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Comparative investigation of clinical/radiographical signs of mineral trioxide aggregate and formocresol on pulpotomized primary molars

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Abstract

The objectives of this study were (1) to evaluate clinically and radiographically the effects of mineral trioxide aggregate (MTA) as a pulp dressing after coronal pulp amputation (pulpotomy) in primary molars, (2) to compare the effects of MTA and formocresol in pulpotomized primary teeth. Sixty primary mandibular molars of thirty healthy children aged between 5-8 years were treated by conventional pulpotomy technique. The teeth on the right side are assigned to MTA (Group A) and the left side for the Formocresol (Group B). The children were examined clinically and radiographically every 6 months over a period of 36 months. Results of present study revealed that both MTA and Formocresol has the same effect on the first as well as second primary molars, with chi-square value being 1.1483 ($P \geq 0.05$). None of the teeth in either group showed any clinical pathology, showing 100% success rate but radiographically formocresol group showed one case of internal resorption that was regarded as failure in the present study. MTA seems to be more promising predictable with positive response in vital pulp therapy in future than formocresol pulpotomy except for the cost factor.

Keywords: Formocresol, mineral trioxide aggregate, primary teeth, pulpotomy

Introduction

The primary objective of dental treatment is to maintain the integrity of dental arch. The treatment of pulpally involved teeth in primary and immature permanent teeth presents unique challenges. When the carious process exposes the pulp it reacts via inflammation limited to the area close to the carious lesion. If the pulp in the root canal seems to be unaffected, pulpotomy is the treatment of choice.[1] Formocresol, a formaldehyde compound has evolved as the preferred medicament for routine pulpal procedures in the pediatric endodontics. Although formaldehyde has been known to be toxic and have mutagenic potential it is still the drug of choice for the pulpotomy in the primary molars.[2,3]

The introduction of a new dental material, Mineral Trioxide Aggregate (Proroot MTA, Tulsa, Oklahoma) has been continuously investigated for its ability to seal the pathways of communication between the root canal system and external tooth surface. The ability of the pulp to tolerate this newer dental material and offer the protection against the microleakage has also been compared. MTA has been proposed as a potential medicament for pulpotomy procedures as well as capping of pulp with reversible pulpitis, apexification, and repair of root perforation.[4,5] In today's world, the approach should be marking the plans for the future and not holding on to the archaic treatment and methodology. Dental professional has both scientific and moral responsibilities to deliver best possible health care to the patients.[6] Formocresol is still the drug of choice in endodontics but there is no reason why dental profession should not consider and be prudent to introduce the latest materials such as MTA.[7] This study was proposed and conducted to evaluate clinically and radiographically the effects of MTA as a pulp dressing after coronal pulp amputation (pulpotomy) in primary molars and to compare the effects of MTA and formocresol in pulpotomized primary teeth.

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Materials and Methods

Sixty primary molars of thirty healthy children aged between 5 and 8 years attending the undergraduate and postgraduate outpatient clinics in the Department of Pedodontics and Preventive Dentistry at KLES's Institute of Dental Sciences, BelgaumKarnataka, India, were treated by conventional pulpotomy technique. The teeth indicated for pulpotomy were assessed by the single clinician who also performed the procedures/techniques and were evaluated every 6 months for 36 months. The criteria for the selection of teeth to be included in the study are as follows:[8]

i. Exposure of vital pulp due to dental caries, approximating to the pulp radiographically.
ii. Absence of symptoms indicative of advanced pulpal inflammation such as spontaneous pain or history of nocturnal pain.
iii. No clinical and radiographical evidence of pulp degeneration such as excessive bleeding from the root canal, tenderness to percussion, swelling or sinus tract, mobility, internal resorption, interradicular and or periapical bone destruction, advanced physiological root resorption.

iv. Teeth should be restorable after completion of the procedure.

The procedure were explained fully to the parents of children involved in the study and their informed consent as approved by the head of the institution and as well as permission of ethical committee was obtained prior to the investigation on an special format.

Technique

The teeth under study in case of selected children were chosen [Figure 1] who required minimum two pulpotomies in either arch or same arch preferably each on the opposite side (i.e. right and left). The teeth on the right side are assigned to the mineral trioxide aggregate (Group A) [Figure 2] and the left side for the formocresol (Group B)[Figure 4] respectively.

The procedure was carried out step by step in one visit using local anesthesia and rubber dam to isolate the teeth. After the standardized technique, all the right sided (Group A) primary molars were treated by MTA (Proroot, Dentsply, Tulsa Dental, Okla, USA). Using a stiff metal spatula, MTA powder was mixed with distilled water provided by manufacturer in 3:1 (powder: liquid) ratio and then placed over the exposure site with a plastic instrument. Then, the mixture was compressed against the exposure site with a moist cotton pellet. A thick mix of zinc oxide eugenol cement was placed into the coronal pulp chamber. A layer of intermediate restorative material (IRM) was placed at the same appointment as the pulpotomy [Figure 3].

All the left-sided (Group B) primary molars under study were treated with cotton pellet moistened with formocresol duly blotted and virtually dry, and were placed over the radicular pulp for 5 minutes. A thick mix of zinc oxide eugenol cement was then placed into the coronal pulp chamber. Intermediate restorative material cement base was placed over the zinc oxide layer at the same appointment [Figure 5].

After 8 days, the pulpotomized teeth were restored with

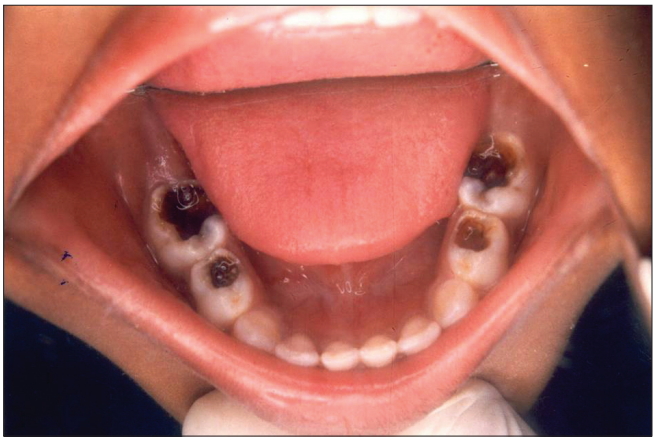

Figure 1: Photograph showing selected mandibular primary molars for the study

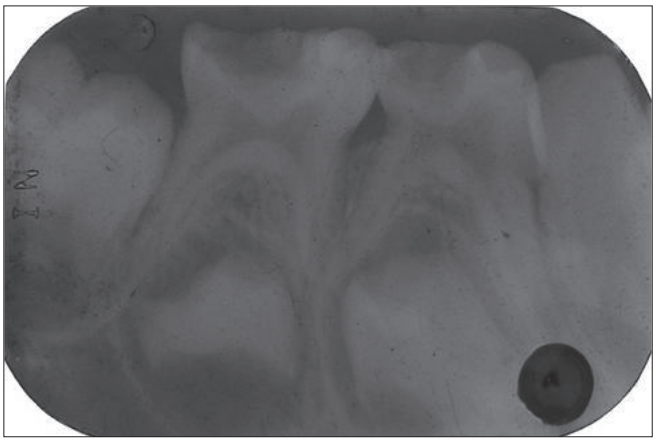

Figure 2: Pre-operative radiograph for MTA pulpotomy (Group a)

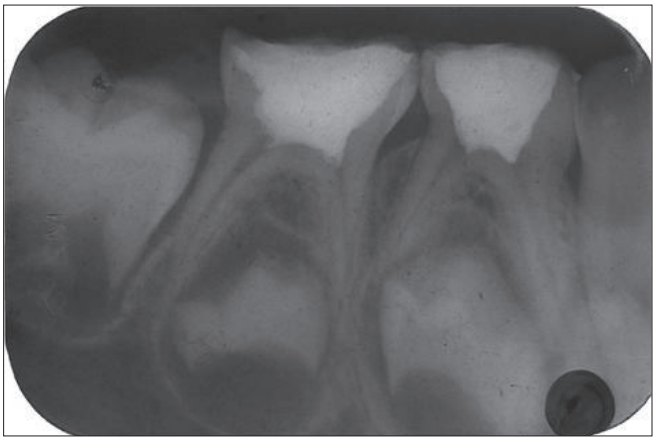

Figure 3: Post-operative radiograph immediately after the pulpotomy procedure(Group a)

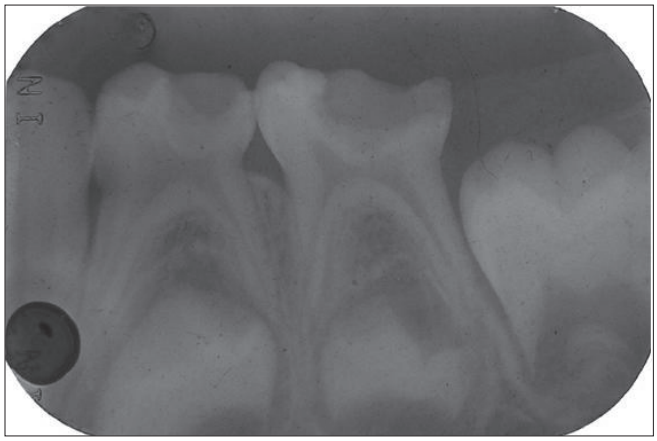

Figure 4: Pre-operative radiograph for formocresol pulpotomy (Group b)

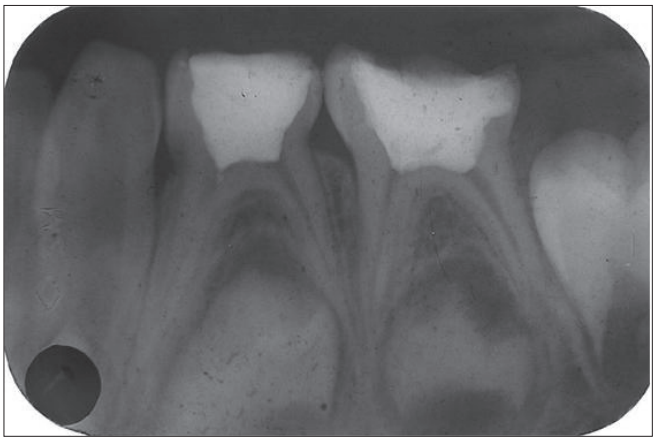

Figure 5: Post-operative radiograph immediately after the pulpotomy procedure (Group b)

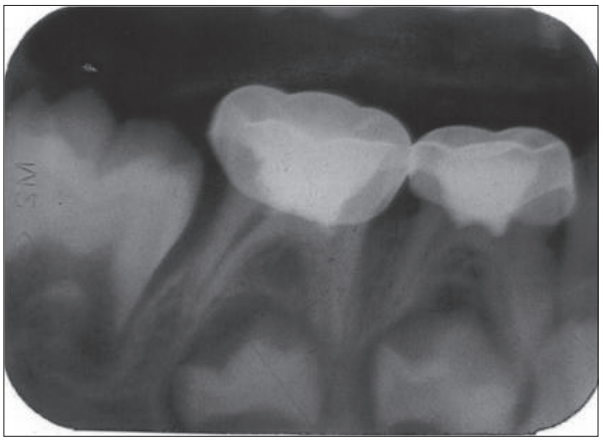

Figure 6: Post-operative radiograph after the stainless steel crown placement for MTA pulpotomized tooth (85)

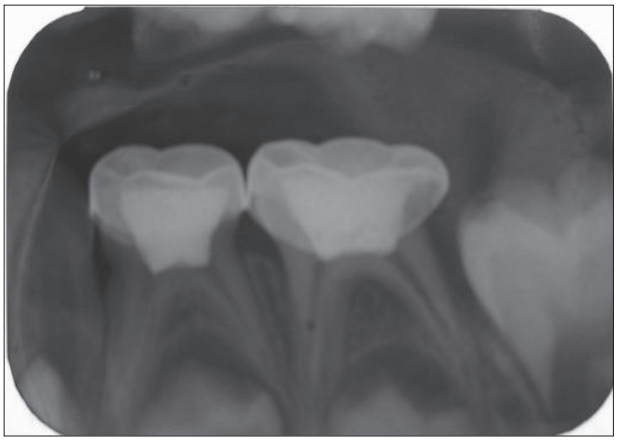

Figure 7: Post-operative radiograph after the stainless steel crown placement for formocresol pulpotomized tooth (75)

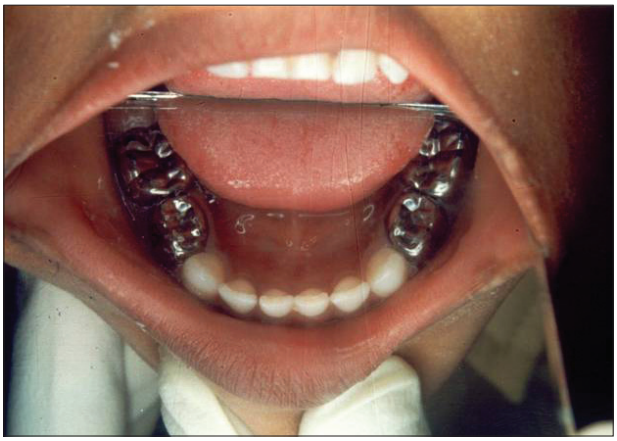

Figure 8: Definitive restoration with preformed stainless steel crown (Group a and Group b)

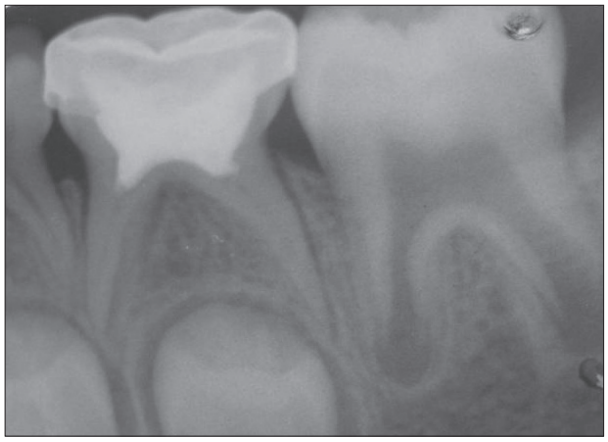

Figure 9: Thirty-six months post-operative radiograph for MTA pulpotomized tooth (85)

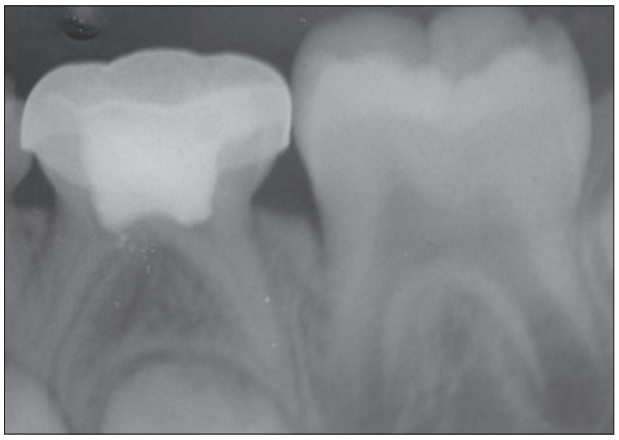

Figure 10: Thirty-six months post-operative radiograph for formocresol pulpotomized tooth (75)

a preformed stainless steel crowns. [Figures 6-8]. The children were recalled for clinical and radiographical examination every 6 months over a period of 36 months [Figures 9 and 10] and were looked for the following signs

and symptoms, viz., pain, swelling, sinus/fistula, periapical changes, furcation radiolucency, and internal resorption by the investigator himself who was aware to which the subject group belonged.

Radiologist's opinion was taken into consideration about the successive evaluation of the radiographs. The treatment was regarded as a failure when one or more of the above mentioned signs and symptoms were present, but pulp canal obliteration (PCO) was not regarded as a failure. Absence of dentinal bridge was not regarded as a failure in case of MTA (Group A). All data were entered into a special format and analyzed statistically by chi-square test and test of proportion Z test to assess the success rate of the treatment with MTA and formocresol every 6 months.

Results

A total of thirty eight first primary molars and twenty two second primary molars were treated by the above technique [Table 1]. Chi-square value for the different tooth types viz. first primary molars, second primary molars was 1.1483 ($P \geq 0.05$). This value indicates that MTA and formocresol has the same effect on the first as well as second primary molars.

The follow-up evaluations revealed 100% clinical success rate in both the groups [Table 2]. Out of thirty pulpotomy carried on primary molars with MTA (Group A), eighteen teeth showed dentin bridge formation, two samples with pulp canal obliteration (PCO), and ten samples did not reveal any calcific bridge but none of them showed signs including internal resorption, furcation involvement, and periapical radiolucency with the 100% success radiographically. However, out of thirty teeth treated with formocresol, twenty nine teeth did not show any pathological changes giving 96.67% of success radiographically. [Table 3]

Although one case showed internal resorption, radiograph did not reveal any furcation involvement and periapical bone destruction, and clinically the patient did not show adverse reaction. 'Z' test value for the internal resorption was 1.0084 ($P \geq 0.05$). This value indicates that there was no significant difference found between MTA-treated and formocresol-treated teeth.

Table 1: Distribution of assessed pulpotomized primary molars by tooth type

	First primary molar	Second primary molar	Total
MTA (Group A)	17	13	30
Formocresol (Group B)	21	09	30
Total	38	22	60

Discussion

Pulpotomy is a common procedure in the treatment of acutely inflamed primary teeth. The importance lies not only with the choice of procedure but also with the different pharmacotherapeutic agent, which have been already used for the above procedure of the primary teeth. Formocresol has been the popular material of choice for the pulpotomy procedure. It has otherwise proved as "gold standard" in pediatric dentistry may be mainly because of its ease in use and excellent clinical success but this clinical success rate has been always in close observation due to its safety considerations and to the availability of the newer materials in the clinical market.

MTA is a relatively new material that has become the material of choice for certain endodontic applications. USA Food and Drug Administration in 1998 approved MTA as an therapeutic and endodontic material in humans.[5] MTA has

Table 2: Clinical assessment in pulpotomized primary molars under study

	Total	No. of primary molars without pain	Percentage of primary molars without pain	No. of primary molars without swelling	Percentage of primary molars without swelling	No. of primary molars without sinus/fistula	Percentage of primary molars without sinus/ fistula
MTA (Group A)	30	30	100	30	100	30	100
Formocresol (Group B)	30	30	100	30	100	30	100

Table 3: Radiographic assessment in pulpotomized primary molars

	Total	No. of primary molars without internal resorption	Percentage of primary molars without internal resorption	No. of primary molars without furcation involvement	Percentage of primary molars without furcation involvement	No. of primary molars without periapical radiolucency	Percentage of primary molars without periapical radiolucency
MTA (Group A)	30	30	100	30	100	30	100
Formocresol (Group B)	30	29	96.67	30	100	30	100

proved as not an inert material but actively promotes hard tissue formation.[9] In this study, no significant difference was found in clinical outcomes for both the medicaments. The success rate of MTA is promising due to its excellent sealing ability, biocompatibility, and ability to regenerate hard tissues.[9-11] The present data indicates that under standardized and optimal clinical conditions and defined period of observation MTA has shown very promising success with all thirty samples not showing any adverse effects.

MTA's effects on amputated pulpal tissue seem to suggest that the material preserves the pulp tissue and promotes the regeneration of hard tissues. The nearly normal pulpal architecture, intact and continuous odontoblastic layer, and reparative dentin bridging observed indicate about the material's biocompatibility and regeneration ability. [7]

The stimulatory effect of MTA on the biosynthetic activity of periradicular cells results primarily in stimulation of fibroblasts to lay down a fibrous connective tissue and rapid growth of periodontal ligament due to its high healing capacity. Hard tissue formation seems to be activated progressively from the peripheral root walls to the centre of the MTA.[12,13] MTA stimulates dentin formation adjacent to the dental pulp, dentinogenesis of MTA can be due to its sealing ability, biocompatibility, alkalinity, and MTA provides a superior seal against bacteria.

The 100% clinical success rate of formocresol pulpotomy (Group B) in our study was attributable to its germicidal action. The chemical bonding with the proteins of microorganisms is the basis of bacteriocidal action of formocresol and also to its fixative qualities. Although the study is imperative to suggest the clinical and radiographic success, it is difficult to forego the actions which are present due to the chemical action of the formaldehyde with reference to fixation with the protein.[3,14]

One tooth from formocresol (Group B) showed radiographically internal resorption which was considered as failure in the post-treatment evaluation period as per methodology. In this study tooth with internal resorption was not treated and was left for the follow up observation as it was not showing any periapical osseous changes. Radiographically, twenty nine treated teeth out of thirty teeth treated with formocresol with 96.67% success rate should be considered to have a good prognosis except for the tooth with internal resorption that remains questionable.[15-17]

Formocresol has recently come to critical review and three concerns about the material should be under immediate inspection. First, local toxicity; second, the effects of the material systemically; and last, its effects of mutagenicity and carcinogenicity.[2] However, in this regard in our study clinically and radiographically formocresol as pulpotomy agent can be considered as a clinical success when evaluated under strict standardization technique.

The radiographic success rate of 100% for MTA (Group A) in our study was comparable with the previous results. MTA appears to meet the requirement for pulp capping materials. It stimulates dentin bridge formation and prevents microleakage. The material sets slowly but far from being a disadvantage, this slow setting time prevents setting shrinkage.[18]

Pulp canal obliteration (calcific metamorphosis) was found in the two cases in MTA-treated teeth was not considered as failure, which is the result of the odontoblastic activity and it suggests that the tooth is retaining some degree of vitality and function overtime.[19] MTA's advantages are related to its ability to effectively seal the material tooth interface to prevent bacterial penetration and to its high level of biocompatibility. This is in contrast to calcium hydroxide, which deteriorates overtime and gradually disintegrates thereby leaving space for potential micro leakage. MTA does not appear to change overtime. Therefore, it preserves the protective cover over, for instance developing reparative dentin, preventing bacterial invasion of the pulp. The pulp can tolerate almost any dental material and produce new dentin as long as it can be protected against microleakage, a function that MTA appear to perform better than any material with which it has been compared.[18] MTA not only yields good success rates but it also does not induce internal resorption, a finding seen with formocresol-treated teeth.

As formaldehyde is a small molecule that can penetrate the apical foramen and the mummification of the pulp only treats the symptoms but does not have the healing capacity. The objectives of formocresol pulpotomy are solely clinical, maintaining the tooth in an asymptomatic condition until normal exfoliation. Although enough evidence is present to suggest that the objective is no longer be complete "mummification". However, one may consider and accept that in fixation they may create a tolerable irritation, which replaces an intolerable irritation caused by bacteria.[19]

Conclusion

The principle conclusions of this study are that there are no significant differences in MTA and formocresol. To draw the definitive conclusions whether to withdraw our popular pulpotomy medicament such as formocresol or to include the newer and the highly biocompatible material like MTA, despite of the high success rate observed in our study remains a debatable topic. Further histologic studies on the larger sample size and longer observational period should be carried out. MTA seems to be more promising predictable with positive response in vital pulp therapy in future than formocresol pulpotomy except for the cost factor.

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