ORIGINAL RESEARCH

Comparison between Mineral Trioxide Aggregate Mixed with Water and Water-based Gel Regarding Shear Bond Strength with Resin-modified Glass Ionomer Cement and Composite

Rudra Kaul[1], Ashish Choudhary[2], Sukhbir Kour[3], Amitu Singh[4], Neelu Kumari[5], Kumar Manish[6]

Abstract

Aim and objective: To compare between mineral trioxide aggregate (MTA) mixed with water and water-based gel regarding shear bond strength with resin-modified glass ionomer cement (RMGIC) and composite.

Methods and materials: In this study, 40 blocks of cylindrical shape were prepared with acrylic. These blocks were divided into four groups with each group consisting of 10 blocks: group-1A: MTA + distilled water + composite, group-1B: MTA + distilled water + RMGIC, group-2A: MTA + polymer + composite, and group-2B: RMGIC + MTA + polymer. After that, a universal testing machine was used for the measurement of shear bond strength. The acrylic blocks were placed under this machine. A blade with a knife-edge was used to provide a crosshead speed of 1 mm/minute. This was continued till bond of MTA in both forms (distilled water/gel) and restorative material failed.

Results: It was observed that a statistically significant difference was found between MTAw + composite and MTAg + composite resin but no statistically significant difference between MTAw + RMGIC and MTAg + RMGIC with $p \geq 0.05$. It was found that a statistically significant difference was present between the RMGIC and composite groups within the same MTA type with $p \leq 0.05$.

Conclusion: It was concluded from the present study that MTA with a water-based gel has a better shear bond strength than composite resin and RMGIC materials.

Clinical significance: It has been found that MTA has different properties when it is mixed with polymer and water. Very few studies have been conducted in the past to compare MTA mixed with water and water-based gel regarding the shear bond strength with RMGIC and composite.

Keywords: Mineral trioxide aggregate, Shear bond strength, Water-based gel.

The Journal of Contemporary Dental Practice (2021): 10.5005/jp-journals-10024-3045

Introduction

Since the introduction of mineral trioxide aggregate (MTA) in dentistry, it is proven to be one-of-a-kind material with many clinical applications and is used widely in both primary and permanent dentitions.[1] Its remarkable quality of being biocompatible, setting in the presence of body fluids, and inducing repair and regeneration while providing a strong barrier, has made it stand out.[2,3] However, difficulty in mixing and handling, long setting time, and the high cost of material remain some of the shortcomings of traditional MTA when mixed with water.[4] MTA has been mixed with various resins or gels to obtain a cohesive mass in order to achieve better handling properties as well as significantly lessen the setting time.[5] MTA, when mixed with a gel based on water for the same procedures (MTA Plus, Prevest Denpro Limited, India), shows reduced tackiness and a considerably short setting time, i.e., from 165 to 55 minutes.[6,7] As per the manufacturer, the powder of MTA Plus has the property that there is a possibility of mixing it with either distilled water or a gel based on water.

Indications of MTA Plus include apexification, important pulp-related procedures like pulpotomy, pulp capping, liner and base in the cavity, sealing perforations, and repairing resorptive defects. MTA mixed with the water-based gel provided by the supplier is preferred because of its better properties. As MTA induces dentinogenesis, it is widely used in pulpotomy.[8-10]

It has been found that MTA either mixed with distilled water or a water-based gel can be used in various endodontic procedures like vital pulp capping and repair of perforations. When these endodontic procedures are completed, then composite resin is used for the restoration of teeth in permanent teeth while RMGIC is used to treat such teeth in children and young adults.[11]

One of the important factors in the prognosis of such restoration of endodontically treated teeth is the strength of the

[1-3]Department of Conservative Dentistry and Endodontic, Indira Gandhi Government Dental College and Hospital, Jammu, Jammu and Kashmir, India

[4]Department of Pedodontics and Preventive Dentistry, Vananchal Dental College and Hospital, Garhwa, Jharkhand, India

[5]Department of Oral and Maxillofacial Surgery, Buddha Institute of Dental sciences and Hospital, Patna, Bihar, India

[6]Department of Dentistry, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India

Corresponding Author: Rudra Kaul, Department of Conservative Dentistry and Endodontic, Indira Gandhi Government Dental College and Hospital, Jammu, Jammu and Kashmir, India, Phone: +91 8825039650, e-mail: rudra.kaul@gmail.com

How to cite this article: Kaul R, Choudhary A, Kour S, *et al*. Comparison between Mineral Trioxide Aggregate Mixed with Water and Water-based Gel Regarding Shear Bond Strength with Resin-modified Glass Ionomer Cement and Composite. J Contemp Dent Pract 2021;22(4):353–356.

Source of support: Nil

Conflict of interest: None

bond between MTA along with water and MTA along with polymer with the composite and RMGIC.[12] There is no study in the literature comparing these parameters. This study was conducted to compare RMGIC and composite with MTA mixed with water and water-based gel regarding shear bond strength.

Methods and Materials

In this study, 40 blocks of cylindrical shape were prepared with acrylic. In each acrylic block, a hole was made in the middle. The diameter of this hole was 4 mm while the height of the hole was 2 mm. The MTA with water (MTAw) was prepared by mixing the MTA powder with distilled water. The ratio between powder and liquid was 1:3. The MTA with polymer gel (MTAg) was prepared by mixing the MTA powder with gel as per the instructions given by the manufacturer. The amount of MTA powder taken was one scoop, while the amount of gel taken was one drop. The mixing was carried out on a glass slab for 30 seconds. Both MTAw and MTAg were placed in the holes of the acrylic blocks. The temperature at which these specimens were kept was 37° while the duration was 72 hours and the humidity was 100%. All the procedures of the study were conducted by the same individual.

These blocks were divided into four groups with each group consisting of 10 blocks: group-1A: MTA + distilled water + composite (Filtek™ Z250), group-1B: MTAw + RMGIC (GC Fuji II LC, Japan), group-2A: MTAg + composite (Filtek™ Z250), and group-2B: MTAg + RMGIC (GC Fuji II LC, Japan). Fifth-generation total-etch bonding agent (Prime and Bond NT Dentsply, USA) was used with 37% orthophosphoric acid as etchant (Scotchbond, 3M, ESPE, USA) for composite subgroups in both groups. The etchant was applied for 15 seconds to the bonding surface followed by rinsing for 30 seconds with water followed by blot drying.

The bonding agent was cured for 10 seconds (Ivoclar Bluephase NMC, Ivoclar Vivadent, Switzerland). Composite and RMGIC were also cured with the same curing light but for 20 seconds. After that, a universal testing machine was used for the measurement of shear bond strength (Fig. 1). The acrylic blocks were placed under this machine. A blade with a knife-edge was used to provide a crosshead speed of 1 mm/minute. This was continued till the bond of MTA in both forms (distilled water/gel) and the restorative material failed. A statistical analysis was carried out with the help of Prism 8, 2018 GraphPad software. Comparison between groups was analyzed using Kruskal–Wallis test and the significance level was adjusted at $\leq$0.05.

Results

It was found that a statistically significant difference was present between RMGIC and composite groups within the same MTA type with $p \leq 0.05$ (Tables 1 and 2). It was observed that a statistically significant difference was found between MTAw + composite and MTAg + composite resin (Table 3). The difference between MTAw + RMGIC and MTAg + RMGIC was not statistically significant with $p \geq 0.05$ (Table 4).

Discussion

One of the most suitable materials for pulpotomy and pulp capping is MTA. Since microleakage is one of the most common reasons for the failure of endodontic treatment modalities, the adhesion in between MTA and the overlying restoration is of paramount importance for a favorable outcome.[13,14] MTA Plus can be mixed with distilled water as well as with a water-based

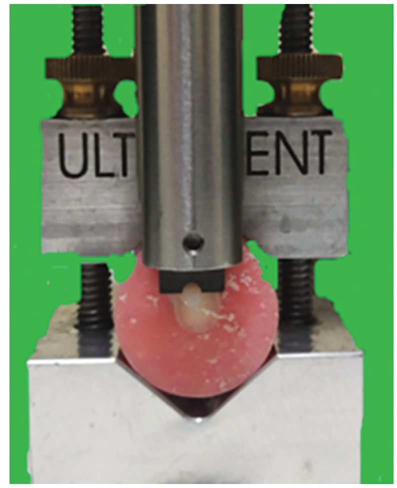

Fig. 1: Ultradent machine measuring shear bond strength

Table 1: Data showing the comparison between groups 1A and B for shear bond strength

Sl. No.	*Group*	*Shear strength (Mean ± S.D)*	*p value*
1	MTAw + composite (group 1A)	16.77 ± 0.34	0.03*
2	MTAw + RMGIC (group 1B)	2.48 ± 0.26	

Table 2: Data showing the comparison between groups 2A and B for shear bond strength

Sl. No.	*Group*	*Shear strength (Mean ± S.D)*	*p value*
1	MTAg + composite (group 2A)	27.33 ± 0.18	0.04*
2	MTAg + RMGIC (group 2B)	2.96 ± 0.23	

Table 3: Data showing the comparison between group 1A and group 2A for shear bond strength

Sl. No.	*Group*	*Shear strength (Mean ± S.D)*	*p value*
1	MTAw + composite (group 1A)	16.77 ± 0.34	0.02*
2	MTAg + composite (group 2A)	27.33 ± 0.18	

Table 4: Data showing the comparison between groups 1A and B for shear bond strength

Sl. No.	*Group*	*Shear strength (Mean ± S.D)*	*p value*
1	MTAw + RMGIC (group 1B)	2.48 ± 0.26	0.10
2	MTAg + RMGIC (group 2B)	2.96 ± 0.23	

*Statistically significant

gel supplied in a package. The gel form has better physical and chemical properties as compared to the distilled water type, hence widely preferred by practitioners.[6] The most common restorative materials used after endodontic treatment with MTA include composite and RMGIC.

Since no study has been conducted to the best of the knowledge of the author to compare the shear bond strength of MTAg + restorations with MTAw + restorations, this study was conducted to compare the shear bond strength of MTAg + restorations with MTAw + restorations. From this study, a very important finding was obtained which can have a significant clinical significance. The finding was that MTA mixed with a water-based gel has better shear bond strength with restorations as compared with MTA mixed with water. It should be taken care of that various restorative procedures must be performed only after 72–96 hours of mixing MTA. This is done to achieve optimum physical properties.[15] This is the reason for storing all specimens for 72 hours before going for any restoration over it.

It has been found that chemical substances called accelerators are present in the water-based gel for the promotion of settings; however, no salt is present.[16] When mixed with MTA Plus (Prevest Denpro, India) powder, an increase in solubility, ion release, and porosity is observed in the organic gel. This is not observed in the case of water mix of ProRoot MTA (Dentsply, USA).[17] Gandolfi et al. hypothesized these properties to be due to a fine grit powder of MTA Plus (Prevest Denpro, India).[17] By using the same powder for both the mixes, that bias has been taken care of in this study. The statistically significant higher bond strength of MTAg when etched and bonded with composite (Filtek, 3M ESPE, USA), in our opinion, is due to the high porosity of the gel mix to begin with. We hypothesize that due to its resultant increased solubility on etching of the mix, deeper resin tags form in MTAg as compared to MTAw.

According to the present study, MTAg + composite (mean = 27.33 MPa) showed values of bond strength greater than 17 MPa, which is the minimum strength required for restoration junctions to prevent microleakage,[18,19] whereas MTAw + composite (mean = 16.77 MPa) almost touched the required mark. From the present study, a conclusion can be drawn that adequate bonding with composite resins is seen in the case of MTAg. Since RMGIC (GC Fuji II LC, Japan) uses a weak acid (polyacrylic acid) for conditioning, due to which proper preparation of bonding surface is not achieved, leading to the development of a honeycomb pattern. This is the reason for the decreased strength of bonds that have been recorded in this case with both MTAg and MTAw.

These findings are in accordance with Ajami et al. and Tulumbaci et al.[20,21] This study used no conditioner over MTA before placing RMGIC. However, better results of shear bond strength have been documented when MTA is conditioned prior to RMGIC. The underlying clinical significance of this study lies in the fact that mixing with the gel makes the resultant material easy to manipulate and to introduce into the cavity thereafter. One can conveniently make sure that it properly covers the entire pulp, sets earlier, releases calcium faster, and gives better biological properties. A faster setting facilitates an earlier permanent composite core buildup, resulting in less secondary caries and microleakage. All factors also result in less pulpal inflammation in underlying pulpotomies, which is the prime requisite for regeneration. Overall, the prognosis of the tooth gets greatly improved.

One of the important limitations of the study was the small sample size. More studies with a large sample size should be conducted in the future to achieve better results. Another limitation was that the results would have been more clinically accepted when it would have taken place using human teeth instead of artificial acrylic cylindrical blocks. Another limitation was that this study used no conditioner over MTA before placing RMGIC. However, better results of shear bond strength have been documented when MTA is conditioned prior to RMGIC.

Conclusion

It was concluded from the present study that MTA mixed with gel has better shear bond strength than composite resin and RMGIC materials.

References

1. Macwan C, Deshpande A. Mineral trioxide aggregate (MTA) in dentistry: a review of literature. J Oral Res Rev 2014;6(2):71–74. DOI: 10.4103/2249-4987.152914.
2. Gandolfi MG, Taddei P, Siboni F, et al. Biomimetic remineralization of human dentin using promising innovative calcium-silicate hybrid “smart” materials. Dent Mater 2011;27(11):1055–1069. DOI: 10.1016/j.dental.2011.07.007.
3. Cantekin K. Bond strength of different restorative materials to light-curable mineral trioxide aggregate. J Clin Pediatr Dent 2015;39(2):143–148. DOI: 10.17796/jcpd.39.2.84x57tp110k46183.
4. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review – Part III: clinical applications, drawbacks, and mechanism of action. J Endod 2010;36(3):400–413. DOI: 10.1016/j.joen.2009.09.009.
5. Kaul R, Farooq R, Kaul V, et al. Evaluation of biological, physical and chemical properties of mineral trioxide aggregate mixed with 4-META/MMA-TBB. Indian J Dent Res 2013;24(4):418–422. DOI: 10.4103/0970-9290.118381.
6. Siboni F, Taddei P, Prati C, et al. Properties of NeoMTA Plus and MTA Plus cements for endodontics. Int Endod J 2017;50(Suppl. 2):e83–e94. DOI: 10.1111/iej.12787.
7. Torabinejad M, Hong CU, McDonald F, et al. Physical and chemical properties of a new root-end filling material. J Endod 1995;21(7):349–353. DOI: 10.1016/S0099-2399(06)80967-2.
8. Sari S, Sönmez D. Internal resorption treated with mineral trioxide aggregate in a primary molar tooth: 18-month follow-up. J Endod 2006;32(1):69–71. DOI: 10.1016/j.joen.2005.10.018.
9. Tuna D, Olmez A. Clinical long-term evaluation of MTA as a direct pulp capping material in primary teeth. Int Endod J 2008;41(4):273–278. DOI: 10.1111/j.1365-2591.2007.01339.x.
10. Min KS, Park HJ, Lee SK, 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(6):666–670. DOI: 10.1016/j.joen.2008.03.009.
11. Bayrak S, Tunç ES, Saroğlu I, et al. Shear bond strengths of different adhesive systems to white mineral trioxide aggregate. Dent Mater J 2009;28(1):62–67. https://doi.org/10.4012/dmj.28.62
12. Tunç ES, Sönmez IS, Bayrak S, et al. The evaluation of bond strength of a composite and a compomer to white mineral trioxide aggregate with two different bonding systems. J Endod 2008;34(5):603–605. DOI: 10.1016/j.joen.2008.02.026.
13. Wang L, Sakai VT, Kawai ES, et al. Effect of adhesive systems associated with resin-modified glass ionomer cements. J Oral Rehabil 2006;33(2):110–116. DOI: 10.1111/j.1365-2842.2006.01536.x.
14. Suresh K, Nagarathna J. Evaluation of shear bond strengths of FUJI II and FUJI IX with and without salivary contamination on deciduous molars – an in vitro study. Arch Sci Res 2011;1(3): 139–145.

15. Bodanezi A, Carvalho N, Silva D, et al. Immediate and delayed solubility of mineral trioxide aggregate and Portland cement. J Appl Oral Sci 2008;16(2):127–131. DOI: 10.1590/s1678-7757200 8000200009.
16. Govindaraju L, Neelakantan P, Gutmann JL. Effect of root canal irrigating solutions on the compressive strength of tricalcium silicate cements. Clin Oral Investig 2017;21(2):567–571. DOI: 10.1007/s00784-016-1922-0.
17. Gandolfi MG, Siboni F, Primus CM, et al. Ion release, porosity, solubility, and bioactivity of MTA Plus tricalcium silicate. J Endod 2014;40(10):1632–1637. DOI: 10.1016/j.joen.2014.03.025.
18. Davidson CL, de Gee AJ, Feilzer A. The competition between the composite-dentin bond strength and the polymerization contraction stress. J Dent Res 1984;63(12):1396–1399. DOI: 10.1177/00220345840630121101.
19. Al-Sarheed MA. Evaluation of shear bond strength and SEM observation of all-in-one self-etching primer used for bonding of fissure sealants. J Contemp Dent Pract 2006;7(2):9–16. https://doi:10.5005/jcdp-7-2-9
20. Ajami AA, Navimipour EJ, Oskoee SS, et al. Comparison of shear bond strength of resin-modified glass ionomer and composite resin to three pulp capping agents. J Dent Res Dent Clin Dent Prospects 2013;7(3):164–168. DOI: 10.5681/joddd.2013.026.
21. Tulumbaci F, Almaz ME, Arikan V, et al. Shear bond strength of different restorative materials to mineral trioxide aggregate and Biodentine. J Conserv Dent 2017;20(5):292–296. DOI: 10.4103/JCD.JCD_97_17.