EFFECT OF DENTIN POWDER ON SURFACE HARDNESS OF MINERAL TRIOXIDE AGGREGATE: AN IN VITRO STUDY

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ABSTRACT

AIM- Inadequate initial surface hardness might limit the use of MTA in endodontic procedures where hardness is critical. Hence effect of dentin as a solid phase additive was tested on hardness of MTA.

MATERIALS AND METHODS

Surface hardness of MTA and MTA dentin combination was compared using a Vickers hardness testing machine. Results were tabulated and statistically analysed using a t-test.

CONCLUSION

From the present study it could be concluded that the hardness of MTA was increased significantly when dentin was added to it.

KEYWORDS

Mineral Trioxide Aggregate; Dentin; Vickers Hardness testing; Surface Hardness; Saline; Root End Filling.

INTRODUCTION

Over the years several materials have been used as root end filling materials and for perforation repair but with limited success.[1,2] Mineral trioxide aggregate (MTA), which was first developed by Torabinejad et al[3], has been successfully used in multifaceted endodontic applications such as root end filling,apexification, pulpotomy and vital pulp therapy-because of its unique biocompatibility, antibacterial nature, sealability and its capacity to promote hard tissue formation.1-3 However, MTA is difficult to use for practitioners because of its properties of granular consistencyand initial loosenesscausing compromised surface hardness. Many attempts to improve the handling properties of MTA by adding additivesas accelerator to enhance viscosity have been madebut with limited success.Many liquid and liquid base additives like lidocaine, 3% NaOCl gel, Chlorexidienegluconate gel, K-Y jelly etc have known to influence the setting time and hardness of MTA.1 However, no solid phase additive has been known so far to affect the above mentioned properties.

Dentin powder has proven to be an effective solid phase additive due to its biocompatibility.It is known to increase the antibacterial effectiveness of bioactive glass against Enterococcus faecalis4 . Hui Zhang *et al*[5] compared the inhibitory effect of MTA and Bioaggregate (BA) with and without addition of dentin powder.They observed that addition of dentin to both MTA and BA significantly enhanced its antibacterial efficacy against Enterococcus faecalis.Thusthis in vitro study evaluates the effect of dentin powder on surface hardness of Mineral Trioxide Aggregate.

MATERIALS AND METHODS

In this study, 10 acrylic blocks were used. In each block a cubic shaped cavity, 5mm in width and 5mm in depth was prepared. The 10 blocks were divided into 2 groups of 5 each.

GROUP I -The MTA (ProRootDentsply, Tulsa Dental, Tulsa, ok) was mixed with sterile water at powder to liquid ratio 3:1 and the mixture was incrementally placed and condensed by condenser in the first 5 samples using hand method.

GROUP II - The MTA (ProRootDentsply, Tulsa Dental, Tulsa, ok) and dentin powder was mixed with sterile water in ratio 1.5: 1.5:1. The mixture was then incrementally placed and condensed by condenser as was done for the group I.

All samples after setting were prepared for Vickers Hardness Test.

Vickers Hardness test using Vickers hardness machine (Wolpert, Germany) consists of an indenter needle the test material with a diamond indenter in the form of a right pyramid with a square base and an angle of 136 degree between opposite faces subjected to a load of 1 to 100 kg. The load is normally applied for 10 to 15 seconds.

The following formula was used to calculate the Vickers Hardness number (VHN) in Kg/mm^2:

VHN = 1.854 p/d2

Where:

P= load (300g), D= average of diagonals.

The results were analyzed statistically using t - test to determine whether there were any statistically significant differences between the groups at the 5% level of significance ($p< 0.05$).

RESULTS

In this study, when MTA was used alone, the load applied for Vickers Hardness Number began at 0.5 Kg/mm2. It increased until it showed fatigue of the material at 1 Kg/mm2. This could be explained by using the formula for surface hardness: VHN= 1.854 p/d2. While, when MTA was used along with dentin powder, the load began at 0.5 Kg/mm2 and increased until fatigue was exhibited at 3 Kg/mm2.

On analysis group II samples showed greater surface hardness than group I. The mean of group II was about 46.3100 Kg/mm 2 whereas the mean for group I samples was 4.8880 Kg/mm2. (Table I).The results were analyzed statistically using t - test (Table II) to determine whether there were any statistically significant differences between the groups at the 5% level of significance (p< 0.05).

TABLE I: COMPARISON OF SURFACE HARDNESS OF MTA BETWEEN GROUPS

GROUP	NO. OF BLOCKS	MEAN (Kg/mm2)	SD
I	5	4.8880	1.127
II	5	46.3100	7.024

TABLE II: T-TEST BETWEEN GROUPS

GROUP	T- Value	Df	p-value
I & II	-18.412	18	0.000

(Significant difference at p< 0.005)

DISCUSSION

This study evaluated the effect of dentin powder on the surface hardness of Mineral trioxide aggregate. The samples after setting were prepared for Vickers Hardness Test using a Vickers hardness machine. Under the limitations of this study it could be concluded that it is preferable to use MTA along with dentin powder as retrograde filling material. There are two universal types of microhardness test, Vickers and Knoop. The main difference is attributed to the shape of the diamond indenter. The shape of the Vickers diamond indenter is a square pyramid whereas the shape of the Knoop diamond indenter is an elongated pyramid shape.

Gong et al. (2002)6, when measuring the silicon nitride ceramic samples, showed that Knoop hardness values were generally lower than the corresponding values for Vickers hardness. However, there is a strong correlation between these two values that may be related to elastic recovery occurring at the indentation. Measurement of the Vickers microhardness formed the basis of the present investigation.Daneshet al7 reported that the Vickers microhardness of MTA was 39.99. Lee et al8 noted that the microhardness of MTA using the Knoop scale was 51.20.

Maha A9 estimated Surface Hardness of Mineral Trioxide Aggregate Material (MTA) using Two Techniques of Condensation by Vickers Hardness Test. It was observed that samples condensed with hand method followed by ultrasonic condensation showed more surface hardness than samples condensed with hand method only. Although the type of condensation technique was not considered as a parameter to evaluate the hardness of MTA in this study.Holt DM et al10evaluated the Compressive Strength of Two Types of Mineral Trioxide Aggregate Mixed with Sterile Water or 2% Chlorhexidine Liquid.It was concluded that addition of chlorexidiene as a liquid reduced the strength of mineral trioxide aggregate. The present research inferred that addition of dentin powder to MTA increased its hardness. This can be attributed because of the internal chemistry of the dentin -MTA mix.

CONCLUSION

Under the limitation of the present study, it could be concluded that addition of dentin powder significantly increased its surface hardness. This mix can be used in single visit endodontic procedures where hardness of the material is critical. However before recommending this mix for clinical use, the MTA dentin combination should be evaluated for its biocompatibility, sealing ability and antibacterial efficacy.

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