

Mineral Trioxide Aggregate as Pulp Capping Agent for Primary Teeth Pulpotomy: 2 Year Follow Up Study

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The aim of the present study was to clinically and radiographically evaluate Mineral Trioxide Aggregate (MTA) as an agent for pulpotomy in primary teeth and to compare it with that of formocresol (FC) pulpotomy. Nineteen children between the ages of 6 to 8 years with 40 carious primary molars were treated with pulpotomy using either FC or MTA. All the molars were evaluated clinically and radiographically at regular intervals over a twenty four month period. The observations were tabulated and statistically analyzed. Eighty five percent success was observed with FC pulpotomy whereas MTA showed 95% success. MTA showed a higher clinical and radiographic success rate than FC. MTA may be a favorable material for pulpotomy in primary teeth whose pulps have been compromised by a carious or mechanical pulp exposure.

Keywords: formocresol, MTA, Pulpotomy

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INTRODUCTION

Conservation of primary dentition is essential for maintenance of arch length, esthetics, mastication, speech and prevention of abnormal habits.¹ Since the thickness of enamel and dentin in primary teeth is less, caries progresses to involve the pulp more frequently. Such teeth with coronally inflamed vital pulps can be salvaged by pulpotomy which is a vital pulp therapy technique. Pulpotomy has been broadly classified as, devitalization, preservation, and regeneration of the remaining pulp tissue.²

In devitalization pulpotomy formocresol has been the medicament of choice for use in primary teeth. Although

formocresol pulpotomy is universally taught and practised, concerns have been raised about its ill effects such as pulpal responses, cytotoxic, mutagenic and carcinogenic potential.^{3,4,5} A number of alternatives have been proposed to counter the ill effects and shortcomings of formocresol.

In more recent times, with the introduction of newer materials, which are not only biocompatible but also bioinductive, the emphasis has shifted from mere preservation to regeneration. One such material that has shown immense potential for regeneration is Mineral Trioxide Aggregate (MTA). MTA was first developed and reported in the year 1993 at the Loma Linda University by Lee, Monsef and Torabinejad.⁶ MTA has been used experimentally for a number of years and was approved for human usage by the FDA in 1998.⁷ MTA has shown to prevent microleakage, is biocompatible and promotes regeneration of the original tissues when it is placed in contact with the dental pulp.^{8,9} Due to its beneficial properties, MTA was thought to be a suitable alternative to formocresol for primary teeth pulpotomy.

Hence, the present study was conducted to evaluate the potential of Mineral Trioxide Aggregate for pulpotomy in primary molars as compared to formocresol.

MATERIALS AND METHODS

Normal, healthy and co-operative children for the study were selected from the patients attending the Department of Pedodontics and Preventive Dentistry, The Oxford Dental College, Hospital and Research Center, Bangalore, India.

A total of forty teeth were selected from 19 children (13 boys and 6 girls) aged 6 to 8 years, who had no medical condition that would contraindicate pulp therapy. Each child had at least two primary molars (first and/or second primary molar) requiring pulpotomy. The procedure was explained to the parents of the children and their written consent obtained

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before the treatment. Ethical clearance to conduct the study was obtained from the institutional review board. The two pulpotomy materials used in the study included formocresol (Pharmadent Remedies Pvt Ltd, India) and Mineral Trioxide Aggregate (ProRoot MTA, Dentsply). The clinical and radiographic criteria^{10, 11} selected for the study are given in Table 1.

Table 1. The Criteria for Selection of teeth^{10,11}

CLINICAL CRITERIA	
1.	Vital primary molars with carious pulp exposures
2.	No spontaneous or persistent pain
3.	Hemorrhage from the amputation site is bright red and easy to control.
4.	No clinical symptoms or evidence of pulp degeneration such as pain on percussion, history of swelling or sinus tracts.
5.	Teeth restorable with stainless steel crowns.
RADIOGRAPHIC CRITERIA	
1.	No radiographic evidence of internal or external root resorption
2.	Furcal and/or periapical radiolucency
3.	Absence of pathologic root resorption
4.	Not more than one third physiologic root resorption had occurred

Allocation of the primary molars to either Formocresol (FC) group (20 teeth) or MTA group (20 teeth) was randomized by the toss of a coin. The alternative medicament was used in the other primary molar so as to allow a direct comparison of the two medicaments within the same mouth. In each child, one molar was treated with formocresol and the other molar with MTA. Only one child had treatment of four molars, two teeth each were treated with formocresol and MTA. Distribution of teeth for treatment is shown in Table 2.

Table 2. Distribution of pulpotted primary molars

MATERIAL	PRIMARY FIRST MOLAR			PRIMARY SECOND MOLAR			TOTAL NO. OF TEETH
	Maxillary	Mandibular	Total	Maxillary	Mandibular	Total	
MTA	4 (20.0%)	3 (15.0%)	7 (35.0%)	10 (50.0%)	3 (15.0%)	13 (65.0%)	20
Formocresol	8 (40.0%)	4 (20.0%)	12 (60.0%)	3 (15.0%)	5 (25.0%)	8 (40.0%)	20

A conventional pulpotomy procedure was performed on the selected teeth. The tooth was anesthetized using local anesthesia and rubber dam isolation was obtained. Dental caries and overhanging enamel were removed with a #330 high-speed bur with water spray. With the same bur access to coronal pulp was gained and the entire roof of the pulp chamber was removed. A sharp discoid spoon excavator, large enough to extend across the entrance of the individual root canals was used to amputate the coronal pulp. The pulp stumps were cleanly excised until the root canal orifices could be seen, with no tags remaining on the pulpal floor. Sterile cotton pellets moistened with water were placed in

the pulp chamber and allowed to remain over the pulp stumps for gaining hemostasis. In the FC group, a cotton pellet moistened with 1:5 concentration of formocresol was applied over the pulp stumps for 1 minute. The pellet was then removed and a thick mix of zinc oxide eugenol was mixed and placed over the pulp stumps. For the MTA group, pulp stumps were covered with MTA paste obtained by mixing distilled water with MTA powder, at a 3:1 powder: liquid ratio. Powder and liquid were mixed on a glass slab with a metal spatula to obtain a creamy consistency. The mixture was carried to cover the pulp stumps using a metal carrier (plastic filling instrument) and condensed lightly using a moistened cotton pellet. This was followed by a thick mix of zinc oxide eugenol. In both FC and MTA groups, at the time of the pulpotomy visit all teeth were restored with glass ionomer cement (Ketac Molar Easy Mix, 3M, ESPE). Final restoration with a stainless steel crown (3M) was given within one week following the pulpotomy procedure.

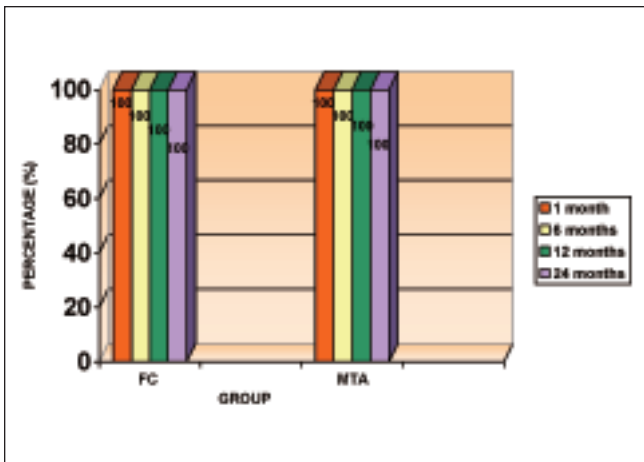
The patients were recalled for clinical and radiographic valuation at 1, 6, 12 and 24 month intervals. The criteria used for clinical evaluation included history of pain, tenderness to percussion, gingival abscess, sinus/fistula and pathologic mobility; and those for radiographic evaluation included internal root resorption, external root resorption, periapical/furcal radiolucency, pulp canal obliteration (PCO) and dentin bridge formation.^{10,11} The treatment was regarded as a success in the absence of all clinical criteria evaluated and also in the absence of internal/external root resorption and periapical/furcal radiolucency. However, the absence of dentin bridge formation and the presence of pulp canal obliteration were not considered as a failure.¹¹

The data recorded was subjected to statistical analysis. The statistical software namely SPSS 11.0, Stata 8.0, Systat 11.0 were used for the analysis of the data. Fisher Exact test was used to find the significance of failures between the two groups.

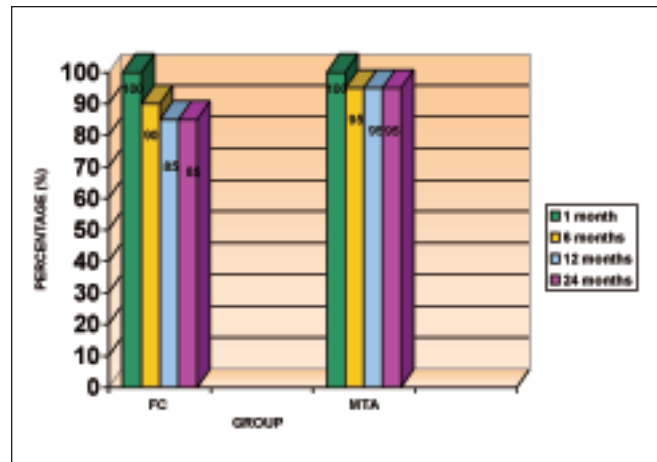
RESULTS

All 40 teeth were available till the end of the study. One hundred percent success was observed clinically at all evaluation periods in both the groups (Graph I). Radiographically 100% success was seen at one month evaluation in both the groups. At the sixth month of evaluation, furcal radiolucency was seen in two teeth (10%) of the FC pulpotomy group and in 1 tooth (5%) of the MTA group. Another finding in the MTA group was PCO seen in 2 teeth (10%) and dentin bridge formation in one tooth (5%). This resulted in 95% success with the MTA group and 90% success with the FC group.

At the twelfth and twenty fourth month of evaluation, furcal radiolucency was seen in an additional tooth of the FC pulpotomy group (15%). However, in the MTA group, furcation radiolucency continued to be seen in the same tooth (5%), whereas PCO was seen in an additional 3 teeth (25%). Thus, the most common cause of failure was furcation involvement which was observed in 3 teeth (15%) of the FC group and only in 1 tooth (5%) of the MTA group. All 4 teeth which showed furcation radiolucency were primary 1st



Graph 1. Percentage of clinical success in both groups



Graph 2. Percentage of radiographic success in both groups

molars. A frequent observation in the MTA group was PCO (25%).

At the twelfth month of evaluation a success rate of 95% and 85% was seen in the MTA and FC groups, respectively (Graph II). This continued to be observed till the end of the study (24 months).

DISCUSSION

The ultimate objective of pediatric pulp therapy is the successful treatment of a pulpally involved tooth and to retain that tooth in a healthy condition, so that, it may fulfill its role as a useful component of the primary and young permanent dentition.

A reparative, biological approach to pediatric pulp therapy is preferable to the absolutist devitalization approach of formocresol pulpotomy. Formocresol was selected as the control group, since it is still considered the gold standard in primary teeth pulp therapy, in spite of its reported toxic, mutagenic and carcinogenic properties. It is used by 92.4 percent of pediatric dentists and endodontists either in pure form or as a diluted solution, with varying degrees of dilution.¹²

The most crucial area of concern in pulpotomy is the

inability to achieve a perfect seal to prevent marginal leakage of the medicament covering the pulp and/or the final restoration. Several in-vitro and in-vivo studies have shown that Mineral Trioxide Aggregate (MTA) prevents microleakage, is biocompatible and promotes regeneration of the original tissues when it is placed in contact with the dental pulp or peri-radicular tissues.^{9,13-16} MTA has shown to provide an enhanced seal over the vital pulp and is non-resorbable. White or tooth coloured MTA was used in the present study.¹¹ Gray MTA has also been used as a pulpotomy agent and has been shown to have superior properties. However, the only disadvantage was its unaesthetic colour, which limits its use in anterior teeth pulpotomies.¹¹

One of the clinical advantages of MTA over FC is the fact that less time is needed for the procedure. With FC, an application time of 1 minute is required prior to the removal of the cotton pellet. Whereas with MTA the pulp chamber is filled with zinc oxide eugenol cement immediately after application of the dressing material. Moreover, during removal of the cotton pellet there is a possibility of the cotton fibers adhering to the pulp stumps resulting in the recurrence of bleeding. This does not occur with MTA as it is applied directly without a cotton pellet.¹⁷



Figure 1. Pulp canal obliteration (PCO) observed with MTA (at 12 months follow up)

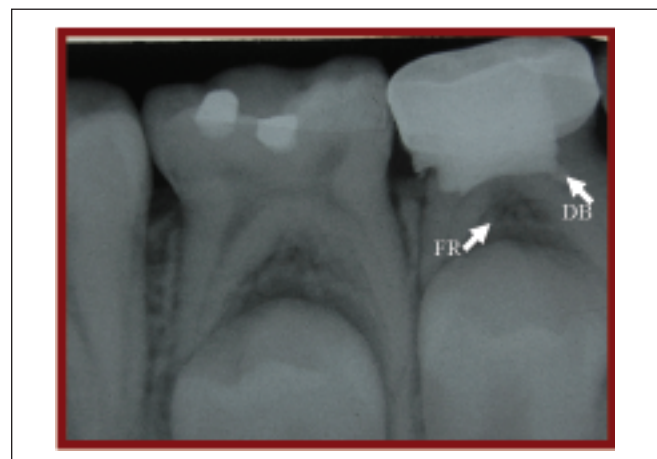


Figure 2. Furcation radiolucency (FR) and dentin bridge (DB) with MTA pulpotomy (at 6 months follow up)

In the present study, at the 6th and 12th month of evaluation, none of the primary molars showed any clinical signs and symptoms in both groups. The gradual increase in furcation radiolucency seen in the three (15%) primary molars treated with FC could be due to the histological reaction of pulp and is dependent on the concentration and application time of FC.¹⁸

A dentin bridge was seen in one (5%) molar treated with MTA after a period of 6 months. Dentin bridges were also found under MTA in animal and human studies when it was used both as a pulp capping and pulpotomy agent.^{11,17} The formation of a dentin bridge is a favorable response to conservative pulp therapy.

MTA forms a homogeneous zone of crystalline structure that is initially found along the pulp-MTA interface, while pulp cells showing changes in their cytology and function are arranged in close proximity to the crystals. Although MTA does not contain calcium hydroxide, calcium oxide is formed after hardening, which can react with tissue fluids producing calcium hydroxide.¹⁹

Histological evaluation of the pulpal tissue in animals and humans demonstrated that MTA produces a thicker dentin bridge, with less inflammation, hyperemia, and pulpal necrosis compared to that of calcium hydroxide. MTA also appears to induce formation of a dentin bridge at a faster rate than calcium hydroxide. Although it is well known that calcium hydroxide encourages the formation of dentinal bridges there are many reports on the tunnel defects seen in the bridge. These multiple defects allow fluid and bacteria to penetrate into the tooth, which in turn can lead to pulp irritation, internal resorption and ultimately loss of tooth.²⁰

In the present study pulp canal obliteration (PCO) was the most common radiographic finding with regard to pulpotomy using only MTA. However it was not regarded as a failure as it occurs due to extensive activity of odontoblast-like cells, indicating that the tooth has retained some degree of vitality.¹¹

Although one primary molar treated with MTA in our study showed furcation radiolucency, it was clinically sound. The furcation radiolucency could be due to improper diagnosis of radicular pulpal status, prior to treatment.²⁸

MTA is a technique sensitive material and takes about 4 hours to set when in contact with moisture. Presently one of the factors limiting the routine use of MTA, especially in developing countries, is the high cost of the material. Although high success rates are reported with MTA, re-entry into the canal in cases indicated for further pulp therapy may not be possible in teeth with pulp canal obliteration.

Based on the observations of this study MTA appears to be a highly successful pulpotomy agent in primary molars. With growing concerns regarding the use of FC, MTA is becoming the preferred choice for pulpotomy in primary molars due to its biocompatibility and regenerative properties. The effect of PCO on the resorption pattern and exfoliation time of pulpotomized primary molars is yet to be reported.

CONCLUSION

MTA is a promising medicament in pediatric pulp therapy and can be recommended as a suitable alternative to the conventional pulpotomy agents.

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