Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2020;10:4:87-91.

Comparative Evaluation of the Dissolving Ability of Carbonic Acid (pH=5.4), 10% Citric Acid and 2% Chlorhexidine Gluconate on Set White MTA and their Effect on the Hardness of Surrounding Sound Dentin: In Vitro Study

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ABSTRACT

Background: To evaluate and compare the dissolving ability of Carbonic acid (pH=5.4), 10% Citric Acid(10%) and Chlorhexidine Gluconate(2%) on set White MTA and its effect on the hardness of surrounding sound dentin.

Materials and Method: 40 dentin disc of 2mm height were packed with white MTA mixed with sterile water in a ratio of 3:1. Specimen were kept in 100% humidity for 21 days and later embedded into the polymerising acrylic resin. Surface roughness and microhardness were checked by using computerised surface roughness tester and Vickers microhardness of White MTA and dentin respectively. The specimens were randomly divided into 4 groups and exposed to experimental chemicals Carbonic Acid (CAG), 10% Citric Acid (CA)S, 2% Chlorhexidine Gluconate (CHX) and Normal Saline (Control Group) for time intervals of 3 and 6 minutes. Surface roughness testing of White MTA and Vickers microhardness of dentin was done again at a time interval of 3 and 6 minutes. Data were analysed by ANOVA and Post-hoc test.

Result: The results showed that Carbonic acid exposure significantly increases the surface roughness of white MTA after 3 and 6 min as compared with Citric acid, Chlorhexidine and Saline.

Conclusions: The result of the present study indicate Carbonic acid was the most effective chemical for MTA dissolution at 21 days of the setting of White MTA. Carbonic acid and 10% citric acid-induced significant reduction in the surface microhardness of dentin except for 2% Chlorhexidine Gluconate.

Keywords: White MTA, Carbonic acid, 10% Citric Acid, Chlorhexidine Gluconate 2%, Dentin, Microhardness, Surface roughness.

INTRODUCTION

The introduction of mineral trioxide aggregate (MTA) in 1993 has revolutionised the field of endodontics and has created a new dimension for the success of complicated clinical procedures.[1] It is considered as an ideal endodontic repair material as it seals the pathways of communication between

Received: June. 21, 2020**: Accepted**: Aug. 23, 2020

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pISSN 2278-0076

eISSN 2321-9270

the root canal system and the surrounding tissues. It has many advantages as nontoxic, non-carcinogenic, nongenotoxic, biocompatible, insoluble in tissue fluids, and dimensionally stable.[2]

Initially MTA was recommended as a root-end filling material and later has been used for pulp capping, pulpotomy, apexogenesis, apical barrier formation, repair of root perforations, and as a root canal filling material. Disadvantages of the MTA are its prolonged setting time (2 hours and 45 minutes) and its inability to be retrieved from within the root canal. Retrieval is a requirement for any root canal filling material so that it becomes possible to re-treat in case of failures.[2] Any change in the mineral content (Calcium and Phosphorus) ratio of the root canal dentine alters its original proportion of organic and inorganic components, reduces the micro-hardness, increases the permeability and solubility.[3]

Root dentin is exposed to various solvents which are used to retrieve MTA and which may cause alterations in its micro-hardness. The purpose of this study was to evaluate the dissolving ability of Carbonic acid (pH=5.4), 10% Citric acid and 2% Chlorhexidine Gluconate on set white MTA and their effect on surrounding sound dentin.

MATERIALS AND METHODS

Forty freshly extracted human non-carious, permanent, single-rooted, intact teeth were collected. Marking of 2 mm was done with a marker at a cementoenamel junction on the root surface. For obtaining this slice, the first horizontal cut was given near cementoenamel junction and second was given 2mm apical from the first cut using a diamond disk .2 mm space was created into the dentin disc with the help of round bur (BR-31) and air-rotor handpiece under water coolant.

White MTA powder (Angelus, PR Brazil) was mixed with sterile water (ratio of 3:10) to a thick creamy consistency. The White MTA was incrementally compacted in the dentin disc with a stainless-steel condenser to minimise voids. All specimen was kept in a moist cotton pellet and stored in 100% humidity in the humidor for 21 days for the setting of MTA. Specimens were embedded into the polymerising acrylic resin.

The set White MTA and dentin layer was grounded with 400-grit, 600-grit and 1200-grit silicon carbide papers to facilitate the polishing of the surface and visualisation for the surface roughness and microhardness test respectively. Surface roughness was checked by using computerised surface roughness tester (Mitutoyo Corporation –Japan, Model: SJ210) (Fig.1) and microhardness by using Vickers microhardness testing machine with a square-based pyramid-shaped diamond indenter (Reichert Austria). (Fig. 2)

Fig 1: Checking the surface roughness of White MTA

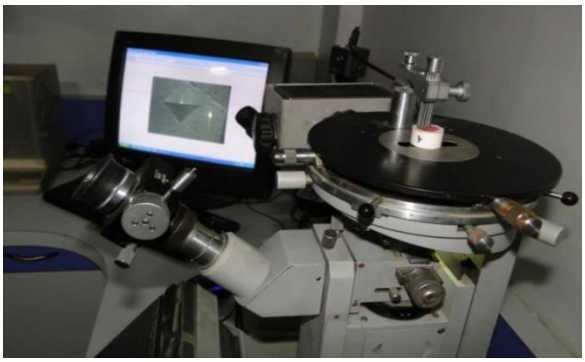


Fig 2: Checking the Vickers microhardness of dentin

The Ra parameter describes the overall roughness of a surface and can be defined as the arithmetical average value of all absolute distances of the roughness profile from the centerline within the measuring length. Three tracings of different locations on White MTA were made. The Ra values were averaged to produce one Ra value for each specimen.

Indentations were made at a minimum of three widely similarly positioned locations at 0.5 mm level. The indentations were made on the top surface of dentin using 100 g and a dwell time of 5 s. The average length of the two diagonals was used to

calculate the micro-hardness values (Vickers hardness number [VHN]. The three values were averaged to produce one value for each specimen.

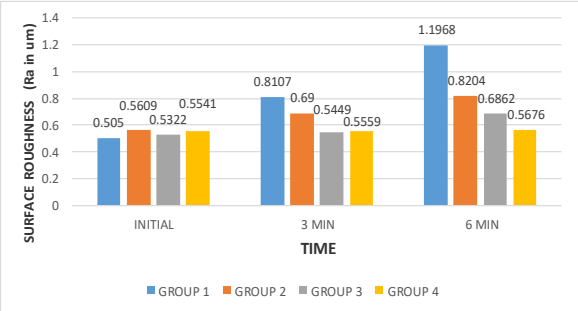
These specimens were then randomly divided into four groups, with ten samples in each group and exposed to experimental chemicals as follows:

- Group 1: Carbonic Acid (CAG)
- Group 2: 10% Citric Acid (CA)
- Group 3: 2% Chlorhexidine Gluconate (CHX)
- Group 4: (Control Group): Normal Saline (CG)

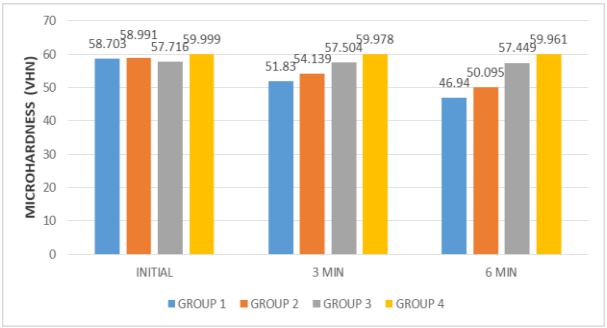
As the vehicle used in the CAG, CA, and CHX is aqueous in nature, saline was selected as the control group (CG).

These 40 samples received irrigation using 26 gauge needle and a 3ml syringe. The tip of the needle was placed over the White MTA surface and continuously irrigated for time intervals of 3 and 6 minutes. Surface roughness testing of White MTA and Vickers microhardness of dentin was done for these 40 samples at a time interval of 3 and 6 minutes after exposure to these chemicals

RESULTS



Graph I: Surface roughness of the study groups at the time intervals.



Graph II: Microhardness of the study groups at the time intervals.

From the data collected the mean surface roughness and microhardness values before and after the exposure to chemicals for all groups were calculated. Comparison of mean change in surface roughness of MTA and microhardness of Dentin values within the groups was made with one way ANOVA test.

Carbonic acid exposure significantly increases the surface roughness of white MTA after 3 and 6 min (0.8107 and 1.1968). The increases in the surface roughness of white MTA was greater in Carbonic acid group as compared with the other test groups. (Graph I) It was observed that 6 min exposure (46.94 VHN) to Carbonic acid showed a greater reduction in the surface hardness of dentin as compared to 3 min (51.83 VHN). (Graph II)

10% citric acid also significantly increases the surface roughness of white MTA after 3 and 6 minutes (0.6900 and 0.8204 respectively) and significantly reduces microhardness of dentin as compared to carbonic acid at a 6-minute interval. In the Chlorhexidine group, no significant effect was noted on the surface roughness of white MTA and microhardness of dentin even after 6 minutes. No mean reduction in hardness of White MTA and dentin was observed with the control.

DISCUSSION

MTA is a hydraulic cement (i.e. sets and stable underwater), relying primarily on hydration reaction for the setting. Caravia et all found that under the wet condition, the push-out strength of MTA showed a statistically significant increase when curing time was increased from 3 to 21 days, showing that full curing necessitates 21 days.[4] Hence for the complete set of the White MTA sample were kept in wet moist cotton for 21 days in the humidor.

Funteas et al. (2004) have shown that the surface hardness of Portland cement is reduced by organic acids like carbonic acid, citric acid and tartaric acid.[5] Carbonic acid (pH of 5.48) was selected as one of the chemicals for retrieval of MTA because it is a part of human blood.[1] 10% Citric acid and 2% Chlorhexidine Gluconate is a frequently recommended root canal irrigant for endodontic use.[6] 10% citric acid is calcium depleting organic acid with a pH of 2.15.[7]

Effect of various acids on MTA shows calcium hydroxide, C-S-H, and the calcium sulfoaluminate phases decomposition successively, producing an altered, calcium-depleted, hydrated silicate layer[8, 9]. This fact may have caused a continued increase in surface roughness of completely set white MTA.[9] Due to these chemical interactions, it is possible to use these organic acids (Carbonic acid and 10% Citric acid) for dissolving the calcium silicate-based material (MTA) in the retreatment cases.

2% Chlorhexidine Gluconate showed significant surface dissolution within 24 hours of WMTA placement. Hence root canal should not be irrigated with 2% Chlorhexidine Gluconate for 24hrs in which WMTA is used.[1] Hence 2% Chlorhexidine Gluconate can be used for the removal of white MTA. The results of the present study confirm the important role of the carbonic acid solution for the retrieval of MTA from the root canal when indicated. Carbonic acid exposure significantly increases the surface roughness of white MTA after 3 and 6 min (0.8107 and 1.1968). There was a significant difference between the 3 and 6 min exposure. The increase in the surface roughness of white MTA was greater in Carbonic acid group as compared with the other test groups. Also, it was observed that 6 min exposure (46.94 VHN) to carbonic acid showed greater reduction in the surface hardness of dentin as compared to 3 min (51.83 VHN).

10% Citric acid exposure also significantly increases the surface roughness of white MTA after 3 and 6 minutes (0.6900 and 0.8204, respectively). But at 3 minutes interval, it was not statistically significant as compared to Carbonic acid (P = 0.053). 10% Citric acid exposure also significantly reduces microhardness of dentin as compare to carbonic acid at 6-minute interval.

In the Chlorhexidine group, no statistically significant effect was noted on the surface roughness of white MTA as compare to Carbonic acid and 10% citric acid. It also had a negligible effect on the microhardness of dentin even after 6 minutes. No mean reduction in hardness of White MTA and dentin was observed with the control group even after 6 minutes (P = 0.877 and 0.996).

In this present study dissolution of WMTA was assessed by an increase in surface roughness after exposure to acids because clinically only the surface of the material will be exposed to solvents hence immersing it in acid for checking solubility might not clinically correlate. Furthermore, particles of cement might fall out from the specimens during immersion in liquid.[2]

In previous studies, the Vickers indenter method was used for measuring the hardness of dentin.[10-12] It has been indicated that microhardness determination can provide indirect evidence of mineral loss or gain in the dental hard tissues.[13] Thus, this method was adopted in the present study.

It has been shown that after 5 minute EDTA and citric acid had the greatest overall effect, causing a sharp decrease in dentin microhardness without a significant difference from each other.[10]Hence in our study irrigation of chemicals has been done for 3 and 6-minute interval. In our study, the interaction of WMTA with Carbonic acid was more effective, i.e. carbonic acid shows more roughness of MTA after 3 and 6 minutes. Fresh carbonic acid dissolved WMTA better because the availability of carbon dioxide for interaction decreases over a period of time as it gets released.[1] These results shows confirmation along with the previous study results of Butt et al[14] and Shojaee NS et al[15] that surface hardness of MTA is reduced by carbonic acid and citric acid.

CONCLUSIONS

The following conclusions may be drawn from this in-vitro research:

1. Carbonic acid was the most effective chemical for MTA dissolution at 21 days of the setting of White MTA.

2. 10% citric acid also potential solvents to aid in the retrieval of set MTA from root canals.

3. Carbonic acid and 10% citric acid-induced significant reduction in the surface microhardness of dentin except 2% Chlorhexidine Gluconate.

4. The exposure to chemicals should not exceed 6 minutes for MTA retrieval in reducing significant alterations in the mechanical and physical properties of the dentin.

5. The present results concluded that Carbonic and 10% of Citric acids are potential solvents for MTA dissolution, but further studies are necessary before their clinical use.

CONFLICTS OF INTEREST

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

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