



## CLINICAL AND RADIOGRAPHIC ASSESSMENT OF DUAL-CURE MINERAL TRIOXIDE AGGREGATE BASED CEMENT ON PULPOTOMIZED PRIMARY MOLARS

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### ABSTRACT

**Objectives:** This study was conducted to evaluate the effect of dual-cure mineral trioxide aggregate (MTA) as pulp capping material on clinical and radiographic success rate of pulpotomized primary molars in comparison with the conventional chemical cure one. **Subjects and Methods:** Children from both genders with age of 3-7 years have a total of eighty decayed mandibular primary molar teeth indicated for pulpotomy treatment were included in the present study. The involved teeth were grouped into two groups according to the received pulp capping material; Group A; Pulpotomized Molars were received dual-cure MTA (D-MTA); Group B; Pulpotomized teeth received conventional white MTA (W-MTA). The clinical and radiographic evaluations were made postoperative immediately of restoration protocol (base-line), after 6-weeks, and 7-months follow specific criteria. **Results:** However, dual-cure MTA showed slightly higher success rate, but both types of MTA and the conventional white MTA showed comparable clinical and radiographic clinical success with no statistically significant difference after all follow-up periods. **Conclusion:** Dual-cure MTA can be used as effective alternative medicament for conventional white MTA in the treatment of pulpotomized primary molars.

**KEYWORDS:** Mineral Trioxide Aggregate, Dual-cure, Primary Teeth, Pulpotomy

### INTRODUCTION

The prime goal of pulp therapy in children is to maintain their deciduous teeth until the time of normal shedding <sup>(1)</sup>. Pulpotomy of the deciduous dentition is one of the commonest pulp therapies that frequently used for retaining the curiously involved primary molars that would otherwise be extracted <sup>(2)</sup>. Therefore, pulpotomy can be expressed as the standard treatment protocol for vital primary teeth with carious pulp exposures <sup>(3)</sup>.

Formocresol is the commonest pulp medicaments which used for decades either in primary or permanent teeth <sup>(4)</sup>. It is the frequently used medicament in the primary teeth pulpotomy to maintain the pulp involved teeth from prematurely loss <sup>(4,5)</sup>. Although, the use of formocresol as a pulpotomy medicaments recently faced a huge refuse because of its aldehyde content which rumored an extensive cytotoxicity, carcinogenic potentials, and systemic distribution, in addition to its ability to stimulates remarkable inflammatory response of the pulp tissues <sup>(6)</sup>.

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Because of these appreciable harmful-effects the researches directed toward looking for other applicable and viable replacement to formocresol<sup>(7)</sup>. These vital replacements include biologic materials such as mineral trioxide aggregate (MTA), calcium hydroxide (Ca-H), or antiseptic materials as glutaraldehyde (GAh), or hemostatic materials like ferric sulfate (FS), or physical-substitutes as electro-surgery, and laser<sup>(7,8)</sup>.

MTA had been extensively used for pulp therapy in root canal fillings, pulpotomy, and pulp capping, as well as in root perforations repair, or formation of apical barrier<sup>(9)</sup>. MTA has alkaline pH which rises in its alkalinity from 10.5-12.5 within 3 hours roughly after mixing during the hydration process and the formation of Ca-H<sup>(10)</sup>.

MTA has favorable characteristics including lower solubility, biocompatibility, bioactivity, and encouraging clinical results<sup>(11)</sup>. Although these desirable qualities of MTA, some of its properties usually limits its clinical use as it is difficult to handle, in addition to its prolonged setting time especially in the presence of blood or moisture which alter its physical and chemical qualities<sup>(12)</sup>.

Dual-cure MTA was developed recently as alternative to the conventional MTA to overcome these limitations. It is resin-based formulation of the conventional MTA.<sup>(13)</sup> Dual-cure MTA has lower solubility, better manipulation characteristics and better mechanical properties, and command setting time.<sup>(14,15)</sup>

There are no clinical studies evaluating pulpotomy of primary molars using dual-cure MTA. Therefore, this study was designed to short term (7-months) evaluate and compare the clinical and radiographical outcomes of pulpotomy of primary molars using MTA and TheraCal LC in randomized controlled clinical study.

## SUBJECT AND METHODS

This study was designed as computerized randomized controlled clinical trial. The enrolled children were aged between 3-7 years and selected from outpatient clinic of the Pedodontics and Oral Health Department, Faculty of Dental Medicine, Al-Azhar University (Cairo, Boys). The ethical approval was obtained from ethical committee, Ref number, 127936, Faculty of Dental Medicine, Al-Azhar University (Boys, Cairo) before starting this study.

This study was performed on eighty carious mandibular primary molars indicated for pulpotomy treatment. The involved molars were randomly divided into two equal groups (n=40) according to the received pulpotomy material; group A; Pulpotomized primary molars were received dual-cured MTA (study group); Group B; Pulpotomized teeth received conventional chemical-cure MTA (control group).

### Subject selection:

#### Inclusion criteria:

1. Primary molars with vital carious pulp exposures.
2. Lack of clinical or radiographic evidence of pulpal degeneration.
3. Absence of radiographic signs of internal or external resorption.
4. Teeth that could be restored with proper restorations.
5. Patient free from any systemic conditions .

#### Exclusion criteria:

1. Physiological root resorption exceeding one-third of the root.
2. Bleeding during the amputation of coronal pulp tissue which is difficult to be controlled.
3. Patients having medical conditions such as history of heart surgery, leukemia, immune

compromised conditions and congenital heart defects.

4. Inadequate structure to be restored with stainless steel crown.
5. Immunity affecting drug administration as antibiotics or immune-suppressed drugs before the pulpotomy procedure by at least 2 weeks.

**A sample size** of 20 in each group has a 90% power to detect a difference between means of 1.48 with a significance level (alpha) of 0.05 (two-tailed). In 80% (the power) of those experiments, the P value will be less than 0.05 (two-tailed) so the results will be deemed “statistically significant”. In the remaining 20% of the experiments, the difference between means will be deemed “not statistically significant”.

$$N = \left( \frac{(Z\delta)}{ME} \right)^2$$

Children enrolled in this study should have at least one decayed mandibular and maxillary primary molar (split mouth technique ) with vital pulp (hot

and cold) tasted involvement without any clinical or radiographic sign of preapical inflammation, degeneration, or pathosis. However, presence of any mobility with tongue pressure bite mechanism, sensitivity to percussion, pathologic root resorption, preapical pathosis or furcation involvement were considered as exclusion criteria <sup>(16,17)</sup>. Parents of all selected children were informed about the all needed information’s about this clinical study before starting and then each child’s parent was signed a detailed informed consent.

#### **Operative procedures:**

##### ***Pulpotomy procedures:***

The pulpotomy procedures was performed as follows: administration of local anesthesia, followed by isolation of the operative side with rubber dam. Then, all caries was removed with a high-speed handpiece and carbide bur. After that, access cavity preparation by a sterile fissure bur. The coronal pulp was amputated entirely with sharp spoon excavator. Then, the pulp chamber was rinsed with water and the hemorrhage was stopped with cotton pellets moistened with normal saline <sup>(16,17)</sup>.

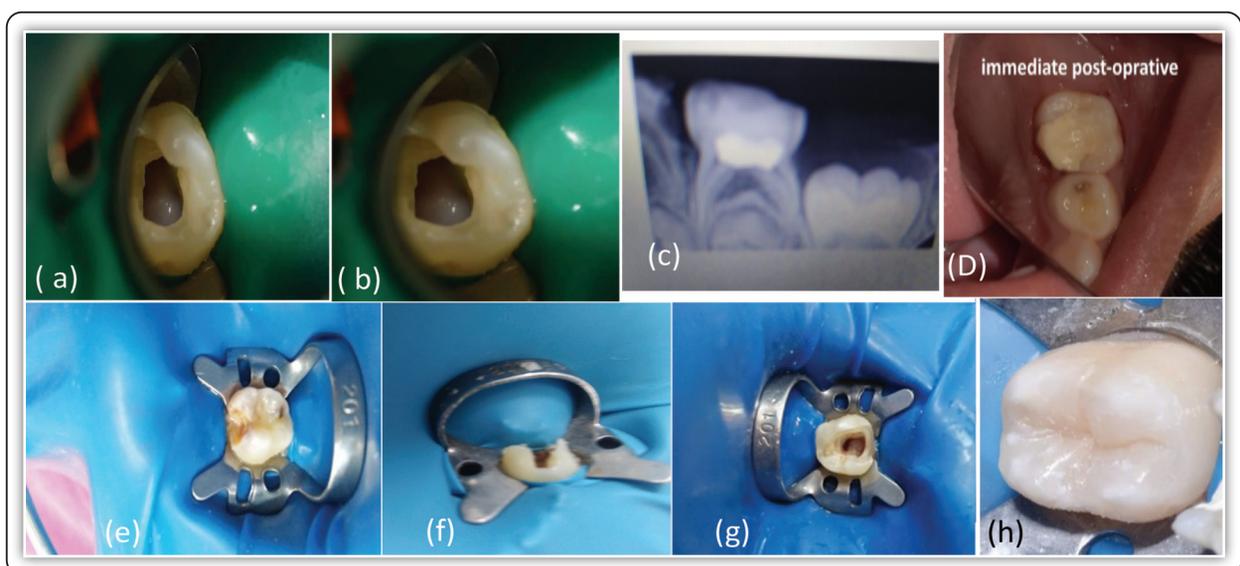


FIG (1) (a) and (b) showing access cavity for lower right second primary molar. (c) post-operative radiograph. (d) immediate post-operative composite restoration. (e) pre operative lower second primary molar with deep distal caries. (f) access cavity. (g) after bleeding stoppage and coronal pulp amputation. (h) immediate post-operative with composite.

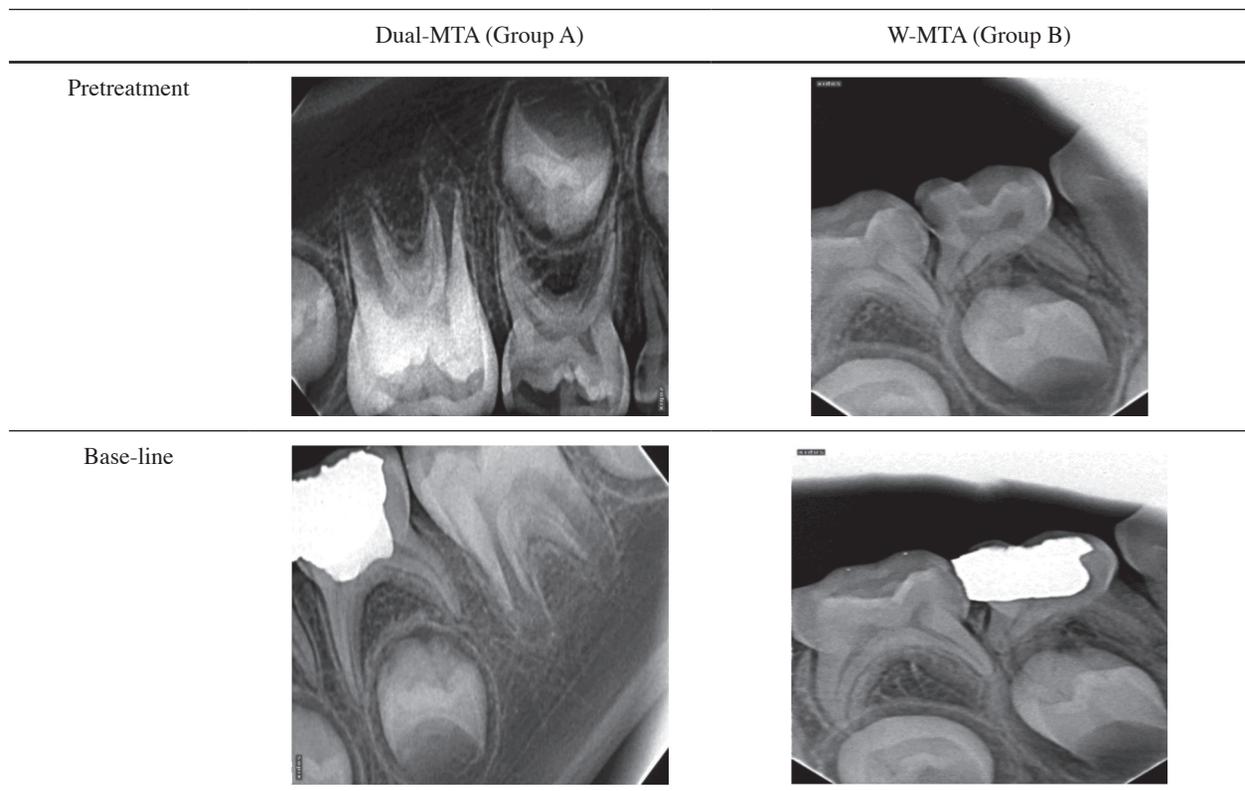
**Restoration procedures:**

After ending the pulpotomy protocols, a capping material, in group A; Dual-cure MTA ProRoot MTA, Dentsply, Tulsa, OK,USA based cement, Theracal LC, BISCO, Dental, was injected to the coronal pulp chamber over the radicular pulp and then light-cured based on the instructions of the manufacturer, figure A . While, in group B; ProRoot MTA, Dentsply, Tulsa, OK,USA, past was prepared (3 powder:1 liquid) and placed directly on the radicular pulp with a sterile carrier. In both groups care should be taken to seal the radicular pulp completely with the both material and to ensure a material thickness of 2 to 3 mm. Then, the cavity was filled with resin-

modified glass ionomer cement (RMGI), Finally, the pulpotomized teeth were restored with stainless-steel crowns<sup>(16,17)</sup> (3M,ESPE,USA).

**Clinical and radiographic evaluation:**

The postoperative clinical and radiographic follow-up evaluation were performed at the base-line (immediately after restoration), 6-weeks, and 7-months. The restored teeth with clinical signs of mobility, pain, swelling, or sensitivity to percussion was considered clinically failure. However, teeth with presence of any preapical sign of pathosis or radiolucency was considered radiographically failed<sup>(17)</sup>.



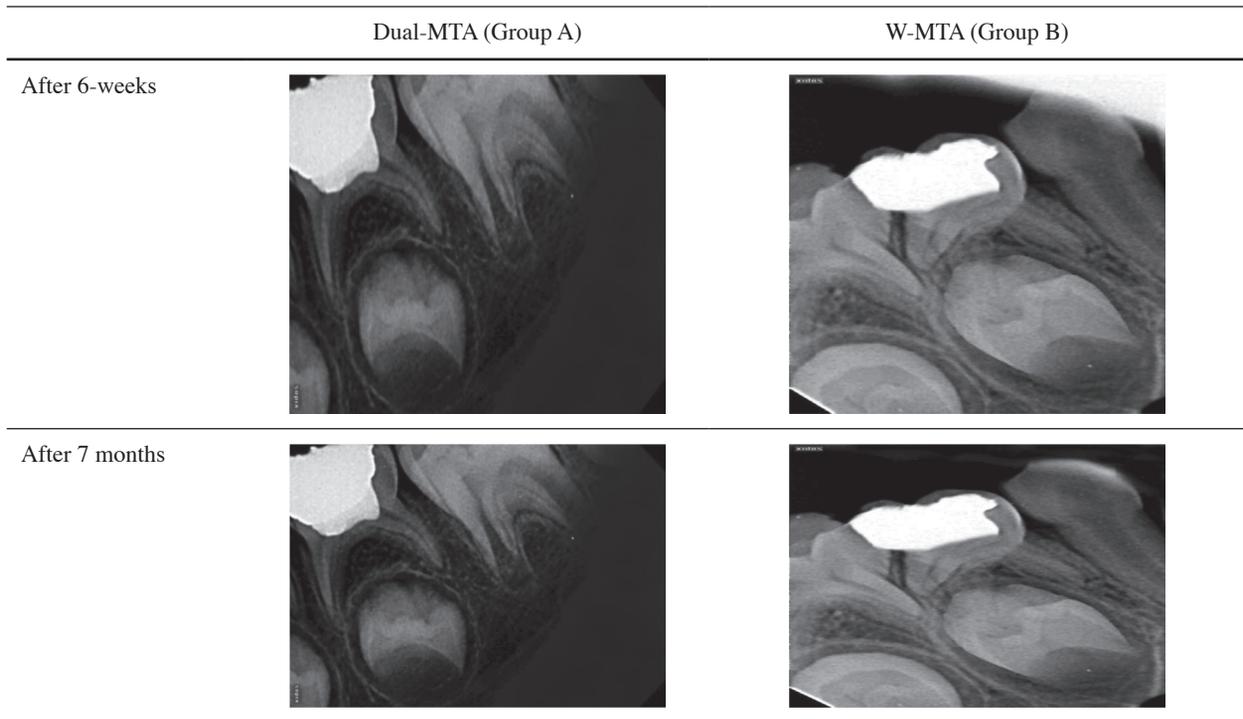


FIG (2) Radiographic photos of both groups at different times

**Statistical analysis:**

The collected numerical data were tabulated and analyzed statistically using Chi-square test to compare between groups at different follow-up time. The results considered significant statistically at p-value less than 0.05.

**RESULTS**

The results of the clinical and radiographic follow-up of dual-cured MTA and the chemically-cured MTA showed non-statistically significant difference between the both studied group regarding to the success and failure rates at the all follow-up periods ((Figure 3). Also, the clinical and radiographic results showed that the dual-cure MTA revealed better success rates when compared to the conventional chemically cured MTA.

**TABLE (1)** Comparison between the two studied groups according to clinical results.

Variables			Success and Failure		
			D-MTA	W-MTA	p-value
Clinical	Base-line	Success; n (%)	40 (100%)	40 (100%)	1 <sup>ns</sup>
		Failure; n (%)	0 (0%)	0 (0%)	
	6-weeks	Success; n (%)	40 (100%)	39 (97.5%)	0.314 <sup>ns</sup>
		Failure; n (%)	0 (0%)	1 (2.5%)	
	7-months	Success; n (%)	36 (90%)	33 (82.5%)	0.337 <sup>ns</sup>
		Failure; n (%)	4 (10%)	7 (17.5%)	

\*; significant at  $p < 0.05$ . ; non-significant (ns) at  $p > 0.05$ .

**TABLE (2)** Comparison between the two studied groups according to radiographic results.

Variables		Success and Failure			
		D-MTA	W-MTA	p-value	
Radiographic	Base-line	Success; n (%)	40 (100%)	40 (100%)	1 <sup>ns</sup>
		Failure; n (%)	0 (0%)	0 (0%)	
	6-weeks	Success; n (%)	39 (97.5%)	37 (92.5%)	0.305 <sup>ns</sup>
		Failure; n (%)	1 (2.5%)	3 (7.5%)	
	7-months	Success; n (%)	35 (87.5%)	30 (75%)	0.152 <sup>ns</sup>
		Failure; n (%)	5 (12.5%)	10 (25%)	

\*; significant at  $p < 0.05$ .

; non-significant (ns) at  $p > 0.05$ .

## DISCUSSION

Ideally, the material used for pulp dressing during pulpotomy treatment of the carious primary teeth must have specific criteria including; bactericidal effect, promoting radicular pulp healing, and did not have adverse effect on pulp or surrounding dental structures, as well as it did not interfere with the physiological process of root resorption<sup>(19)</sup>. Hence, the current study was aimed to investigate the effect of MTA either dual-cured or chemically-cured on the success rate of pulpotomized primary molars.

MTA as pulpotomy agent had proven good clinical success rates and long-term good prognosis<sup>(20)</sup> Studies reported that MTA possesses not only better sealing ability, and excellent biocompatibility but also has favors respect in tissue regeneration. Also, MTA has an alkaline pH (10.2) which increase after 3 hours of setting to (12.5) that stimulate the pulp tissue to form dentin bridge.<sup>(21)</sup> Therefore, it was selected in this study as pulp capping material for the pulptomized primary molars.

To avoid the known limitation of the conventional MTA, dual-cure MTA was invited to replace it because of its unique resin formula, as it consisting of tricalcium (tri-Ca) and dicalcium (di-Ca) silicate particles in a particulate hydrophilic monomer which affords marked ion release of calcium (Ca) and hydroxide (OH) ion which induces precipitation of hydroxyapatite and formation of tertiary dentine bridge and hence contributing in good seal of the pulp tissue<sup>(22,23)</sup>. Therefore, dual-cure MTA was chosen as a comparative studied material with the conventional chemically-cured MTA in the present study.

In the current study children were selected with age ranging between 3 -7 years, this because, this age range is the most preferable age range in which the root of teeth was with considerable length where, and no root resorption started yet or minimal range of root resorption could only exist<sup>(24)</sup>. Moreover, in this study primary mandibular molars were selected as the involved teeth because of their ease of clinical visualization and the less radiographic overlapping of successor tooth buds onto their roots in comparison to the maxillary primary molars that facilitate to diagnose the radiographic pathosis or healing more certainly<sup>(25)</sup>.

In the current study RMGIC was chosen as a restorative material over the tested pulp-capping material (W-MTA and D-MTA) to restore the coronal portion of the pulpotomized primary molars followed by stainless-steel crown as final restoration tooth coverage to give an efficient seal to the restored tooth from leakage and prevent its fracture and to ensure that the success or failure of the restoration protocol only dependent on the tested materials<sup>(26)</sup>.

In this study, the clinical and radiographic results of this study showed there was higher initial success rate (100%) of the two tested pulp capping materials (W-MTA and D-MTA) in the present study immediately after ending of treatment without any sign of failure. This is because of the

pulpotomy disinfection protocol were followed properly in this study in an attempt to reduce the potential bacterial load before the placement of the capping material<sup>(27)</sup>. As it proven that the bacterial disinfection has a marked role in pulp healing after vital pulp therapy<sup>(28)</sup>.

Also, in the present study the two studied groups showed higher clinical success rate after 6- week of follow-up with success rate of 100% for D-MTA and 97.5% for W-MTA. This could be attributed to the Ca-H which released during the hydration reaction of MTA which induce favorable biological mechanism<sup>(27,29)</sup>. Moreover, it could attribute to the higher antimicrobial properties, and proper sealing ability of MTA based materials<sup>(27)</sup>.

However, the insignificant decrease in success rate in regard to W-MTA when compared to D-MTA after 6-weeks and 3-months of clinical and radiographic follow-up in the present study, could be attributed to the higher initial solubility of conventional W-MTA as well as its lower sealing ability when compared to the light-cured MTA (D-MTA)<sup>(27)</sup>. As it was reported that the light-cured MTA has higher sealing ability than the conventional W-MTA<sup>(30)</sup>.

## CONCLUSION

Both dual-cure MTA and the conventional MTA have a comparable clinical and radiographic success rate as a pulp dressing material; Dual-cure MTA can be used as effective alternative pulp medicament for the conventional MTA during pulpotomy of primary molars.

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