ORIGINAL ARTICLE

EFFECT OF SODIUM PHOSPHATE DIBASIC SOLUTION ON THE APICAL SEALING ABILITY OF WHITE MINERAL TRIOXIDE AGGREGATE; AN IN VITRO STUDY

[1]MUNAZZAH IJAZ, [2]TAHIR ALI KHAN, [3]AMJID NASEER, [4]NAYYAB AMIN, [5]AAMIR SHEHZAD

ABSTRACT

The purpose of this in vitro experimental study was to evaluate the effect of 20% sodium phosphate dibasic solution on apical sealing ability of white mineral trioxide aggregate (WMTA).

Mineral trioxide aggregate (MTA) was originally introduced to seal perforations and root-end cavities. It has been used widely for numerous applications through root repair to bone healing due to its capabilities to seal off the routes of communications among external surface of tooth and root canal system. The apical sealing ability of MTA as retrograde filling material has been tested through different leakage technique. The main target in apical resection is to achieve an enclosed seal between the periapical tissues and apical portion of the root canal by retrograde root- end filling.

Forty single rooted extracted lower premolar teeth were subjected to instrumentation and obturation procedure. The specimens were sectioned at 2mm from the apex and were coated with three layers of nail varnish, except for the apical surface. Standardized 4mm deep and 0.8mm wide retrograde cavities were prepared. The specimens in control group were filled with WMTA mixed with distilled water while specimens of experimental group were filled with WMTA mixed with 20% sodium phosphate dibasic solution. The specimens were then submerged in 0.2% Rhodamine B dye for a period of one week. Light microscope with ocular micrometer was used to analyze the dye leakage data. Chi - squared test revealed no significant difference between two groups.

It was concluded from the present study that the addition of 20% sodium phosphate dibasic solution had no effect on apical sealing ability of WMTA.

Key Words: *Mineral Trioxide Aggregate, apical sealing ability, sodium phosphate dibasic solution.*

INTRODUCTION

Among the various biocompatible dental materials Mineral Trioxide Aggregate (MTA) was presented in 1993 to seal perforations and root end cavities.[1,2] Mineral trioxide aggregate is presented as powder and liquid form. The powder mainly consists of hydrophilic particles consisting of Tri-calcium silicate, Tri-calcium aluminate, Tri-calcium oxide, Silicate oxides and Bismuth oxide. Mineral trioxide aggregate is basically available as Grey Mineral Trioxide Aggregate (GMTA) and White Mineral Trioxide Aggregate (WMTA). The WMTA contains less percentage of Tetra calcium alumino ferrite as compared to GMTA.[3] The liquid component of WMTA is usually distilled water.

Mineral Trioxide Aggregate has been used widely for numerous applications through root repair to bone healing due to its capabilities to seal off the routes of communications among external surface of tooth and root canal system.[4,5] Retrograde root canal filling is the preferable choice of treatment once teeth with constant periapical infection fails to resolve with standard therapy. The purpose of retrograde filling material is to provide good apical seal that prevents ingress of foreign substances from root canal system into peri-radicular tissues.[6]

In regard to literature review various materials like dental amalgam[7], zinc oxide eugenol cements[7] and dental composites[8] have been used as retrograde filling materials. Mineral Trioxide Aggregate (MTA) has gained popularity due to its superior biocompatibility and currently a material of choice as retrograde filling material.[9] During surgical conditions it is nearly impossible to attain a completely dry environment

[1] **For Correspondence** Dr Munazzah Ijaz, BDS, MPhil, Lecturer Dental Materials, Sardar Begum Dental College, Gandhara University, Peshawar. Email: dr.munazzah84@gmail.com. Cell:0333-9111836.

[2] Dr Tahir Ali Khan, BDS, MDSc, Professor Dental Materials, Sardar Begum Dental College, Gandhara University, Peshawar. Cell: 0333-9132759

[3] Dr Amjid Naseer, BDS, MSc, Associate Professor Dental Materials Sardar Begum Dental College, Gandhara University, Peshawar. Cell:0345-9042258.

[4] Dr Nayyab Amin, BDS, Lecturer Dental Materials Rehman College of Dentistry, Peshawar.

[5] Dr Aamir Shehzad, BDS, MSc, Assistant Professor Dental Materials, Women Dental College, Abbotabad.

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regardless of applying pressure with cotton pellets in order to control haemorrhage, but MTA is advantageous in such conditions as it remains insensitive in the presence of moisture.[10]

The apical sealing ability of MTA as retrograde filling material has been tested through different leakage techniques like dye leakage, fluid filtration, protein leakage and bacterial leakage. The results of various studies have mentioned that MTA is better in terms of apical sealing ability as compared to other materials.[6,11] However, the addition of sodium phosphate dibasic as an accelerator to mineral trioxide aggregate has yet to be determined to look at its sealing ability. Sodium phosphate dibasic is an inorganic compound with alkaline pH and hygroscopic in nature.[12] Numerous dye leakage studies have been performed on MTA when used as a root-end filling material using different types of dyes such as methylene blue, fuchsin, rhodamine B, silver nitrate, India ink, and Pelikan ink.[13,14] In this study rhodamine B dye was used for dye penetration. Rhodamine B dye was selected for dye leakage in our study because it is a fluoresce dye and thus can be detected easily. However, rhodamine B dyes are used extensively in biotechnology applications such as fluorescence microscopy, flow cytometry and fluorescence correlation spectroscopy. [14]

In this study 20% sodium phosphate dibasic solution was used as liquid to determine the effect on apical sealing ability of WMTA. The WMTA is usually mixed with water but has long setting time of 165 minutes[10]. Various accelerators like calcium chloride, chlorhexidine, KY-jelly and sodium hypochlorite have been added to WMTA powder and liquid to reduce its setting time[3]. It was found by Huang *et al* that 15% sodium phosphate dibasic solution significantly reduced the final setting time of white mineral trioxide aggregate and also improved its apical sealing ability[15]. This study was done in an attempt to evaluate the effect of 20% sodium phosphate dibasic solution on apical sealing ability of WMTA. The 20% sodium phosphate dibasic solution was added to shorten the final setting time and to improve the apical sealing ability of WMTA. As reduction in final setting time cuts the absorption of water and permits the WMTA to defy hydrostatic pressure and thus avoid leakage of cement water[7]. These characteristics are necessary when root end cavities are restored during the procedure of apical surgery. The WMTA with short setting time also prevents its washout during surgery[7]. The principal factor to attain achievement in surgical endodontics is the apical seal of root-end filling materials.[16] A variety of root-end filling materials have been used and the selection of these materials can be determined by their handling properties, biocompatibility, apical sealing and long term clinical success records. [16]

The purpose of this in vitro experimental study was to evaluate the effect of 20% sodium phosphate dibasic solution on apical sealing ability of white mineral trioxide aggregate.

MATERIALS AND METHODS

The study was conducted for a period of six months in the Department of Science of Dental Materials at Sardar Begum Dental College and Department of Pathology, Kabir Medical College, Gandhara University Peshawar, after the approval from Advance Research and Ethical Committee of Sardar Begum Dental College, Gandhara University Peshawar. A total of forty extracted single rooted lower premolar teeth were used for evaluation of apical sealing ability of WMTA (Nexobio Co, Korea) as retrograde filling material. The crown of each tooth was segmented at cemento-enamel junction with # 701 diamond tapered fissure bur (Mani Incorporation, Tochigi Japan) with high-speed air turbine (NSK Japan) at 360,000- 450,000 rpm under constant irrigation with water spray. The root canals were initially prepared with a size of 10 K file, (Weilkang, China). The root canals were prepared upto 40# K file (Weilkang, China), using step-back technique.

After cleaning and shaping, root canals were dried with #40 paper points (Gapadent Co, China) and obturation was done with gutta purcha (Gapadent Co, China) and sealed with Endomethasone N root canal sealer (Septodont, USA) using standard lateral condensation technique. The specimens were wrapped in gauze and soaked in saline solution stored at 37 □ C for fifteen days. The apical 2mm of all obturated specimens were marked[17] and resected from apical end at 90 □ towards the long axis of root using diamond fissure bur in high-speed hand piece (Fig 1).

The standardized 4mm deep and 0.8mm wide root end cavities were prepared with straight fissure diamond bur (Mani Incorporation, Tochigi Japan) with low speed hand piece. The non-probability sampling technique was used to randomly divide the obturated specimens into 2 groups (n=20 teeth) on the basis of root end filling materials as:

Control: WMTA powder mixed with distilled water (Haq Chemical Suppliers, Peshawar)

Experimental: WMTA powder mixed with 20% sodium phosphate dibasic solution (BDH Prolabo, Leuven Belgium)

The root-end cavities of specimens in control group were packed with WMTA powder mixed with distilled water and specimens in experimental groups were packed with WMTA powder mixed with 20% sodium phosphate dibasic solution using amalgam gun and small condenser. The specimens were then wrapped in gauze, soaked in saline solution and placed in an incubator (Jouan CELL life Thermo Fisher Scientific) at 37 ℃ for 48 hours to allow sufficient time for the setting of the root-end filling materials. After removing the specimens from incubator, they were dried and all

the external surfaces of the roots were coated with three layers of nail varnish (Revlon) except the apical 2mm of resected root. After the first coating, the nail varnish was allowed to dry for 24 hours, and then a second coat was applied and allowed to dry for 4 hours. The final coating was done and the teeth were left undisturbed for 48 hours (Fig 2). All the teeth were then suspended upright in airtight containers containing 3ml of 0.2% Rhodamine B dye (BDH Prolabo, Leuven Belgium) and were kept in an incubator at 37℃ for 1 week. Roots were removed from the dye and were rinsed under running tap water for 12 hours[17] in order to remove the dye and nail varnish. The separating disc was used to section the roots vertically in a buccolingual direction into two halves in order to expose the root-end fillings (Fig 3). Dye penetration was recorded for each specimen and scored according to the scale (Table 1). [17] Dye penetrations were examined on light microscope with ocular micrometer with 40X magnification.

RESULTS

The microleakage score for specimens in control group are shown in Table 2. According to results, 70% of specimens showed no leakage through retrograde filling while 20% specimens showed leakage upto 1/3rd and 10% showed leakage upto 2/3rd of retrograde filling. Among all specimens none of specimen showed leakage through retrograde filling.

The microleakage score for specimens in experimental group are shown in Table 3. According to results 55% of specimens showed no leakage through retrograde filling while 40% specimens showed leakage upto 1/3rd and 5% showed leakage upto 2/3rd of retrograde filling. Among all specimens none of specimen showed leakage through retrograde filling.

The data from the two groups were submitted for statistical analysis. The chi- squared test revealed no statistically significant difference between control and experimental groups (Table 4). The results revealed that the addition of sodium phosphate dibasic solution had no effect on apical sealing ability of Mineral Trioxide Aggregate.

DISCUSSION

The purpose of placing a retrograde seal after apicoectomy is to seal all portals of exit and to establish an effective barrier between the root canal and the periapical tissues. [18] Dye penetration technique was used in the current study to evaluate the degree of microleakage, because it has a molecular weight even lower than that of bacterial toxins, has a high degree of staining and is inexpensive to use. Rhodamine B dye was used in the current study because of its smaller particle size, easy visualization and large diffusion of the dye into dentinal tubules.[17] Mineral Trioxide Aggregate consists of calcium oxide that reacts with water to produce calcium hydroxide that makes it alkaline. This is the reason methylene blue cannot be used in conjunction with MTA as it gets stained by interaction with alkaline material and loses its identification.[17] Rhodamine B is an organic xanthenic dye with better diffusion on human dentin than methylene blue.[17] The Rhodamine B dye also have nanosized particles which

TABLE 1: SCALE FOR DYE PENETRATION[17]

Value	Status of Leakage
0	No Leakage
1	Leakage upto 1/3rd of retrograde obturation
2	Leakage upto 2/3rd of retrograde obturation
3	Leakage through retrograde obturation

TABLE 2: MICROLEAKAGE SCORES FOR CONTROL GROUP: WMTA MIXED WITH DISTILLED WATER

Total Specimens	Leakage Results for Apical Sealing Ability of Specimens			
20	No Leakage	Leakage upto 1/3rd of retrograde obturation	Leakage upto 2/3rd of retrograde obturation	Leakage through and through retrograde obturation
	14 (70%)	04 (20%)	02 (10%)	00 (00%)

TABLE 3: MICROLEAKAGE SCORES FOR EXPERIMENTAL GROUP: WMTA MIXED WITH 20% SODIUM PHOSPHATE DIBASIC SOLUTION

Total Specimens	Leakage Results for Apical Sealing Ability of Specimens			
20	No Leakage	Leakage upto 1/3rd of retrograde obturation	Leakage upto 2/3rd of retrograde obturation	Leakage through and through retrograde obturation
	11 (55%)	08 (40%)	01 (05%)	00 (00%)

TABLE 4: STATISTICAL DIFFERENCE BETWEEN CONTROL AND EXPERIMENTAL GROUP

CHI Square Test			
	Value	Difference	P value
Pearson Chi-Square	2.027	2	0.05
Likelihood Ratio	2.060	2	

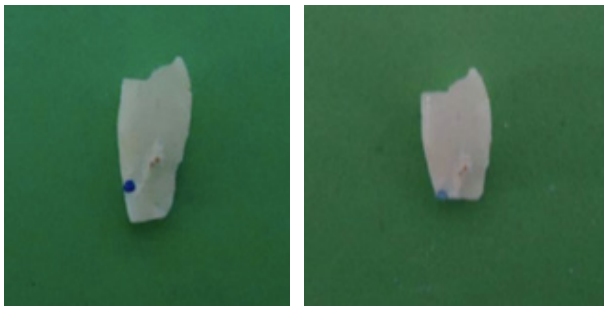

Fig 1: Apical 2/3 marked and sectioned in specimens

Fig 2: Coating of specimens with nail varnish

Fig 3: Sectioning of specimens in buccolingual direction

mimic enzymes and toxins of leakage triggering from bacterial breakdown.[17]

In this study 4mm deep and 0.8mm wide retrograde cavities were prepared with reference from previous studies [8,10]. The apical leakage also increases as the angle of the bevel increases, due to larger number of dentinal tubules and its permeability.[17] It is easily detectable in radiographs as it is more radiopaque than gutta purcha and dentin.[16] Ding *et al* reported that sodium phosphate dibasic solution did not interfere with the biocompatibility of the mineral trioxide aggregate. They also reported that incorporating sodium phosphate dibasic solution did not change the chemical composition of the WMTA.[19]

The results of the current study also showed no statistical significant difference between the apical sealing abilities of WMTA mixed with distilled water and 20% sodium phosphate dibasic solution. The results showed that 70% of specimens from control and 55% of specimens from experimental group showed no microleakage through retrograde filling, however none of the specimens showed microleakage beyond the retrograde preparation. The apical sealing ability of the WMTA is not compromised by mixing WMTA with 20% sodium phosphate dibasic solution. Torabinejad *et al*, Aqrabawi *et al* and Sayed *et al* proved that WMTA have superior apical sealing ability in comparison from other root end filling materials in different dye leakage studies [10, 16,20] that is in accordance with results of our study. Sayed *et al* compared the sealing ability of diadent bioaggregate, intermediate restorative materials, amalgam and WMTA. It was concluded from the study that WMTA and diadent bioaggregate showed improved sealing ability in comparison with other root end filling materials.[20]

Shahi *et al* [21] used dye penetration to compare the apical sealing ability of white and gray MTA mixed with distilled water and 0.12% chlorhexidine gluconate. The results showed no significant difference in the apical sealing ability. It appears that chlorhexidine does not have any influence on the sealing ability of MTA. Bortoluzzi *et al* evaluated the effect of calcium chloride on sealing ability of MTA and Portland cement. Single rooted tooth were suspended in used and were suspended for 72 hours in 0.2% Rhodamine B dye. The results showed that the sealing ability of mineral trioxide aggregate was improved with addition of calcium chloride.[17]

Mineral Trioxide Aggregate has an excellent marginal sealing ability because of its hydrophilic nature.[22] The main ions present in MTA are calcium and phosphorous which are also the primary ions present in dental hard tissues. It was also verified that in the presence of a fluid, MTA has the capability to precipitate hydroxyapatite crystals which may be responsible for minimizing leakage afterwards.[23] The other factor includes that hydration of MTA powder in the presence of humidity can result in rise in the compressive strength and thereby reduction in leakage.[19] Assessment of the data attained from numerous leakage studies displays significant variation in the results of these studies.[24] This variation may be due to changes between commercial brands of MTA, methods and dissimilar kind of dyes used, scarcity of standardization or assessment criteria for measurable results

acquired in these studies.[20] Inspite of the differences mentioned, none of the roots in both groups showed microleakage beyond the root-end filling material. This result is in agreement with previous studies, which reported that WMTA showed excellent, apical sealing ability and demonstrated superiority in contrast with other commonly used root end filling materials.[20]

CONCLUSION

Within the limitations of this *in vitro* study it was concluded that 20% sodium phosphate dibasic solution had no effect on apical sealing ability of White Mineral Trioxide Aggregate.

LIMITATIONS OF THE STUDY

In vitro dye leakage studies have been accomplished with slight or no resemblances to *in vivo* settings. The use of 20% sodium phosphate dibasic solution to evaluate the apical sealing ability of WMTA was an experimental attempt. Advance studies are required to govern the suitability of this material for *in vivo* use.

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CONTRIBUTIONS BY AUTHORS

1 Munazzah Ijaz:	Principal Researcher, Data Collection.
2 Tahir Ali Khan:	Supervisor and Conception of Study.
3 Amjid Naseer:	Manuscript/Article writing.
4 Nayaab Amin:	Statistics and Data Collection.
5 Aamir Shehzad:	Proof Reading.