%	
Moderate pain	0	0.0%	0	0.0%	
Severe pain	0	0.0%	0	0.0%	
After 6 months					
No pain	49	98%	45	90%	0.312 ^{ns}
Mild pain	1	4%	5	10%	
Moderate pain	0	0.0%	0	0.0%	
Severe pain	0	0.0%	0	0.0%	

Data were expressed in number and percentage. Statistical analysis was done by Chi-square test. The test of significance was calculated and p values < 0.05 was accepted as level of significance. ns = Not significant; n = Number of samples. Group I = MTA Fillapex; Group II = Sealapex

Pain status

In Table-I, It was found that at baseline, 40 of 50 teeth (80 %) in MTA group and 35 of 50 teeth (70%) in Calcium Hydroxide group showed no pain. The differences between two groups were not statistically

significant ($p > 0.05$). At 3 months, 44 of 50 teeth (88%) showed no pain in Calcium Hydroxide group and the remaining 6 teeth (12%) showed mild pain. On the other hand, 48 teeth (96%) of MTA group showed no pain. The differences between two groups were not statistically significant ($p > 0.05$). Furthermore, at 6 months follow up period, 98% of MTA treated teeth and 90% of Calcium Hydroxide treated teeth showed no pain. Again the differences between MTA and Calcium Hydroxide treated groups were not statistically significant ($p > 0.05$).

Table II: Comparison of tenderness on percussion between two groups (n=50 teeth in each group).

Evaluation period	Group I (MTA) (n=50 teeth) No. %		Group II (Calcium Hydroxide) (n=50 teeth) No. %		P value
Baseline					
Present	10	20%	15	30%	0.440 ^{ns}
Absent	40	80%	35	70%	
After 3 months					
Present	5	10%	12	24%	0.297 ^{ns}
Absent	45	90%	38	76%	
After 6 months					
Present	1	2%	6	12%	0.312 ^{ns}
Absent	49	98	44	88%	

Tenderness on percussion

In Table-II, It was revealed that at baseline, tenderness was present 10 of 50 MTA group and 15 of 50 teeth in Calcium Hydroxide group. The differences between two groups were not statistically significant ($p>0.05$). After 3 months, 12 of 50(24%) teeth showed tenderness on percussion in Calcium Hydroxide group. On the other hand, tenderness was present in 5 of 50

teeth (10%) of MTA group. The differences between two groups were not statistically significant ($p>0.05$). Furthermore, after 6 months follow up, 98% MTA treated teeth and 88% of Calcium Hydroxide treated teeth showed no tenderness on percussion. Again the differences between MTA and Calcium Hydroxide treated groups were not statistically significant ($p>0.05$).

Table-III: Comparison of size of the lesion (mm) between two groups (n=50 teeth in each group).

Evaluation period	Group I (MTA) (n=50 teeth) Mean±SD (mm)	Group II (Calcium Hydroxide) (n=50 teeth) Mean±SD (mm)	t value	p value
Baseline	2.86±1.890	3.01±1.583	2.22	0.825 ^{ns}
After 3 months	2.276±.448	2.456 ±.685	-1.758	0.085 ^{ns}
After 6 months	1.788±.381	1.954 ±.543	-2.221	0.031 [*]
After 12 months	2.12 ± 0.781	1.60 ±0.913	-2.164	0.035 [*]

Size of the periapical lesion

The results of size of the periapical lesion were showed in Table-III. At base line, the mean periapical lesion size in MTA and Calcium Hydroxide sealer treated teeth were 2.860±1.890 and 3.01 ±1.583 mm respectively, which was statistically not significant ($p>0.05$). It was revealed that in both groups, lesion size was decreased after the time elapse. At 6 months follow up period, the mean lesion size was reduced to 1.788 ±0.381 and 1.954 ± 0.543 mm in MTA and Calcium Hydroxide treated teeth, respectively. The differences between two groups were statistically significant ($p<0.05$).

Discussion

The present study was designed to compare the clinical and radiological outcome of two different root canal sealers. The result of this study had confirmed the hypothesis that MTA based sealer is more effective than calcium hydroxide based sealer for obturation of the non-vital teeth with or without periapical lesion. When pain, tenderness on percussion and size of the lesion was observed at 3 and 6 months, it was found that MTA was more capable of reducing size of the lesion, which is statistically significant than that of

Calcium Hydroxide sealer. Mineral Trioxide Aggregate (MTA) also effective in reducing pain, tenderness on percussion and reduction of periapical lesion.

At 3 and 6 months observation period, pain gradually decreased following MTA therapy. When pain was analysis by VAS, it was found that 48 (96%) MTA treated teeth showed no pain at 3 months, followed by 49 (98%) at 6 month observation period. Previous studies have reported that MTA can reduce pain due to its high alkaline pH as well as antibacterial activity,⁵ excellent biocompatibility and stimulate mineralization.¹² Furthermore, MTA based sealer provides effective seal against dentin and cementum that can reduce re-entry of bacteria.¹³

However, 10 (20%) MTA treated teeth showed mild pain at base line, followed by 2 (4%) at 3 months. Although the reason of pain of those MTA treated teeth is not clearly understood from the present study but it may be due to mild toxicity of MTA sealer that toxic material may extrude through the apical foramen that causes irritation of the periapical tissues.¹⁴

On the other hand, 15(30%) Calcium Hydroxide treated teeth showed mild pain at base line, followed by 6 (12%) at 3 months and 5 (10%) at 6 month.

Previous studies have indicated that calcium hydroxide based sealer induces pain due to its tissue toxicity and invoke an inflammatory response in connective tissue.¹⁵ Furthermore, solubility of sealer may also lead to microleakage, which helps in bacterial penetration and causes post operative pain. The results found in the present study was also corresponded to an another study¹⁶ that pain occurred in 20% cases when treated in two visit root canal treatment. However, they might also associated with depend with treatment protocol or size of the previous lesion.

Regarding tenderness on percussion, it was found that tenderness gradually decreased in both MTA and Calcium Hydroxide sealer and the differences between two groups were not statistically significant ($P>0.05$). Previous studies have indicated that tenderness following MTA may be reduced due to it promotes biological repair and regeneration of periodontal ligament.¹³ On the other hand; the incidence of tenderness on percussion could be minimized due to periradicular healing by Calcium Hydroxide.¹⁷

Previous study indicated that a reduction in the size of pre-operative periapical radiolucency may be a sign of success in the absence of clinical signs and symptoms.¹⁸ In the present study, when periapical lesion was carefully observed by radiograph, it was found that lesion size decreased gradually with increasing periodontal healing by both MTA and Calcium Hydroxide sealer. However, the reduction ability in size of lesion as well as re-establishment of lamina dura by MTA treated teeth at all observation period was also statistically significant than that of Calcium Hydroxide sealer. At baseline, the size of the lesion of MTA treated tooth was 2.86 ± 1.890 mm. However, at 6 months lesion size was decreased to 1.788 ± 0.381 mm. On the other hand, in Calcium Hydroxide sealer, the size of lesion was decreased from 3.01 ± 1.583 to 1.954 ± 0.781 mm at 6 months observation period. Previous study also indicated that MTA was able to decrease more than 50% of the diameter of the periapical lesion.¹⁹

The mechanism of apical healing by MTA or Calcium Hydroxide sealer is not clarified in the present study.

However, previous studies have indicated that MTA stimulates interleukin (IL-6 & IL-8) production, allows the overgrowth of cementum (osteocementum) and formation of bone, which facilitates the regeneration of periodontal ligament.²⁰ Excellent biocompatibility and well tolerance by the periapical tissue without affecting the periapical healing process are responsible for high success rate of MTA.²¹ Furthermore, the stimulation of mineral deposition following MTA may deprive the microorganisms in the root canal delta as well as reduce the space for multiplication for the remaining bacteria. Therefore, further chance of reinfection could be reduced by MTA.²¹

Conclusion

Mineral Trioxide Aggregate (MTA) is more effective in reducing the size of the periapical lesion than that of Calcium Hydroxide sealer. However, the clinical sign and symptoms, both materials showed almost equally effectiveness in reducing pain and tenderness.

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