International Journal of Research in Health and Allied Sciences

Journal home page: www.ijrhas.com

Official Publication of "Society for Scientific Research and Studies" [Regd.]

ISSN: 2455-7803

Original Research

Bond strength of composite resin to white mineral trioxide aggregate

[1]Dr. Aastha Arora, [2]Dr. Avneet Chauhan

[1,2]Private Practitioner, India

ABSTRACT:
Background: To study the effect of different surface treatments of MTA on bond strength of composite resin to MTA. **Materials & methods:** A total of 20 cylindrical acrylic blocks, each containing a hole, were prepared and filled with ProRoot MTA. The blocks were divided into four groups for further analysis: Group 1, which received no surface treatment; Group 2, where phosphoric acid etching was performed. The results were analysed using SPSS software. **Results:** The Kruskal-Wallis test revealed a statistically significant difference in microshear bond strength values among the four study groups ($P < 0.05$). Among these groups, Group 4, which underwent HF etching and silane application, exhibited the highest microshear bond strength (28.0), while Group 3, treated with sandblasting, demonstrated the lowest value (4.8). **Conclusion:** The preferred methods for surface treatment of MTA before bonding with composite resin were found to be phosphoric acid etching or HF etching combined with silanization.

Keywords: Mineral trioxide aggregate, Composite, Bond strength.

Received: 11 April, 2023 Accepted: 16 May, 2023

Corresponding Author: Dr. Aastha Arora, Private Practitioner, India

This article may be cited as: Arora A, Chauhan A. Bond strength of composite resin to white mineral trioxide aggregate. Int J Res Health Allied Sci 2023; 9(3):35-38.

INTRODUCTION

The mineral trioxide aggregate (MTA) is a hydrophilic and biocompatible endodontic cement, capable of stimulating healing and osteogenesis. It consists of a powder of fine trioxides (tricalcium oxide, silicon oxide, bismuth oxide) and other hydrophilic particles (tricalcium silicate, tricalcium aluminate, responsible for the chemical and physical properties of this aggregate), which hardens in the presence of humidity. [1-3] The hydration of the powder results in the formation of a colloidal gel with pH 12.5, which solidifies in a structure in about 3 to 4 hours. [4,5]Mineral trioxide aggregate (MTA) has received considerable attention in vital pulp therapy (VPT) due to its proper biological characteristics and favorable histological/clinical results. [6] MTA consists of hydrophilic particles which set in the presence of moisture by formation of calcium hydroxide and silicate hydrate gel. Grey and white ProRoot MTA (PMTA) have different chemical compositions, and other commercial forms of this biomaterial such as Root MTA (RMTA) have been manufactured in Iran.[7] RMTA has demonstrated similar results with PMTA in terms of clinical/radiographic success of pulpotomy of primary molars as well as bacterial and dye microleakage. [8,9]

Pulp capping with MTA has gained very popularity because of providing dentinogenesis in human pulp cells. [10,11] When compared with calcium hydroxide as a pulp capping agent; MTA forms faster, uniform and thicker dentinal bridge, provides less pulp inflammation and bacterial microleakage with lower solubility and better marginal adaptation. [12] However, it has disadvantages such as high cost, long setting time, difficulty in manipulation, low resistance to compression and flow capacity, discoloration of tooth structure, and release of arsenic. [13]

Surface treatments had been suggested to improve the adhesion properties between bi-materials interface, by providing micromechanical and chemical retention between different constituents.[14,15] Various surface treatments had been applied to enhance the bond strength between the fibre post and other restorative materials as composite core and resin cements including sandblasting, silane coupling agent, and acid etching agents. [15-17] Hence, this study was conducted to evaluate the effect of different surface treatments of MTA on bond strength of composite resin to MTA.

MATERIALS & METHODS

A total of 20 cylindrical acrylic blocks, each containing a hole, were prepared and filled with ProRoot MTA. The blocks were divided into four groups for further analysis: Group 1, which received no surface treatment; Group 2, where phosphoric acid etching was performed; Group 3, involving sandblasting; and Group 4, which underwent hydrofluoric acid (HF) etching, rinsing, and silane application. OptiBond Solo Plus adhesive was used across all groups to ensure consistency. Following that, composite resin cylinders were bonded to the surfaces of the samples. The data was analysed using Kruskal–Wallis test and Mann-Whitney tests. The results were analysed using SPSS software.

RESULTS

The Kruskal-Wallis test revealed a statistically significant difference in microshear bond strength values among the four study groups ($P < 0.05$). Among these groups, Group 4, which underwent HF etching and silane application, exhibited the highest microshear bond strength (28.0), while Group 3, treated with sandblasting, demonstrated the lowest value (4.8).There were significant differences in bond strength values between Group 1 and Groups 3 and 4. In addition, there were significant differences in bond strength values between Group 2 and Group 3 and Group 3 and Group 4.

Table 1: mean values and 95% confidence intervals of microshear bond strength

Study groups	Mean	95% CI for mean	
		Lower bound	Upper bound
No treatment	16.85	10.20	22.52
Phosphoric acid	23.25	17.54	26.80
Sandblasting	4.82	3.10	7.52
Hydrofluoric acid	28.09	15.84	32.75

DISCUSSION

The bond strength of pulp capping biomaterials to composite resin depends on their physical and chemical properties. MTA and CEM are hydrophilic biomaterials which harden in the presence of moisture. The main ingredients of gray or white MTA include calcium oxide, silica and bismuth oxide; [18] on the other hand, one of the main ingredients of CEM cement is phosphorous which is present in negligible amounts in MTA. [19] Over both biomaterials, hydroxyapatite crystals are precipitated in phosphate-buffered solution. [20]Hence, this study was conducted to evaluate the effect of different surface treatments of MTA on bond strength of composite resin to MTA.

In the present study, the Kruskal-Wallis test revealed a statistically significant difference in microshear bond strength values among the four study groups ($P < 0.05$). Among these groups, Group 4, which underwent HF etching and silane application, exhibited the highest microshear bond strength (28.0), while Group 3, treated with sandblasting, demonstrated the lowest value (4.8). A study by Samimi P et al, evaluated means and standard deviations of bond strength values in study groups 1–4 were 14.83 ± 7.76, 21.85 ±7.99, 6.48 ± 3.89, and 26.01 ± 11.09 Mpa, respectively. Phosphoric acid etching or HF etching plus silanization was preferred to surface treatment of MTA before composite resin bonding.[21]

In the present study, there were significant differences in bond strength values between Group 1 and Groups 3 and 4. In addition, there were significant differences in bond strength values between Group 2 and Group 3 and Group 3 and Group 4. Another study by Shin JH et al, for WMTA and AMTA, untreated surfaces showed an irregular crystalline plate with clusters of globular aggregate particles. For EMTA, the untreated surface presented a reticular matrix with acicular crystals. After surface treatment, superficial crystalline structures were eroded regardless of the MTA cement and adhesive system used. WMTA bonded significantly more strongly than AMTA and EMTA, regardless of the adhesive system used. In the WMTA and AMTA groups, AdheSE One F showed the highest bond strength to the composite. For EMTA, no significant differences were found across adhesive systems. Acidic treatment of the MTA surface affected the micromorphology and the bond strength to the composite. Within the limitations of the study, using a 1-step self-etch adhesive system might result in a strong bond to WMTA when the composite resin restoration is required over MTA cement.[22] Kang et al [23] in a 1-year follow-up study investigated three different materials applied to pulpotomy technique. The procedure was classified as safe and predictable with ProRoot MTA, Ortho MTA, or RetroMTA documented through clinical and radiographical data. Bakhtiar et al [24] published an in vitro study about how some endodontic biomaterials could be efficient than others for the pulp capping procedures. The authors performed histology to evaluate dentinal bridge formation and organization after teeth extraction (disodontiasis third molar). In a study by Oskoee et al, there was no reported difference between shear bond strength of adhesive resin cylinders to MTA and CEM cement using Single Bond. The researchers assessed the shear bond strength of composite resin to MTA and CEM cement with and without the use of acid etch; it was concluded that etching did not affect the bond strength, and that surface preparation of the above biomaterials was not necessary in VPT.[25]A study used scanning electron microscopy to evaluate the effects of acid etching on surface characteristics of MTA and showed that the disordered structure and spindle-shaped crystals were removed during the process; therefore, the selective removal of the matrix surrounding the crystals results in a sponge-like surface suitable for bonding to composite resins with no significant effect on MTA structure.26 It seems that the stronger acidic treatment resulted in a more destructive surface than the weaker acidic treatment, and the eroded surface enhanced the bond strength. [27] Several studies have reported the presence of different amounts of silica in the MTA phase. Torabinejad et al. showed 2.47% and 6% silica in the crystal and amorphous phases, respectively. [28] In addition, Dammaschke et al. reported the presence of tricalcium and dicalcium silicate in MTA crystals.[29]

CONCLUSION

The preferred methods for surface treatment of MTA before bonding with composite resin were found to be phosphoric acid etching or HF etching combined with silanization.

REFERENCES

1. Lopes M B, Soares V CG, Fagundes F HR et al. Analysis of molecular changes induced by mineral trioxide aggregate on sPLA2. Braz Dent J. 2019;30(05):453–458.
2. Liu Y, Liu X M, Bi J et al. Cell migration and osteo/odontogenesis stimulation of iRoot FS as a potential apical barrier material in apexification. IntEndod J. 2020;53(04):467–477
3. Lin YT, Lin YJ. Success rates of mineral trioxide aggregate, ferric sulfate, and sodium hypochlorite pulpotomies: a prospective 24-month study. J Formos Med Assoc 2019
4. Lapinska B, Klimek L, Sokolowski J, Lukomska-Szymanska M. Dentine surface morphology after chlorhexidine application-SEM study. Polymers (Basel) 2018;10(08):905.
5. Cervino G, Fiorillo L, Spagnuolo G et al. Interface between MTA and dental bonding agents: scanning electron microscope evaluation. J IntSocPrev Community Dent. 2017;7(01):64–68.
6. Eghbal MJ, Asgary S, Baglue RA, Parirokh M, Ghoddusi J. MTA pulpotomy of human permanent molars with irreversible pulpitis. AustEndod J. 2009;35:4–8.
7. Asgary S, Parirokh M, Eghbal MJ, Brink F. Chemical differences between white and gray mineral trioxide aggregate. J Endod. 2005;31:101–3.
8. Haghgoo R, Abbasi F. Clinical and Radiographic Success of Pulpotomy with MTA in Primary Molars: 30 Months Follow up. Iran Endod J. 2010;5:157–60.
9. Kazem M, Eghbal MJ, Asgary S. Comparison of bacterial and dye microleakage of different root-end filling materials. Iran Endod J. 2010;5:17–22.
10. Tuna D, Olmez A. Clinical long-term evaluation of MTA as a direct pulp capping material in primary teeth. IntEndod J. 2008;41:273–8
11. Min KS, Park HJ, Lee SK, Park SH, Hong CU, Kim HW, et al. Effect of mineral trioxide aggregate on dentin bridge formation and expression of dentin sialoprotein and heme oxygenase-1 in human dental pulp. J Endod. 2008;34:666–70.
12. Hakki SS, Bozkurt SB, Hakki EE, Belli S. Effects of mineral trioxide aggregate on cell survival, gene expression associated with mineralized tissues, and biomineralization of cementoblasts. J Endod. 2009;35:513–9.
13. Parirokh M, Torabinejad M. Mineral trioxide aggregate: A comprehensive literature review – Part III: Clinical applications, drawbacks, and mechanism of action. J Endod. 2010;36:400–13
14. Sumitha M, Kothandaraman R, Sekar M. Evaluation of post-surface conditioning to improve interfacial adhesion in post-core restorations. J Conserv Dent. 2011;14(1):28–31.
15. Elsaka SE. Influence of chemical surface treatments on adhesion of fiber posts to composite resin core materials. Dent Mater. 2013;29(5):550–558.
16. Elsaka SE, Elnaghy AM. Bonding durability of titanium tetrafluoride treated glass fiber post with resin cement. Dent Mater J. 2019;38(2):189–195.
17. Goracci C, Raffaelli O, Monticelli F, Balleri B, Bertelli E, Ferrari M. The adhesion between prefabricated FRC posts and composite resin cores: microtensile bond strength with and without post-silanization. Dent Mater. 2005;21(5):437–444.
18. Asgary S, Parirokh M, Eghbal MJ, Brink F. Chemical differences between white and gray mineral trioxide aggregate. J Endod. 2005;31:101–3.
19. Asgary S, Eghbal MJ, Parirokh M. Comparison of mineral trioxide aggregate's composition with Portland cements and a new endodontic cement. J Endod. 2009;35:243–50.
20. Asgary S, Eghbal MJ, Parirokh M, Ghoddusi J. Effect of two storage solutions on surface topography of two root-end fillings. AustEndod J . 2009;35:147–52
21. Samimi P, Kazemian M, Shirban F, Alaei S, Khoroushi M. Bond strength of composite resin to white mineral trioxide aggregate: Effect of different surface treatments. J Conserv Dent. 2018 Jul-Aug;21(4):350-353
22. Shin JH, Jang JH, Park SH, Kim E. Effect of mineral trioxide aggregate surface treatments on morphology and bond strength to composite resin. J Endod. 2014 Aug;40(8):1210-6.
23. Kang C M, Sun Y, Song J S et al. A randomized controlled trial of various MTA materials for partial pulpotomy in permanent teeth. J Dent. 2017;60:8–13.
24. Bakhtiar H, Nekoofar M H, Aminishakib P et al. Human pulp responses to partial pulpotomy treatment with TheraCal as compared with Biodentine and ProRoot MTA: a clinical trial. J Endod. 2017;43(11):1786–1791.
25. Oskoee SS, Kimyai S, Bahari M. Comparison of shear bond strength of calcium-enriched mixture cement and mineral trioxide aggregate to composite resin. J Contemp Dent Pract. 2011;12:457–62.
26. Kayahan MB, Nekoofar MH, Kazandağ M, Canpolat C, Malkondu O, Kaptan F, et al. Effect of acid-etching procedure on selected physical properties of mineral trioxide aggregate. IntEndod J. 2009;42:1004–14
27. Shin JH, Jang JH, Park SH, Kim E. Effect of mineral trioxide aggregate surface treatments on morphology and bond strength to composite resin. J Endod. 2014;40:1210–6

28. Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical properties of a new root-end filling material. J Endod. 1995;21:349–53
29. Dammaschke T, Gerth HU, Züchner H, Schäfer E. Chemical and physical surface and bulk material characterization of white ProRoot MTA and two Portland cements. Dent Mater. 2005;21:731–8.