Success of mineral trioxide aggregate in pulpotomized primary molars

Najat Farsi* / Najlaa Alamoudi** / Khalid Balto*** / Abdullah Mushayt****

The aim of the present study was to compare, clinically and radiographically, the mineral trioxide aggregate (MTA) to formocresol (FC) when used as medicaments in pulpotomized vital human primary molars. Methods: The sample consisted of 120 primary molars, all teeth were treated with the same conventional pulpotomy technique. Sixty molars received FC and 60 received MTA throughout a random selection technique. Results: At the end of 24-month evaluation period, 74 molars (36 FC, 38 MTA) were available for clinical and radiographic evaluation. None of the MTA treated teeth showed any clinical or radiographic pathology, while the FC group showed a success rate of 86.8% radiographically and 98.6% clinically. The difference between the two groups in the radiographic outcomes was statistically significant. It was concluded that MTA treated molars demonstrated significantly greater success. MTA seems to be a suitable replacement for formocresol in pulpotomized primary teeth.

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INTRODUCTION

Despite the well-documented decline in dental caries in the permanent dentition, extensive dental decay in the primary dentition that progresses to the dental pulp remains a common problem in pediatric dental practice.[1] The endodontic approach to manage early pulp infection in primary teeth is by amputation of the coronal pulp and application of a medicament to maintain the healthy radicular pulp for the normal life span of the primary tooth (pulpotomy). In spite of clinical success, the pulpotomy technique has been questioned for safety and effectiveness of currently available medicaments.

* Najat Farsi, BDS, Ms. Associate Professor, Department of Preventive Dental Sciences, Faculty of Dentistry King Abdulaziz University.

** Najlaa Alamoudi, BDS, Ms, DSc. Professor, Department of Preventive Dental Sciences, Faculty of Dentistry King Abdulaziz University.

*** Khalid Balto, BDS, DMSc. Assistant Professor, Department of Conservative Dental Sciences, Faculty of Dentistry King Abdulaziz University.

**** Abdullah Mushayt, BDS, Pedi, cert., PhD. Assistant Professor, Department of Preventive Dental Sciences, Faculty of Dentistry King Abdulaziz University.

Send all correspondence to Dr. Najat Farsi, Associate Professor of Pediatric Dentistry, Pediatric Dentistry Division, Department of Preventive Dental Sciences, Faculty of Dentistry King Abdulaziz University, P.O. Box 80209, Jeddah 21089, Saudi Arabia.

Voice: (966-2) 640 3443 ext. 22136
Fax: (966-2) 640 4048
Email: N_Farsi@yahoo.com

Pulpotomy agents remain unsatisfactory for several biological reasons. Among these medicaments formocresol (FC) has been considered the most popular pulpotomy medicament for the past 60 years, and the most universally taught and preferred pulp therapy for primary teeth.[2-3] However, concerns have been raised about formocresol, because of its association with systemic toxicity and carcinogenic potential, so that safety especially in children is questioned.[4-5] Calcium hydroxide, although it is successful for dressing healthy pulp tissue,[6] has been found to be associated with severe internal root resorption after pulpotomies of primary teeth, and therefore is not used as a pulpotomy agent in primary teeth.[7]

In recent years, electrosurgery[8-9] and lasers[10] have been studied as alternative methods to formocresol pulpotomy and have shown varying degrees of clinical success.

Chemicals, such as ferric sulphate have been also tested as experimental agents,[11-12] however the long-term out comes showed some controversy.[13-14] Other alternatives for dressing the pulp have been used as Freeze-dried bone[15-16] bone morphogenic protein[17-18] and osteogenic protein[19] and shown successful results, although the physical and antimicrobial properties were questionable.

Recently the physical and chemical properties of a new root canal material mineral trioxide aggregate (MTA) were described by Torabinejad and his colleagues.[20] MTA has been used experimentally for a number of years and was approved for human usage by the FDA in 1998.[21]

The biocompatibility of MTA has been found to be

equal or superior to amalgam, IRM and ZOE.[20-21-24] In a histological study of perforation repair using MTA in the canine model, cementum was shown to grow over the MTA with minimal inflammation present even when the material is extruded beyond the perforation site.[25] The sealing ability of MTA was reported to be higher than super-EBA.[26]

The material has also been shown to have antimicrobial properties similar to that of ZOE.[20] MTA has been found to have low cytotoxicity when compared with IRM and SuperEBA.[27-28]

MTA has been demonstrated to have diverse applications for all fields of dentistry. These indications include direct pulp capping, repair of internal resorption, root end filling, apexification, and repair of root perforations. In a recent case report, MTA was used to obturate retained primary molar where no succedaneous permanent tooth was present. MTA seemed to provide a biocompatible seal of the root canal.[29] In a later preliminary report MTA was used as a pulp dressing agent in pulpotomized primary molars and it seemed to be a suitable replacement for formocresol.[30]

MTA is a new material that possesses numerous exciting potentials for pulpal therapy to avoid the excessive use of toxic agents especially in children who have multiple teeth indicated for pulpotomy. Although animal studies and short-term clinical results are highly encouraging, MTA has not been yet evaluated for long term clinical success.

The aim of the present study was to, clinically and radiographically, determine the effects of using MTA as a pulp dressing after coronal pulp amputation in primary molars and compare them to those of formocresol.

MATERIALS AND METHODS

Methods

The purpose of this study was to evaluate, clinically and radiographically, the efficacy of MTA as a pulp dressing material in pulpotomized primary molars. One hundred children were randomly selected and included in the present study. The selected children had an age range of 3 – 8 years. A total of 120 teeth were selected and the coronal pulp was amputated using the conventional pulpotomy technique. All groups were exposed to the same surgical protocol. The teeth were then divided into two equal groups, in one group MTA was used as a pulp dressing agent and FC was used in the other group. The efficacy of each material as a therapeutic modality was assessed throughout a strict follow-up recall program.

Criteria for teeth selection

The criteria for selection of teeth to be included in the study were: 1) exposed vital tooth without signs and symptoms of acute inflammation such as history of nocturnal pain, 2) no clinical or radiographic evidence of pulp degeneration, such as excessive bleeding from the root canal, internal root resorption, interradicular and /or periapical bone destruction, swelling or sinus tract; and 3) the possibility of proper restoration of the tooth.

Technique

The teeth were randomly assigned to either group by a toss of a coin. In case a child had two molars needing pulpotomy, the second tooth was assigned to the alternative group. All molars were properly isolated with rubber dam. After caries removal, coronal access was obtained using a # 330 high-speed bur with water spray to de-roof the pulp chamber. Following removal of the coronal pulp with a large round bur, hemostasis was obtained using damp sterile cotton pellet. The pulp stump in the experimental group was covered with an MTA paste, prepared by mixing MTA powder with sterile saline using a 3:1 powder/saline ratio. In the control group, a squeezed dried cotton pellet moistened with FC was placed for 5 minutes on the amputated pulp. The pulp was then covered by zinc oxide-eugenol (ZOE) paste. In both groups, a layer of IRM was placed prior to restoration with a stainless steel crown.

The children were recalled for clinical and radiographic evaluation every 6 months for a total follow-up period of two years. Periapical radiographs were taken of all treated molars. The radiographs were taken on size 0 film using a Rinn holder (Dentsply Rinn), Elgin, III) and bisecting angle technique. The case was regarded as a failure when one or more of the following signs were present: internal root resorption, furcation radiolucency, periapical bone destruction, pain, swelling, or sinus tract. Pulpal canal obliteration was not regarded as a failure.

The difference between the two materials was statistically analyzed using the Chi-square test.

RESULTS

Out of 120 teeth, only 74 were assessed clinically and radiographically throughout the follow up period (24 months). The age at the start of the study ranged from 3 to 8 years with a mean age of 6.03 ± 1.25 years in the MTA group and 5.87 ± 1.98 years for the FC group. The distribution of teeth by type of tooth and material used is shown in Table I.

Table I. Distribution of the assessed teeth according to type of material.

Material	Primary 1st molar	Primary 2nd molar	Total
FC	22	14	36
MTA	25	13	38
Total	47	27	74

Throughout the first 12 months follow up period of evaluation, no clinical or radiographic pathosis was

Table 2. Radiographic evaluation of pulpotomized primary molar at 18 months follow up visit.

	Radiographic findings				
Material	**Pulpal pathology resorption (%)**	**Internal root radiolucency (%)**	**Furcation radiolucency (%)**	**Periapical Obliteration (%)**	**Canal (%)**
FC 36	4 (10.5)	3 (7.9)	1 (2.6)	–	–
MTA 38	–	–	–	–	1 (2.7)
Total 74	4 (5.4)	3 (4.1)	1 (1.4)	–	1 (1.4)

recorded in either group. Table 2 shows the results at the 18 months follow-up period by type of radiographic pathology and material used. Radiographic pathosis was evident in 4 cases out of 38 (10.51%), treated with FC, whereas, no clinical symptoms of failure were evident at this stage. Out of the reported cases failures, 3 teeth showed internal root resorption and one tooth showed furcation involvement.

The results also showed that none of the MTA treated teeth presented with any radiographic pathology nor clinical sign of failure. The difference, however, was not statistically significant (p=0.64).

Table 3 shows the clinical and radiographic results after 24 months of evaluation. The FC group showed 5 cases with pulp pathosis (13.2%), with only one case reported pain. All reported failure cases showed internal resorption, two of them showed furcation involvement. On the other hand, all the 38 teeth treated with MTA were considered successful radiographically and clinically. The significant difference between the 2 groups after 24 months of evaluation was evident in the radiographic pathology (p=0.031).

DISCUSSION

The present study, which was based on 74 primary molars, showed that the treatment of pulpotomized primary molars with MTA is a clinically and radiographically successful procedure.

The pulpotomy technique has been the procedure of choice for treating vital primary teeth with carious exposure using formocresol as a pulp dressing material.[3] Many specialists are considering the use of other dressing materials, as concerns relating to the toxicity, mutagenicity and cariogenicity of formocresol has previously been voiced in the dental literature.[31] According to Block and his colleagues formocresol should not be brought in contact with human tissue.[32]

It is clear that many specialists in pediatric dentistry would abandon formocresol if they were able to identify effective, non-toxic alternative.

MTA is a new, biocompatible material with numerous exciting clinical applications in endodontics. Several *in vitro* and *in vivo* studies have shown that MTA is biocompatible material that promotes regeneration of the original tissues when it is placed in contact with the dental pulp or periradicular tissues and prevent microleakage as well.[27, 29]

The present study showed a perfect success rate in teeth treated with MTA throughout the 24-month evaluation period. In animal studies, MTA was also found to be more compatible than IRM which is used as dressing material in FC pulpotomy.[20-21] A fact that explains the higher success rate of MTA, which when placed directly over the pulp tissue, reduces the risk of subsequent inflammation. On the other hand formocresol group showed 100% success rate only at the 6-month and 12-month routine recall visits. The success rate of formocresol dropped to 89.5% and 86.8% at the 18 and 24 months visits respectively. Three cases of FC showed internal root resorption at 18-month evaluation. Teeth with internal root resourption were not treated, but left for follow-up observation, because

Table 3. Clinical and radiographic evaluation of pulpotomized primary molar at 24 months follow up visit

	Radiographic findings					Clinical findings		
Material	**Pulpal pathosis (%)**	**Internal root Resorption (%)**	**Furcation radiolucency (%)**	**Periapical radiolucency (%)**	**Canal Obliteration (%)**	**Pain (%)**	**Swelling (%)**	**Sinus tract (%)**
FC 36	5 (13.2)	5 (13.2)	2 (5.3)	— —	1 (2.8)	1 (2.8)	—	—
MTA 38	—	—	—	—	3 (7.9)	—	—	—
Total 74	5 (6.8)	5 (6.8)	2 (2.7)	—	4 (5.4)	1 (1.4)	—	—

they were asymptomatic and did not show any sign of clinical failure. At the end of the study the number of cases with internal root resorption increased to 5 cases (13.2%). This might be explained on the basis of the irritative nature of both FC and IRM.

The present findings concerning the FC success rate when compared to other pulpotomy research showed better results when time is considered. In the present study, the one-year success rate for the FC was 100% compared to 95% and 96% success rate reported earlier.[12,33] This higher success rate could probably be due to the strict criteria used for selection of teeth in the present study.

Pulpal canal obliteration was the most common radiographic finding in the MTA group. The obliteration is the result of odontoblastic activity and suggests that the tooth is retaining some degree of vitality[24] and therefore was not regarded as failure. Pulpal canal obliteration has been reported as a common radiographic finding in pulpotomized teeth treated with formocresol (13%), MTA (40%),[30] and ferric sulfate (60%).[14] In our present study pulpal canal obliteration was present in 5.4% of the sample, which is considered lower than the frequency reported in any of the previous studies.

In addition to the higher success rate of MTA over FC, MTA can be applied in a shorter chair time procedure, which is considered as an appreciated clinical advantage in young children. FC requires 5 minutes application, whereas; with the MTA the pulpal chamber is filled with IRM immediately after application of MTA.

Based on the present evidence, MTA could be used as a safe medicament for pulpotomy in cariously exposed primary teeth and could be a substitute for formocresol successfully especially in young children with multiple teeth requiring pulpotomy treatment.

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