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MTA Pulpotomy in Primary Molars: A Prospective Study

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Abstract: This study was designed to evaluate clinical and radiographic success rates of Mineral Trioxide Aggregate (MTA) as a relatively new pulpotomy agent for pulp treatment of primary teeth. This prospective investigation was carried out on a group of children with a mean age of 6.4 years who were referred to Shiraz Dental School for routine care. Pulp amputation was carried out following routine local anesthetic induction on selected primary molars and then MTA (Pro root, USA) was placed over the already formed clot at the canal orifices. All teeth were restored using Stainless Steel Crowns and a recall program was set for 6, 12 and 24 months. Clinical and radiographic evaluations were attempted in all recall visits. Overall 55 primary molar teeth were treated by this new technique 4 of which failed for any follow-up evaluations. Apparently, all of the remaining 51 treated teeth were found to be sound and without any sign or symptoms both by clinical and radiographic means (100% success at 12 and 24 months), postoperatively. Based on the findings of this study, it seems that MTA could be used as an alternative to the current Formocresol medication with high clinical and radiographic success in pulpotomy of primary teeth.

Key words: Pulpotomy, primary molar, teeth, MTA, clinical, radiographic

INTRODUCTION

As many young individuals regardless of their race and social backgroung are proved to be in daily need to relive sever dental pain originated from pulp pathosis due to large cavities, the need for pulp treatment is clearly highlighted. In the 3rd world community this issue is more critical as pulpotomy is one of the most frequently needed treatments in order to retain carious primary molar teeth that would otherwise be lost.

On the other hand, there are growing concerns over the faith of formocresol and its wide use among scientists due to its potential carcinogenicity (Myers *et al*., 1978; Lewis and Chestner, 1981). Formocresol had been a popular pulpotomy medicament in the primary dentition for the past 60 years and is still considered as the gold standard in performing vital pulpotomy for primary teeth in many countries (Eidelman *et al*., 2001; Avram and Pulver, 1989; Strange *et al*., 2001; Primosch *et al*., 1997). However, in spite of years of success on its use, concerns had been raised about its potential toxicity, mutagenicity and carcinogenicity in human during recent years (Myers *et al*., 1978; Agamy *et al*., 2004; Lewis and Chestner, 1981; Lewis, 1998; Swenberg *et al*., 1980). Several alternatives have been recommended over the past decades to replace fomocresol with various reported degree of success. Mineral Trioxide Aggregate (MTA) is one of the most recent developments in the field of dental materials which is proved to be a biocompatible agent.

This relatively new material has first been introduced to dentists in 1995 by Torabinejad (1999) who had suggested it for endodontic root filling. The US Food and Drug Administration approved Mineral Trioxide Aggregate (MTA) in 1998 as a safe therapeutic endodontic material for human. Its principal components are tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. It also contains oxides of iron, magnesium and bismuth oxide which is added for radiopacity purpose (Agamy *et al*., 2004; Lewis, 1998; Salako *et al*., 2003). High sealing ability is among the many favorable features of MTA as well as its biocompatibility, ability to form dentin bridge and cementum and periodontal ligament regeneration (Salako *et al*., 2003; Nakata *et al*., 1998; Pitt Ford *et al*., 1996; Torabinejad, 1999).

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MTA also has the ability to stimulate cytokine release from bone cells, so it has the capacity to actively promote hard tissue formation (Eidelman *et al*., 2001). The use of this material has recently been extended to Pulp capping and Pulpotomy of Primary teeth in children. However there is little clinical documents available of the safe and sound use of this material in long term for primary teeth. The aim of this *in vivo* investigation was, therefore, to evaluate the potential clinical and radiographic effectiveness of MTA as a pulp filling material in primary molar teeth.

MATERIALS AND METHODS

A total of 55 teeth were selected from children who attended the pedodontic department at Shiraz Medical University. The selected samples consisted of 23 maxillary and 32 mandibular primary molars (both 1st and 2nd molars). Parents were thouroghly informed of the procedure and requested to sign the consent form for the ethical point of view. The criteria for selection of cases were as follows: symptomless exposure of vital pulp by caries, no clinical and/or radiographic evidences of pulp degeneration such as internal root resorption, furcation and/or periapical radiolucency of the bone, fistula or swelling around the tooth and possibility of proper crown restoration of the teeth. In addition to these criteria, each patient must have had no medical condition contradicting pulp treatment. An arrangement was made with the parents to have their child returned for routine and set follow up appointments. The treatment protocol consisted of two separate visits with the 1st appointment, being for a thorough clinical examination in addition to obtaining a peri-apical radiograph of the selected teeth as the inclusion criteria.

This was followed by administration of a suitable local anesthesia (Xylocaine, Darupakhsh, Iran) and caries removal using a large round bur mounted on a slow-speed hand piece. The roof of the pulp chamber was removed with a high-speed bur as soon as the pulp was exposed. The coronal pulp was then removed using a sharp spoon excavator and the area was irrigated with normal saline. Sterile cotton pellets moistened with normal saline were then placed on to the pulp canal orifices under a light pressure in order to obtain homeostasis. These pellets were then removed and pulp stumps were covered with a thin layer of MTA paste, which was prepared by mixing MTA powder with sterile saline at a 3:1 powder/saline ratio, according to the manufacturer's recommen-dation (Pro root MTA, USA).

As the setting time of the MTA is around 4 h, a cotton pellet moistened with sterile water was placed over the MTA paste and a ZOE dressing paste (Zonalin, Kempdent, UK) was placed over the MTA inside the pulp chamber. In 2-4 days later, the second appointment was arranged in which the temporary restoration and cotton pellet were removed and a layer of zinc-phosphate base was placed over the MTA paste. This was followed by the tooth restoration using Stainless Steel crowns. All the patients were placed on a recall program of 12 and 24 months follow up periods with clinical and radiographic examinations.

The criteria for clinical success were defined as the absence of pain, fistula, soft-tissue abscess formation and/or abnormal mobility of the tooth at the recall visit. Whereas the radiographic criteria for success were as follows: normal periodontal ligament space on the periapical radiograph absence of internal and/or pathologic external root resorption and no sign of any pathologic process including thinning of the trabecular pattern to large radiolucencies in the furcation and/or peri apex. Collected data was analyzed using basic statistics.

RESULTS

Fifty-five children (27 girls and 28 boys) aged between 5 and 9 years with a mean age of 6.4 years, were included in this clinical investigation. The number of the treated teeth were 29 1st primary and 26 2nd primary molars (Table 1). Of the 55 original patients participated for treatment, 51 returned for follow up. The remaining 4 patients had either moved from the area or changed their address and contacts. Therefore, the information presented here relates to the 51 patients (teeth) who attended the follow-up appointments. Based on the recorded data, in 12 and 24 months follow up stages there was a no case with any of the failure criteria such as pain, fistula, abnormal mobility or swelling (100%). Radiographic evaluation was also confirming that treated cases were intact with no radiographic evidence of any pathosis after 12 and 24 months follow up (100%). In terms of the patients response rate, the number of missing was 4 (8%) and attended 51 (92%) which were available for follow up examinations, indicating a high rate of complience.

Table 1: Distribution of MTA treated teeth according to the type of the teeth

Teeth types	1st molar (%)	2nd molar (%)	Total (%)
Maxilla	11 (20)	12 (22)	23 (42)
Mandible	18 (33)	14 (25)	32 (58)
Total	29 (53)	26 (47)	55 (100)

DISCUSSION

To date, dental caries scores the highest among the dental problems of children all over the world. As many of these children do not attend the dentist in regular basis, their attendance is associated with dental pain in most of the instances. This is routinely due to some degree of pulp involvement following caries progress. Primary teeth pulp is routinely removed through a process of coronal pulp removal leaving the root part intact using a medicament, usually Formocresol, to provide a fixed layer as barrier to the remaining vital tissue. For many years the use of formocresol has been proved as the most successful agent for pulpotomy of primary teeth. However, several studies have raised concerns over the safe use of this material in pulp. This has led to several investigation looking atr the potential alternative for Formocresol including, Glutaraldehyde, ferrous sulfate and MTA. In the current investigation clinical and radiographic effect of MTA was tested through pulpotomy of primary molar teeth. Mineral trioxide aggregate has well been documented as a success material for use in several endodontic procedures in permanent teeth (Aeinehchi *et al*., 2007). Several *in vitro* and *in vivo* studies have shown that this material prevents microleakage and promotes regeneration of the original tissues, when it is placed in direct contact with the dental pulp or periradicular tissues (Aeinehchi *et al*., 2007; Maroto *et al*., 2005). Since several different brands of MTA are currently available in the market, the use of so called gray-MTA (original product) in this investigation enabled the investigators to look at the effect of the drug being used in earlier report in a more consistent outcome to other studies of the same nature. An interestingly high success rate (100%) in both occasions of 12 and 24 months is an indication of the material's suitability to pulpotomy in primary molar teeth of children. As this result was achieved from both clinical and radiographic aspects, the successful use of the material can be further acknowledged. This high success rate result is consistent with several earlier reports on favorable effects of this material as a possible reasonable replacement to formocresol in primary teeth pulpotomy (Eidelman *et al*., 2001; Fuks, 2002; Salako *et al*., 2003; Agamy *et al*., 2004; Naik and Hegde, 2005; Holan *et al*., 2005; Farsi *et al*., 2005).

In addition, the successful and effective use of MTA has been tested through several more investigations indicationg the suitability of the material for application on vital pulpotomy in human primary teeth (Maroto *et al*., 2005, 2007; Caicedo *et al*., 2006; Fuks and Papagiannoulis, 2006; Deery, 2007; Aeinehchi *et al*., 2007).

A meta analysis report by Peng *et al*. (2006), has indicated that the use of MTA versus formocresol for primary molar pulpotomy is promissing. The overall result of that study also showed that MTA faces less undesirable responses that are seen associated with formocresol which makes it a suitable replacement for Formocresol (Peng *et al*., 2006).

Currently, MTA is available in the market in 2 forms: gray MTA (the original material) and white MTA which is introduced more recently as an esthetic improvement over the original material for placement in anterior teeth (Agamy *et al*., 2004). In the current investigation and almost all of the previously published studies which reported high success rate, the gray MTA has been used as the pulp medication over the pulp remains in primary teeth. Agamy *et al*. (2004) compared the histologic responses of the pulp tissues to the gray MTA and white MTA as pulp dressing in pulpotomized primary teeth. They reported that after 6 months follow up period normal pulpal architectural pattern is seen in the gray MTA group with a very few inflammatory cells and odontoblastic layer with a continuous regular arrangement in histologic sections. However, irregular odontoblastic layer can be found in the pulp tissues of pulpotomized teeth with some loss of continuity, inflammatory cells and areas of partial necrosis in the white MTA group. The architectural pattern of the pulp tissues after application of gray MTA may help to explain the high success rate of this material as a pulp capping agent in exposed and pulpotomized primary teeth. Perhaps the minor difference in composition between gray and white MTA accounts for the differences in pulp tissue response to these materials.

A more recent study by Maroto *et al*. (2007) represents a similar 100% success rate when white MTA was used as pulpotomy medicament in primary molar teeth after 6 months follow up period. According to Koh *et al*. (1997) MTA stimulates the release of cytokine that in turn, promotes hard tissue genesis which can result in bridge formation across the pulp tissue. It may be assumed that this effect accompanied by favorable pulpal responses and presence of some chronic inflammatory cells indicate a bacterial tight seal preventing microleakage (Cox, 1987; Browne *et al*., 1983). During the course of this investigation it was also noted that gray MTA paste could be easily applied over the pulp stumps and also minimal time is needed for completion of the procedure. While formocresol requires 3-5 min application before the cotton pellet is removed, MTA paste is applied immediately after obtaining homeostasis. In addition, the formocresol cotton pellet could sometimes adhere to the clot and damage it causing bleeding to start when the

pellet is removed. This does not occur with MTA that is applied directly without a cotton pellet. According to the Fuks (2002), internal root resorption is a common sequela after formocresol or ferric sulfate pulpotomies in primary teeth. Surprisingly, this problem has not been found in any cases of MTA treated teeth in the current investigation. It has also been suggested that direct contact of the ZOE as a base following formocresol or ferric sulfate application on pulp can cause pulp inflammation with a risk of subsequent internal resorption (Watts and Paterson, 1987).

Whereas, in this and other earlier studies MTA had been placed directly over the pulp stumps and then a layer of zinc phosphate cement to cover it. This could be a possible explanation for the lack of internal resorption in teeth treated with MTA. Some of the previous studies reported that pulp canal obliteration is of the most frequent consequences of pulpotomy treatment with MTA in primary teeth (Holan *et al*., 2005; Maroto *et al*., 2005, 2007).

However, this finding was not seen in any of the cases in current investigation. The only disadvantage of this relatively new material which could be referred to is crown discoloration of the treated teeth. This is mostly detected at follow up appointments and during clinical examination of the teeth. This discoloration was a dark brown to black color change which was more prominent on the clinical crown of the first primary molars than on the second primary molars. It seems that the color change is related to the use of pro root MTA which has a darker appearance and shines through following its setting process is complete. This paste has an initial white appearance which alters after 2-4 days (the time interval between 2 treatment sessions). A white to grayish color was detected in the paste when temporary restoration and moistened cotton pellet were removed from the pulp chamber.

This color change can continue during the next few days and after permanent restoration of the treated teeth. So at the follow up appointment (several months later) this color change may be more intensive and can be seen via the thin residual structure of the treated teeth if they are not fully covered by an SS crown restoration.

In the 1st primary molar teeth because of the lower thickness of enamel and dentin, this color change may be more prominent than in the 2nd primary molars. In order to overcome this drawback, the use of SSC for crown restoration following pulpotomy is suggested. The use of more recent product of white MTA could also contribute to solve the color issue particularly in anterior teeth.

CONCLUSION

Based on the results of this investigation, gray-MTA has a reasonably high success on preserving pulp vitality of primary teeth. It's potential for use as a suitable alternative to formocresol as a dressing material following pulpotomy in primary teeth can be seen promising.

REFERENCES

Aeinehchi, M., S. Dadvand, S. Fayazi and S. Bayat-Movahed, 2007. Randomized controlled trial of mineral trioxide aggregate and formocresol for pulpotomy in primary molar teeth. Int. Endod. J., 40 (4): 261-267. PMID: 17309744.

Agamy, H.A., N.S. Bakry, M.F. Mounir Maha and D.R. Avery, 2004. Comparison of Mineral Trioxide Aggregate and Formocresol as pulp capping agents in pulpotomized primary teeth. Pediatr. Dent., 26 (4): 302-309. PMID: 15344622.

Avram, D.C. and F. Pulver, 1989. Pulpotomy medicaments for vital primary teeth. J. Dent. Child, 56 (6): 426-434. PMID: 2530256.

Browne, R.M., R.S. Tobias, I.K. Crombie and C.G. Plant, 1983. Bacterial microleakage and pulpal inflammation in experimental cavities. Int. Endod. J., 16 (4): 147-155. PMID: 6581132.

Caicedo, R., P.V. Abbott, D.J. Alongi, M.Y. Alarcon, 2006. Clinical, radiographic and histological analysis of the effects of mineral trioxide aggregate used in direct pulp capping and pulpotomies of primary teeth. Aust. Dent. J., 51 (6): 297-305. PMID: 17256303.

Cox, C.F., 1987. Biocompatibility of dental materials in the absence of bacterial infection. Oper. Dent., 12 (4): 146-152. PMID: 3506997.

Deery, C., 2007. Mineral trioxide aggregate a reliable alternative material for pulpotomy in primary molar teeth. Is mineral trioxide aggregate more effective than formocresol for pulpotomy in primary molars? Evid Based Dent., 8 (4): 107. PMID: 18158545.

Eidelman, E., G. Holan and A.B. Fuks, 2001. Mineral trioxide aggregate vs formocresol in pulpotomized primary molars: A preliminary report. Pediatr. Dent., 23 (1): 15-18. PMID: 11242724.

Farsi, N., N. Alamoudi, K. Balto and A. Mushayt, 2005. Success of mineral trioxide aggregate in pulpotomized primary molars. J. Clin. Pediatr. Dent., 29 (4): 307-311. PMID: 16161395.

Fuks, A.B., 2002. Current concepts in vital primary pulp therapy. Eur. J. Pediatr. Dent., 3 (3): 115-120. PMID: 12870999.

Fuks, A.B. and L. Papagiannoulis, 2006. Pulpotomy in primary teeth: Review of the literature according to standardized criteria. Eur. Arch. Pediatr. Dent., 7 (2): 64-71. PMID: 17140530.

Holan, G., E. Eidelman and A.B. Fuks, 2005. Long-term evaluation of pulpotomy in primary molars using mineral trioxide aggregate or formocresol. Pediatr. Dent., 27 (2): 129-136. PMID: 15926290.

Koh, E.T., M. Torabinejad, T.R. Pitt Ford, K. Brady and F. Mcdonald, 1997. Mineral trioxide aggregate stimulates a biological response in human osteoblasts. J. Biomed. Mater. Res., 37 (3): 432-439. PMID: 9368148.

Lewis, B., 1998. Formaldehyde in dentistry: A review for the millennium. J. Clin. Pediatr. Dent., 22 (2): 167-177. PMID: 9643194.

Lewis, B.B. and S.B. Chestner, 1981. Formaldehyde in dentistry: A review of mutagenic and carcinogenic potential. J. Am. Dent. Assoc., 103 (3): 429-434. PMID: 7024387.

Maroto, M., E. Barberia, P. Planells and F. Garcia Godoy, 2005. Dentin bridge formation after Mineral Trioxide Aggregate (MTA) pulpotomies in primary teeth. Am. J. Dent., 18 (3): 151-154. PMID: 16158803.

Maroto, M., E. Barberia, V. Vera and F. Garcia Godoy, 2007. Mineral trioxide aggregate as pulp dressing agent in pulpotomy treatment of primary molars: 42-month clinical study. Am. J. Dent., 20 (5): 283-286. PMID: 17993022.

Myers, D.R., H.K. Shoaf and T.R. Driksen, 1978. Distribution of 14C formaldehyde after pulpotomy with formocresol. J. Am. Dent. Assoc., 96 (5): 805-812. PMID: 418090.

Naik, S. and A.M. Hegde, 2005. Mineral trioxide aggregate as a pulpotomy agent in primary molars: An *in vivo* study. J. Indian Soc. Pedod. Prev. Dent., 23 (1): 13-16. PMID: 15858300.

Nakata, T.T., K.C. Bae, J.C. Baumgarther, 1998. Perforation repair comparing mineral trioxide aggregate and amalgam using an anaerobic bacterial leakage model. J. Endod., 24 (3): 184-186. PMID: 9558584.

Peng, L., L. Ye, H. Tan and X. Zhou, 2006. Evaluation of the formocresol versus mineral trioxide aggregate primary molar pulpotomy: A meta-analysis. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod., 102 (6): 40-44. PMID: 17138165.

Pitt Ford, T.R., M. Torabinejad, H.R. Abedi, L.K. Backland and S.P. Kariyawasam, 1996. Using mineral trioxide aggregate as a pulp-capping material. J. Am. Dent. Assoc., 127 (4): 491-494. PMID: 9594770.

Primosch, R.E., T.A. Glom and R.G. Jerrell, 1997. Primary tooth pulp therapy as taught in predoctoral pediatric dental programs in the United States. Pediatr. Dent., 19 (2): 118-122. PMID: 9106874.

Salako, N., B. Joseph, P. Ritwik, J. Salonen, P. John and T.A. Junaid, 2003. Comparison of bioactive glass, mineral trioxide aggregate, ferric sulfate and formocresol as pulpotomy agents in rat molar. Dent. Traumatol., 19 (6): 314-320. PMID: 15022999.

Strange, D.M., N.S. Seale, M.E. Nunn and M. Strange, 2001. Outcome of formocresol/ZOE sub-base pulpotomies utilizing alternative radiographic success criteria. Pediatr. Dent., 23 (4): 331-336. PMID: 11572492.

Swenberg, J.A., W.D. Kerns and R.I. Mitchell, 1980. Induction of squamous cell carcinomas of the rat nasal cavity by inhalation exposure to formaldehyde vapor. Cancer Res., 40 (9): 3398-3402. PMID: 7427950.

Torabinejad, M., 1999. Chivian Clinical applications of mineral trioxide aggregate. J. Endo., 25 (4): 197-205. PMID: 9594770.

Watts, A. and R.C. Paterson, 1987. Pulpal response to a zinc oxide-eugenol cement. Int. Endo. J., 20 (2): 82-86. PMID: 3471729.