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# Clinical and Radiographic Evaluation of Mineral Trioxide Aggregate and Biodentine as Pulp Medicaments in Primary Molars

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**Abstract**

The aim of the study was to compare the clinical and radiographic success of Mineral Trioxide Aggregate and Biodentine in partial pulpotomy in primary molars at 12 and 18 months. This study included 50 primary molars in 18 healthy children aged 4-7 years. Teeth were randomly divided into two groups, each consisting of 25 molars. NeoPUTTY MTA Partial Pulpotomy group (A) (n=25 primary molars). Biodentine™ partial pulpotomy group (B) (n=25 primary molars). Clinical and radiographic evaluation were performed at 12 and 18 months according to the modified Zurn and Seale Criteria, based on the clinical and radiographic findings. The overall success rates of partial pulpotomy at 12 and 18 months were 79.17% and 70.83% for group (A) and 70.83% and 66.67% for group (B). Results of this study showed that NeoPUTTY MTA and Biodentine™ have similar efficacy as pulp capping materials in primary molars partial pulpotomy.

**Keywords:** Partial pulpotomy, MTA, Biodentine, Deep caries.

**Full length article** **Corresponding Author*, e-mail: *Marwa.Magdy@bue.edu.eg*

## 1. Introduction

In recent years, so-called "Bioactive Pulp Medicaments" were introduced for vital pulp therapy, having changed treatment strategies for the primary dentition [1-2]. This is also true for deep dentine lesions or exposed vital pulps with reversible pulpitis. Therefore, several new statements and guidelines about pulp therapy in primary teeth were published [3]. Prevention and treatment of dental caries have a pivotal role in oral health [4]. In this scenario, preserving the vitality of primary teeth with conservative or minimally invasive treatment principles [5], such as interim therapeutic restoration approach [6], partial carious removal, or atraumatic restorative treatment [7] is essential since pulp infection and the early loss of primary teeth may lead to malocclusion and the risk of esthetic, phonetic, or functional problems [8]. Interventions for treating deep carious lesions in teeth with no history of pain or teeth with reversible pulpitis are referred as vital pulp treatments (VPT), which may involve the placement of a protective liner, indirect pulp capping (IPC), direct pulp capping (DPC), partial pulpotomy, and pulpotomy.

Pulpotomy is considered the gold standard in pediatric dentistry with high success rate worldwide of 82.6% [9]. However, it is the most invasive, resulting in a significant amount of substance removal, thus jeopardizing the integrity of tooth anatomy [10]. Partial pulpotomy is indicated when the pulp is exposed accidentally or during deep caries excavation suffering partial chronic pulpitis [11]. The superficial part of the sound, non-infected pulp is removed, and an appropriate coverage is applied [12]. In comparison to cervical pulpotomy, it is more conservative as it causes less harm to the pulp and to the surrounding hard tissues, making the tooth easier to restore. Clinical studies for partial pulpotomy mainly deal with post-traumatic treatment of permanent anterior teeth with calcium hydroxide as this was its initial indication. According to AAPD best practice recommendations, partial pulpotomy is suggested for carious pulp exposure with controlled bleeding in permanent teeth. Regarding other capping materials, MTA has been reported in a single study with primary teeth [13].

NeoPUTTY® MTA, initially released by Avalon Biomed™ and acquired by NuSmile® in 2016, is a premixed

bioactive/bioceramic material consisting of fine, inorganic powder of tricalcium/dicalcium silicate in a water-free organic liquid [14]. Biodentine™ released by (Septodont, France in 2009), is a tricalcium silicate based on organic non-metallic material. It was designed as a dentine replacement material. It has physical and biological properties, biocompatibility, improved manipulation and it does not cause tooth discoloration compared to MTA, quicker setting time, superior compressive strength, reduced porosity and ability to induce reparative dentine composition [15-17]. Hence, the purpose of this study was to compare the clinical and radiographic success of Mineral Trioxide Aggregate and Biodentine™ in partial pulpotomy procedure in primary molars.

## 2. Materials and Methods

This study was conducted at the outpatient clinic of the Pediatric Dentistry and Dental Public Health Department, Ain Shams University. The study was approved by the Ethics Committee of Faculty of Dentistry, Ain Shams University, with the approval number FDASU-Rec ID 072033. Parents or legal guardians were given information about the steps and the purpose of the study and asked to sign a consent prior to any oral examination for their children. Procedures were explained orally to all participants. The participants consisted of 50 primary molars in 18 healthy children.

### *2.1. Inclusion Criteria*

- Healthy children aged ***4-7*** years with at least one carious primary molar that may require vital pulp therapy.
- Primary molars with clinical symptoms, history of reversible pulpitis, no spontaneous pain, or pain persisting after stimuli removal.
- Absence of periapical/interradicular radiolucencies, inflammatory root resorption, sinus tract or gingival abscess.
- Physiologic root resorption should not exceed one third of the root [18-19].

### *2.2. Exclusion Criteria*

- Children who are extremely uncooperative and difficult to manage.
- Parents who refused to sign an informed consent.

They were divided into 2 groups

- NeoPUTTY MTA Partial Pulpotomy group (A) which consisted of 25 primary molars.
- Biodentine™ partial pulpotomy group (B) which consisted of 25 primary molars.

Clinical and radiographic evaluation were performed at 12 and 18 months according to the modified Zurn and Seale Criteria, based on the clinical and radiographic findings [20-21].

### *2.3. Intervention*

All interventions were performed by the primary investigator as follows

- Clinical examination was done using a dental mirror and aided by the tactile detection of a dental explorer to make sure that the molars fulfill the inclusion criteria, followed by radiographic examination.
- For both groups (A and B), a pre-operative periapical radiograph of the carious molar was taken using the Rinn XCP extension cone paralleling technique as a baseline [22].
- Topical anesthetic gel was applied to the mucosa for 1 minute (Dharma Research, Inc, USA) followed by administration of local infiltration anesthesia containing 4% Articaine 1:100.000 epinephrine (INIBSA Dental S.L.U, Spain).
- Molars were isolated using a rubber dam (Sanctuary Health, Malaysia).
- Caries was completely removed using a large #4 sterile round diamond bur mounted in a high-speed handpiece (NSK, Japan) with constant coolant removing the peripheral carious dentin first followed by the pulpal floor [23].

If pulp exposure was encountered, and a small area of the pulp tissue was inflamed partial pulpotomy was done as follow

- At the exposure site, a spherical diamond bur on a high-speed handpiece was used to eliminate around 2 to 3 mm of coronal pulp tissues with constant coolant [24]. Hemostasis was acquired by irrigation with saline solution. Rinsing of the amputated pulp with sterile saline allowed hemostasis without blood clot formation.
- Following the rinsing of the pulp the state of the pulp tissues below the amputation level was thoroughly evaluated. If the pulp tissues' appearance was normal with no sign of infection or degradation, hemostasis was attained by applying a cotton pellet drenched in saline to the wound pulp [25].
- Hemostasis should be achieved within 2-3 minutes otherwise teeth were assigned for pulpotomy [24].

### *2.4. Dressing Application*

Teeth were **randomly** allocated to one of the following groups based on the dressing material applied to the pulp stumps as follows

- **For the MTA group (A)**
  A One-millimeter-thick layer of the MTA (NeoPUTTY) was applied from the manufacturer's syringe using a plastic instrument (ZEFFIRO, Italy) to cover the exposed pulp. The layer was then gently adapted using a tweezer with a moist cotton pellet after squeezing out excess moisture. The dressing material was immediately covered with glass ionomer restorative material (EQUIA® Fil, Tokyo, Japan) avoiding any pressure.

- **For the Biodentine group (B)**
  The Biodentine powder and liquid were mixed according to the manufacturer's instructions. The capsule containing the powder was opened, five drops from the liquid were poured into the capsule then placed in the amalgamator for 30 seconds. The mixture was then applied over the exposed pulp using a plastic instrument

(ZEFFIRO, Italy) followed by gentle adaptation using a tweezer with a moist cotton pellet after squeezing out excess moisture [26]. The dressing material was immediately covered with glass ionomer restorative material (EQUIA® Fil, Tokyo, Japan) avoiding any pressure.

- All teeth were then covered with stainless steel crowns SSC (3M ESPE, USA) at the same visit to achieve proper sealing.

- Post-operative periapical radiographs were taken after the SSC cementation using the Rinn XCP extension cone paralleling technique.

## 3. Results

Out of the 50 primary molars allocated in this study, 2 molars were lost throughout the follow up period. One from the NeoPUTTY MTA partial pulpotomy group (A) and one from Biodentine group (B). Within both materials, the majority of the treated teeth were lower first molars, and the differences between tested groups regarding different demographic characteristics were not statistically significant ($p>0.5$).

### *3.1. Clinical evaluation*

For both materials (Group A and Group B), majority of cases in all intervals had clinical score (1) and there was no significant difference between tested groups nor a significant difference between scores measured in different intervals ($p>0.05$).

For Group (A) partial pulpotomy with NeoPUTTY MTA there was a significant increase in measured scores after 12 and 18 months (Increase in failure rates) ($p=0.006$).

For Group (B) partial pulpotomy with Biodentine™ there was a significant increase in measured radiographic scores after 12 and 18 months (Increase in failure rates) ($p=0.018$).

### *3.2. Radiographic evaluation*

- For Group (A) partial pulpotomy with NeoPUTTY MTA
  - After 12 months, majority of the cases had score (1).
  - There was a significant increase in measured scores after 12 and 18 months (Increase in failure rates) ($p=0.006$).
- For Group (B) partial pulpotomy with Biodentine™;

There was a significant increase in measured radiographic scores after 12 and 18 months (Increase in failure rates) ($p=0.018$).

## 4. Discussion

Despite the high success rate of formocresol as a pulp medicament and its wide use in pulp therapy in primary teeth [27], the debate about its carcinogenicity and mutagenicity shifted interest towards alternative pulp medicaments [28].

The introduction of biocompatible and bioactive dental materials allowed the application of the concept of biomimetics across different dental fields with the advantages of enhanced strength, sealing, regenerative and antibacterial abilities [29]. Moreover, several biomimetic materials were claimed to overcome significant limitations of earlier available generation counterparts especially in regenerative and restorative dentistry such as bioceramic root repair materials [30].

The current study attempted to apply a novel biomimetic approach in pediatric dentistry combining bioceramic materials, NeoPUTTY MTA and Biodentine™, as pulp capping agents with a stain-less steel crown as a final restoration for partial pulpotomy procedure. The aim of this study was primarily to evaluate the clinical and radiographic success rates of Mineral Trioxide Aggregate and Biodentine as a pulp dressing material in direct pulp capping, partial pulpotomy, and pulpotomy in primary molars at 12 and 18 months. Each material's success was evaluated with the added peripheral seal of SSC over the glass hybrid restoration.

Patients included in the study ranged from 4 to 7 years of age to ensure that minimal or no physiological root resorption occurs during the course of the study. The study was conducted on 18 healthy children (50 teeth). For molars restored with NeoPUTTY MTA (Group A), for partial pulpotomy majority of the cases were males. However, for Biodentine (Group B), no significant difference was found in gender distribution. Although clinical examination and dental history are of paramount importance in the selection of cases for vital pulpotomy, the physical and medical condition of the child can affect treatment prognosis and should be considered [18]. Therefore, for ethical reasons and to eliminate confounders related to a compromised immune response, medically compromised children were excluded from this study.

Nevertheless, differential diagnosis of pulpal disease due to caries with the diagnostic aids available nowadays, has its limitations. The history of presence or absence of pain was found not reliable in the differential diagnosis of the condition of the exposed primary pulp as it is in permanent teeth [31]. Degeneration of primary pulp and even abscess formation without the child complaining of pain or discomfort is common. This, however, does not rule out the history of pain as the first consideration in selection or rejection of teeth for vital pulp therapy and was also a diagnostic aid in this study [18].

Success of vital pulp treatment (VPT) does not only depend on pulp tissue health, but on a variety of factors, including the amount of affected tissue, an adequate blood supply to the tooth, a healthy periodontium, and the opportunity to create an appropriate coronal seal [32]. For their exceptional sealing ability [26], bioceramic materials have risen as alternatives to other pulp capping materials and were hence chosen in this study. In this study, we have modified the cutoff point in the Zurn and Seale clinical criteria to consider teeth with score 1 as well as score 2 as successful procedures.

**Table 1:** Intergroup comparisons and summary statistics for demographic data.

| Material | Parameter | | Partial pulpotomy |
|---|---|---|---|
| NeoPUTTY MTA | Gender [n (%)] | Male | 12 (50.00%) |
| | | Female | 12 (50.00%) |
| | Age (Mean±SD) (years) | | 5.67±0.86 |
| | Treated primary tooth [n (%)] | First molar | 15 (62.50%) |
| | | Second molar | 9 (37.50%) |
| | Treated arch [n (%)] | Lower | 17 (70.83%) |
| | | Upper | 7 (29.17%) |
| Biodentine | Gender [n (%)] | Male | 12 (50.00%) |
| | | Female | 12 (50.00%) |
| | Age (Mean±SD) (years) | | 5.43±1.20 |
| | Treated primary tooth [n (%)] | First molar | 15 (62.50%) |
| | | Second molar | 9 (37.50%) |
| | Treated arch [n (%)] | Lower | 16 (66.67%) |
| | | Upper | 8 (33.33%) |

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

**Table 2:** Intragroup comparisons, frequencies, and percentages for overall outcome **(NeoPUTTYMTA Group A).**

| Time | Overall outcome | |
|---|---|---|
| | | Partial pulpotomy |
| | Failure | 3 (12.50%) |
| 12 months | Success | 19 (79.17%) $^{Aa}$ |
| | Failure | 5 (20.83%) |
| 18 months | Success | 17 (70.83%) $^{Aa}$ |
| | Failure | 7 (29.17%) |
| p-value | | **0.049*** |

Values with different superscript letters within the same **horizontal row** are significantly different *; significant ($p<0.05$) ns; non-significant ($p>0.05$).

**Table 3:** Intragroup comparisons, frequencies, and percentages for overall outcome **(Biodentine Group B).**

| Time | Overall outcome | |
|---|---|---|
| | | **Partial pulpotomy** |
| | **Failure** | 6 (25.00%) |
| **12 months** | **Success** | 17 (70.83%) [Aa] |
| | **Failure** | 7 (29.17%) |
| **18 months** | **Success** | 16 (66.67%) [Aa] |
| | **Failure** | 8 (33.33%) |
| **p-value** | | **0.223ns** |

Clinical score 2 includes the condition "gingival inflammation (due to poor oral hygiene)", which is a reversible gingival condition that may be present at a certain follow up and then not anymore at the next due to change in the patient's oral hygiene practices [33]. It would have been an underestimation of the survival rate of the vital pulp therapies if teeth exhibiting reversible plaque induced gingivitis were considered failed procedures especially when covered with a stain-less steel crown. Radiographically, we considered successful procedures as those teeth showing no radiographic changes (score 1). Teeth, indicated in scores 2, 3, and 4, showing progressive internal resorption, external root resorption, interradicular radiolucency, or need for extraction were considered as radiographic failures.

- For NeoPUTTY MTA partial pulpotomy Group A; there was a single clinical failed case (Score 3) after 12 months and 18 months.
- For Biodentine™ treated cases (Group B); After 12 and 18 months, there were 2 failed cases. There was no significant difference in clinical outcome between different groups and intervals ($p>0.05$).
- For NeoPUTTY MTA group A (Partial pulpotomy); radiographic failure rates after 12 and 18 months were 20.83%. and 29.17% respectively.
- For group B, partial pulpotomy with Biodentine failure rates at 12 and 18 months were 29.17% and 33.33% respectively. The high failure rate might be partly related to the inclusion criteria of this group, where it was observed that uncontrolled bleeding at the carious exposure site could be associated with generalized inflammation of the pulp [34].

Moreover, enlarging exposure size can increase the risk of contamination with dentin chips and bacteria [35], indicating that the treatment might have benefited from a disinfection procedure preceding to capping. Altogether, these could be considered important points requiring further clarification in future studies. Our study's most frequent radiographic failure was furcation radiolucency, followed by internal root resorption (IRR). The type of radiographic failures reported in different VPT studies was not consistent for a single type of treatment. However, it was commonly reported that IRR is a reaction of an inflamed vital pulp in response to irritation [36]. Furcation radiolucency is also a common finding in primary teeth with infected and inflamed pulp due to the high prevalence of accessory canals in the floor of pulp chambers [36-37].

It was mentioned in a previous study by Nematollahi,Hossein et al. conducted a randomized control trial to evaluate the clinical and radiographic success rates of mineral trioxide aggregate partial pulpotomy (PP) that clinical and radiographic evaluation at 6, 12, and 24 months were 90.9 percent, 90.5 percent, and 81.8 respectively, which was consistent with our results [13].

## 5. Conclusions

Within the limitations of this study, it can be concluded that:

1- NeoPUTTY MTA and Biodentine™ have similar efficacy as pulp capping materials in primary molar vital pulp treatment.
2- Biodentine™ can be used as an alternative to MTA in primary molar partial pulpotomy.

Partial pulpotomy is an alternative acceptable treatment but only with the right diagnosis and perfect isolation during procedure.

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