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Original Research

A Comparative Evaluation of Compressive Strength of Four Pulp Capping Agents on Primary Molar; An In-Vitro Study

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***ABSTRACT*:**
Introduction: Modern day endodontics includes the study, diagnosis, prevention and management of diseases and injuries of the dental pulp and periradicular tissues. **Material & Methods:** Experimental groups were established according to the materials to be tested for compressive strength- SINGLE PASTE MTA, SINGLE PASTE MTA WITH PROPOLIS, MTA WITH PROPOLIS & CONVENTIONAL MTA as control group. Total of 120 samples will be evaluated. **Results:** In this in vitro study one way ANOVA and independent t test was used to compare the compressive strength among different materials. The p value ≤ 0.05 was considered as statistically significant.**Conclusion:** Propolis have anti-inflammatory, antibacterial and immune modulating effect. However biocompatibility along with the antibacterial property when mixed with MTA should be studied.
Key Words: Pulp capping agents, primary molar.

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INTRODUCTION-

Modern day endodontics includes the study, diagnosis, prevention and management of diseases and injuries of the dental pulp and periradicular tissues.[1] The practice of managing teeth with pulpally-related disorders has significantly evolved over the years, with the development of improved diagnostic/therapeutic equipment, knowledge and materials, like MTA. With the conservative, ‘minimally invasive’ direction dentistry is starting to take, MTA has some favourable properties complimentary to this management approach. The compressive strength of MTA is important when they are used in pulp-capping, where they must be able to resist fracture when subjected to occlusal forces. Compressive strength is an indicator of the hydration process of this material which directly indicates the setting procedure of the material.[2]

MATERIALS AND METHODS

Mineral trioxide aggregate (MTA) is a dental restorative cement that has been used in dentistry for just over two decades now.[3] It was originally developed as a root-end filling material, though has since been successfully used in perforation repairs, pulp-capping, pulpotomies, apicectomies and the treatment of non-vital immature permanent teeth through apexification or the regenerative endodontic technique. Despite having some negative traits, MTA has revolutionised how dentists practice, especially in the fields of endodontics and paediatric dentistry. Grey and white versions of commercial MTA are available at this time.[4-7]The original grey MTA comprised approximately 75 wt% Portland cement (PC), 20 wt% Bi_2O_3 and 5 wt% calcium sulphate (gypsum). Bi_2O_3 is a radiopacifier and necessary for radiographic assessment intra-/post-operatively. Calcium sulphate is used as a setting modifier to improve setting time and the short-term hardness of the cement.[8]White MTA was released a few years later in response to discolouration problems experienced with the grey version; the iron-containing phase (Tetracalcium alumino-ferrite) was removed from the cement in the hope of resolving the problem, however this was not the case. It was recently been found that when exposed to sodium hypochlorite (NaOCl), the Bi_2O_3 radiopacifier in MTA gradually discolours to a dark brown colour.[9]MTA exhibits unique physiochemical properties that can provide exceptional outcomes when used for complete or partial canal obturation. Both gray and white MTA can be used for this procedure.[10]The release of calcium from setting MTA diffuses through dentinal tubules, and the concentration of the calcium ions increases with time as the material cures. It appears that the biocompatibility of the cement might be attributable to the release of hydroxyl ions and formation of calcium hydroxide during the hydration process.[11-13]When mixed MTA is compacted against dentin, a dentin-MTA interfacial layer forms in the presence of phosphates.[14] This adherent interstitial layer resembles hydroxyapatite in composition and structure when examined under x-ray diffraction and scanning electron microscopy (SEM) analysis; however, the calcium to phosphorus ratio varies slightly from that reported in actual hydroxyapatite.[15] This interface between dentin and MTA has demonstrated superior marginal adaptation compared with amalgam, intermediate restorative material, or Super-EBA under SEM in resin models.[16]Propolis is a resinous bee-hive product, Its constituents include resin and balsams (50-70%), wax (30- 50%), pollens (5-10%), amino acids, minerals, vitamins A, B and E, phenols and aromatic compounds. The percentage of carbohydrates varies in different types of propolis. Propolis has antioxidant activity , which is even more potent than the antioxidant activity of vitamin C . Flavonoids comprise a large part of the resinous portion of propolis and its active component. They are responsible for the majority of anti-oxidative, antibacterial, antiviral, antifungal, anti-cariogenic and anti-inflammatory properties of propolis.[17]The following experimental groups were established according to the materials to be tested for compressive strength- SINGLE PASTE MTA, SINGLE PASTE MTA WITH PROPOLIS, MTA WITH PROPOLIS & CONVENTIONAL MTA as control group. Total of 120 samples will be evaluated. 30 samples of each material will be prepared and divided into following groups.

Group A- single paste MTA
Group B- single paste MTA with propolis
Group C- MTA with propolis
Group D- conventional MTA (Control Group)

Steel cylinder with an internal diameter 3mm and height of 6mm will be prepared. In group A cylinders will be filled with single paste MTA. In group B cylinders will be filled with single paste MTA incorporated with 30% propolis. In group C cylinders will be filled with MTA incorporated with 30% propolis(powder and liquid will mixed with manufactures formula).In group D cylinders will be filled with conventional MTA(powder and liquid will mixed with manufactures formula). Materials and instrument will be kept at 23 degree centigrade for 1 hour before use. samples will be mixed by operator and mixing time is 10 sec. within 2 minutes after initiation of mixing the materials were placed into steel cylinders and packed with condenser. The internal surface of cylinder will be greased with paraffin before putting material. Then the sample will be wrapped in gauze soaked in distilled water. Sound samples were stored at 37°C and 95±5% humidity and were subjected to compressive strength testing in a universal testing machine at a crosshead speed of 0.5mm/minute after 4 days.[18]
Compressive strength will determine by calculating equation.[19]

$$CS = \frac{L}{A} = \frac{L}{\pi\left(\frac{d}{2}\right)^2}$$

CS = compressive strength (MPa)
L = load (N)
A = cross-sectional area of sample (cm²)
d = diameter (cm)

RESULTS

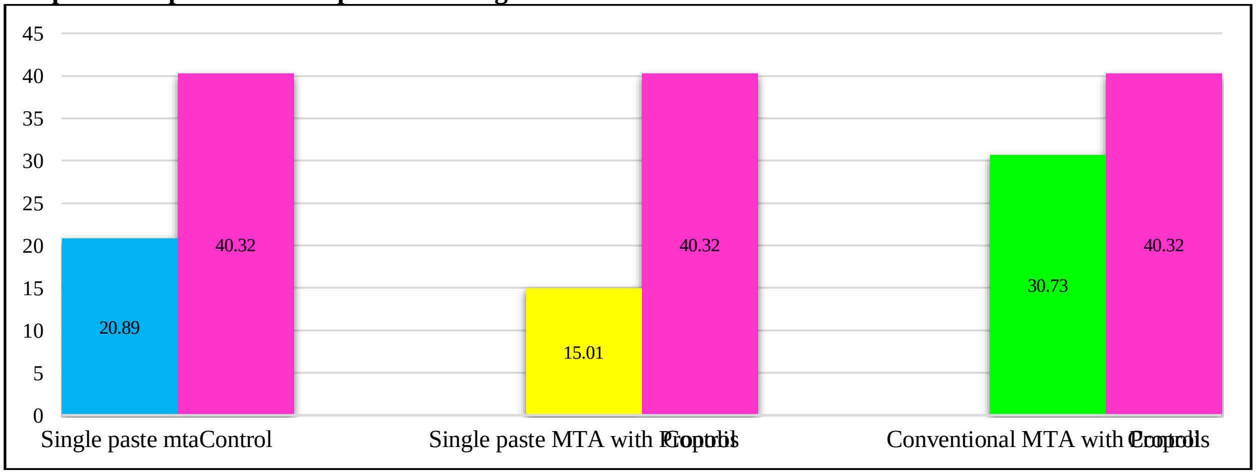
In this invitro study one way ANOVA and independent t test was used to compare the compressive strength among different materials. The p value ≤ 0.05 was considered as statistically significant.

Table 1 Comparison of compressive strength between the materials and control using independent t test

Materials	Mean	SD	t	p	Significance
Single paste MTA	20.89	1.2	11.47	0.000	Statistically Significant
Control	40.32	1.1			
Single paste MTA with Propolis	15.01	1.2	9.48	0.000	Statistically Significant
Control	40.32	1.1			
Conventional MTA with Propolis	30.73	1.2	10.03	0.000	Statistically Significant
Control	40.32	1.1			

Observations-
All the materials showed lower compressive strength in comparison to control. Single paste MTA (20.89), single paste MTA with propolis(15.01), conventional MTA(30.73) having lowest mean compressive strength than conventional MTA(control). All the differences are statistically significant (p<0.05).

Graph 1. Comparison of compressive strength between the materials and control



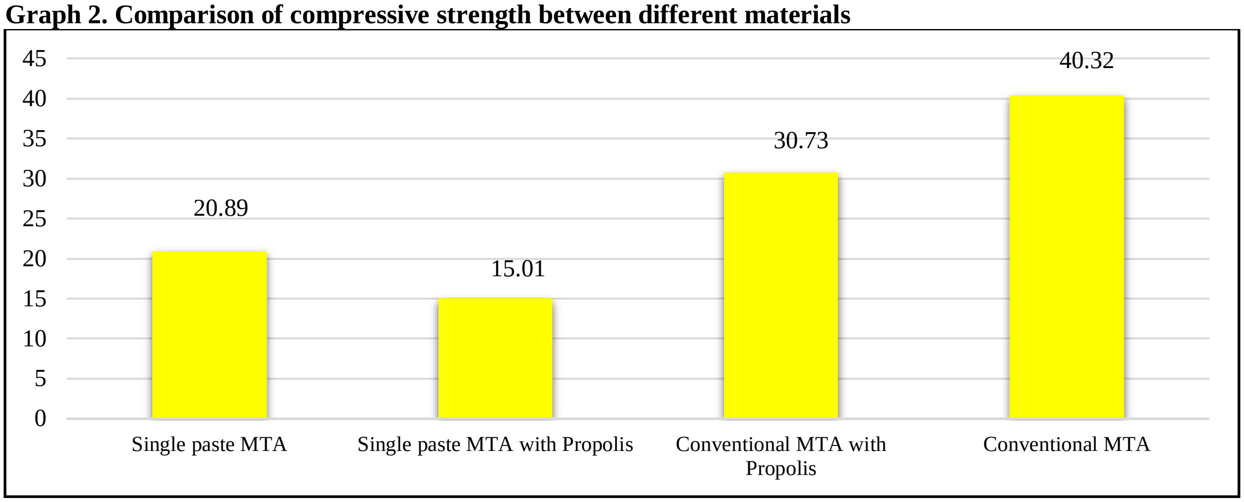
Observations-
Graph 1 represents the compressive strength of all three group as compared with the control group. All the materials showed lower compressive strength in comparison to control.

Table 2. Comparison of compressive strength between different materials using One way ANOVA

Materials	Viability	F value of ANOVA	p value	Significance
Single paste MTA	20.89±1.2	32.881	0.000	Statistically Significant
Single paste MTA with Propolis	15.01±1.2			
Conventional MTA with Propolis	30.73±1.2			
Conventional MTA	40.32±1.1			

Observations-
Highest compressive strength was shown by Conventional MTA (40.32±1.1) followed by Conventional MTAwith Propolis(30.73±1.2), Single paste MTA (20.89±1.2) andSingle paste MTA with Propolis (15.01±1.2) and the difference between them is statistically significant (p<0.05).

Graph 2. Comparison of compressive strength between different materials



Observations- Graph 2 represents the conventional MTA(control) have highest compressive strength followed by conventional MTA with propolis followed by single paste MTA and single paste MTA shows lowest compressive strength.

DISCUSSION

In vital pulp therapy, the applied cement must remain in place despite experiencing dislodging forces resulting from operative procedures. The higher mechanical properties of the cement are considered an important feature when this cement is used as pulp capping or as a coronal restorative material where it is subjected to occlusal loads. Typical test parameters to assess mechanical properties of hydrated cement include compressive strength.[20]In our study we found that highest compressive strength was shown by Conventional MTA followed by Conventional MTAwith Propolis, Single paste MTA and Single paste MTA with Propolis. The results of our study corroborated by the study conducted by Hanan Alzraikat et al in 2016, who concluded that MTA showed a significantly higher compressive strength after 21 days compared with day 1.[22] According to Torabinejad *et al.*, the compressive strength of MTA was 40 MPa after 24 hours and 67.3 MPa after 3 weeks.[23]The strength of cements depends primarily on the water-to-powder ratio. The high water-to-powder ratio of single paste MTA seems to have contributed to its low compressive strengthpropolis to MTA causes compressive strength to decrease significantly according to the results of the study. This could be because, after mixing propolis extract form the combination of calcium hydroxide-propolis, the structure of the combination in the form of solid after the setting is affected and results in decreased compressive strength. There are several things that can affect the compressive strength of a combination of calcium hydroxide with propolis. In the combination of calcium hydroxide with propolis, there is a bond between molecules that occurs between hydrogen atoms aromatic compounds from propolis with oxygen atoms from water or ethanol. This bond is a weak hydrogen bond. In addition to hydrogen bonds, aromatic compounds in propolis have van der waals bonds with hydroxyl groups derived from calcium hydroxide and active ingredients in propolis. The van der waals bond is a weak bond and can make molecules in the material bond tightly so that it produces a weaker structure and will make the compressive strength lower.[24]

CONCLUSION

In our study we found out that single paste MTA could be a better alternative for conventional MTA as it can reduce the dependability on the operator. However the compressive strength of single paste MTA even though comparable to conventional MTA but is seen to be lesser. This could be due to smaller sample size. So may be study with larger sample size will give a clear picture. In the present study when mixed with propolis, both single paste MTA and conventional MTA seems to show lower compressive strength this could be due to interference of propolis in binding with calcium, In the combination of calcium hydroxide with propolis, there is a bond between molecules that occurs between hydrogen atoms aromatic compounds from propolis with oxygen atoms from water or ethanol. This bond is a weak hydrogen bond. In addition to hydrogen bonds, aromatic compounds in propolis have vanderwaals bonds with hydroxyl groups derived from calcium hydroxide and active ingredients in propolis. The vanderwaals bond is a weak bond and can make molecules in the material bond tightly so that it produces a weaker structure, However depending upon the requirement of the situation like in case of pulpotomy in infectious teeth or young anterior permanent teeth that have required apexogenesis, propolis mixed with MTA can be considered. Because in case of anterior teeth there will be lees occlusal load, so reduced compressive strength can be considered. In addition propolis have anti-inflammatory, antibacterial and immune modulating effect. However biocompatibility along with the antibacterial property when mixed with MTA should be studied.

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