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Effectiveness of Bioceramics in Pulpotomy of Primary Molars

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ABSTRACT

This study was performed to assess success rate, clinical and radiographic findings of two bioceramics, Mineral Trioxide Aggregates (MTA) versus Biodentine, used in deciduous teeth pulpotomy. Eighty primary molars requiring pulpotomy satisfying the inclusion criteria selected from 80 children 5–7 years old and divided into two groups: MTA group and Biodentine group. rate of success was 100% in both groups after 1- and 6- months, while it was 90% for each group after one year. No statistically significant difference in the clinical success rate throughout the study was revealed. no statistically significant difference regarding mode of failure either by internal root resorption (p=.555), external root resorption (p=.555), furcal radiolucency and widening of periodontal ligament (p=.645).

Keywords: *Bioceramics, Biodentine, MTA, Pulpotomy, Primary teeth*

1.Introduction

Pulpotomy is a process 0f conservative vital pulp therapy directed to asymptomatic primary molars with extensive caries but without evidence of root pathology [(1)]. The dressing material used in pulpotomy must be save for the cells and oral structures, not affect physiologic root resorption, bactericidal and enhance pulp tissue healing [(2)]. According to the treatment objectives, pulpotomy can be classified into devitalization (cauterization), Preservation (minimal devitalization with no induction) and regeneration (reparative or inductive)[(3)].

In pediatric dentistry, Mineral trioxide aggregate and Biodentine have come into widespread use recent. it is not only have the biocompatibility that redirect the inflammatory response and enhance healing of the remaining vital pulp but also stimulate pulp cell regeneration[(4)].

Mineral Trioxide Aggregates (MTA) was used in direct pulp capping, apexification, repair of perforations in root or furcation and as a root end filling[5]. One of the wonder advantages of MTA is the induction of dentinal bridge within a short period with less inflammation or necrosis of the pulp. These clinical efficacy of MTA is associated with radiographic and histological improvement [6]. In opposite to the advantages of this marvel cement, it has a lot of disadvantages as expensive cost, delayed setting, troublesome handling, and induce a significant discoloration[7]. Biodentine (BD), a material introduced as a powder and liquid. the main components of the powder are zirconium oxide, tricalcium silicate, and calcium carbonate, most of the liquid is water with calcium chloride and a water-soluble polymer[8]. The wonder effect of Biodentine when come in contact with vital pulp cells is the early formation of reparative dentin. It has excellent biological properties so can be used near to the dental pulp [9].

2.Material and methods

This randomized control trial conducted between May 2022 and January 2024 at the Pediatric Dental Clinics in Delta University. Approval was obtained by the faculty's delta university ethics committee (No. DU.2022-00108). Prior to the beginning of the treatment the aim of the study and clinical procedures were explained to the parents and a written informed consent was obtained.

2.1. Sample size calculation:

Based on a previous study evaluated the efficacy of iRoot BP Plus and Mineral Trioxide Aggregate (MTA) in pulpotomy of primary molars the minimal sample size of the present study was calculated [10]. Wang et al. (2022)[10] reported that the success rate was 89.9% and 93.3%, respectively with no significant difference between the two groups. Depending on their results, the minimum required sample size was found to be 38 teeth per each group of the two groups, adopting a power of 80% to detect a standardized effect size of 10% in the success rate, and level of significance 95% (α=0.05) [11]. online Power calculators[1] was used to determine the sample size.

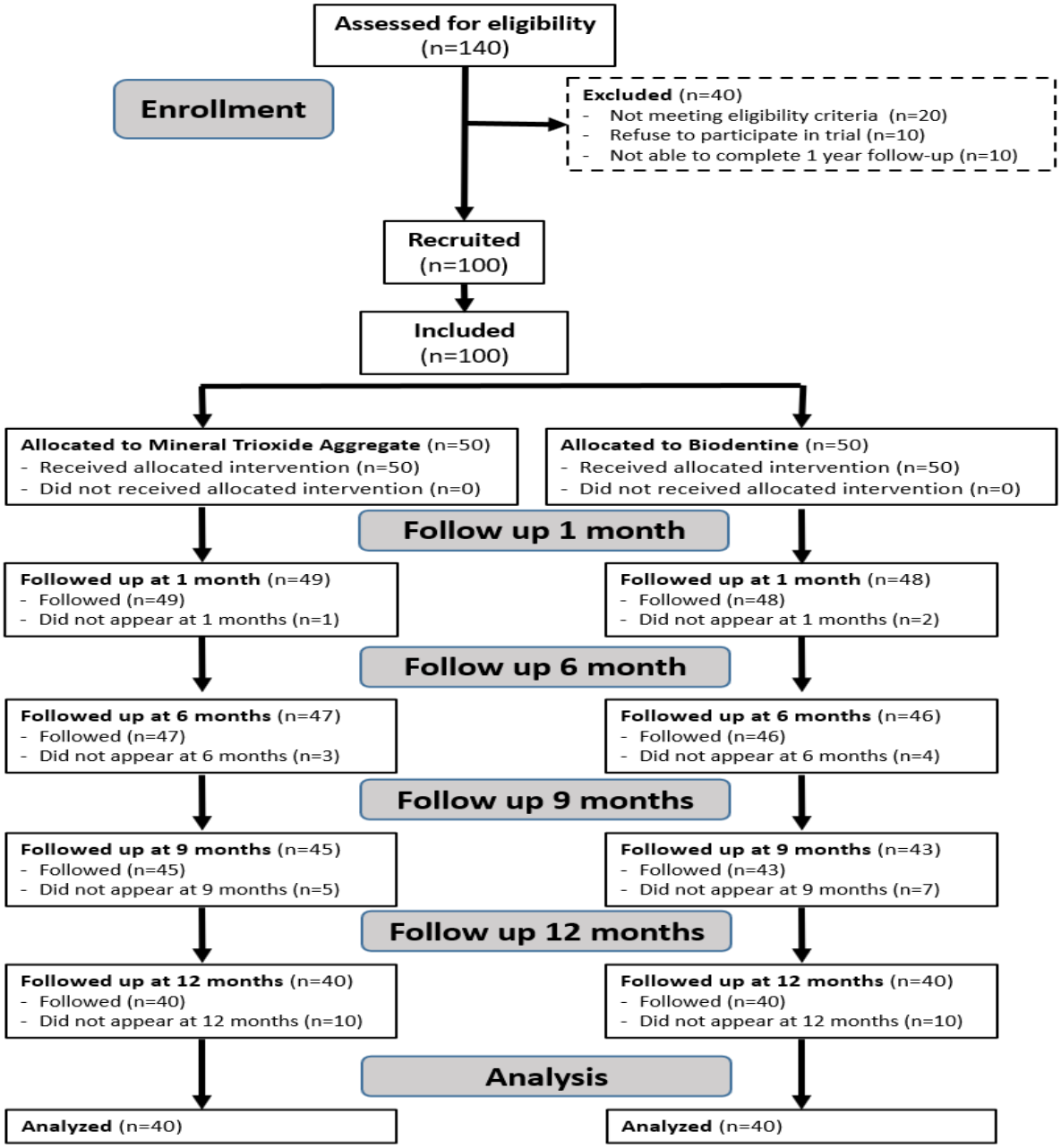
2.2. Method of randomization

According to permuted block randomization technique the allocation series was created and the block size was variable[12]). Allocation sequence/code was masked from the person responsible for introducing the participants to the subdivisions using envelopes[13]. Double blinded method was followed. Masking/blinding was recruited to participants and statistical analysis team who were blinded to group allocation of patients[14] .

2.3. Tooth Allocation and concealment

[1] Available at https://www.sealedenvelope.com/power/binary-noninferior/

According to simple random allocation, two balanced groups were allocated to 40 teeth to each group either MTA or Biodentine. Allocation table were created using computer-generated random numbers. Participants and statistical analysis team were blinded to allocation.



2.4. Teeth selection

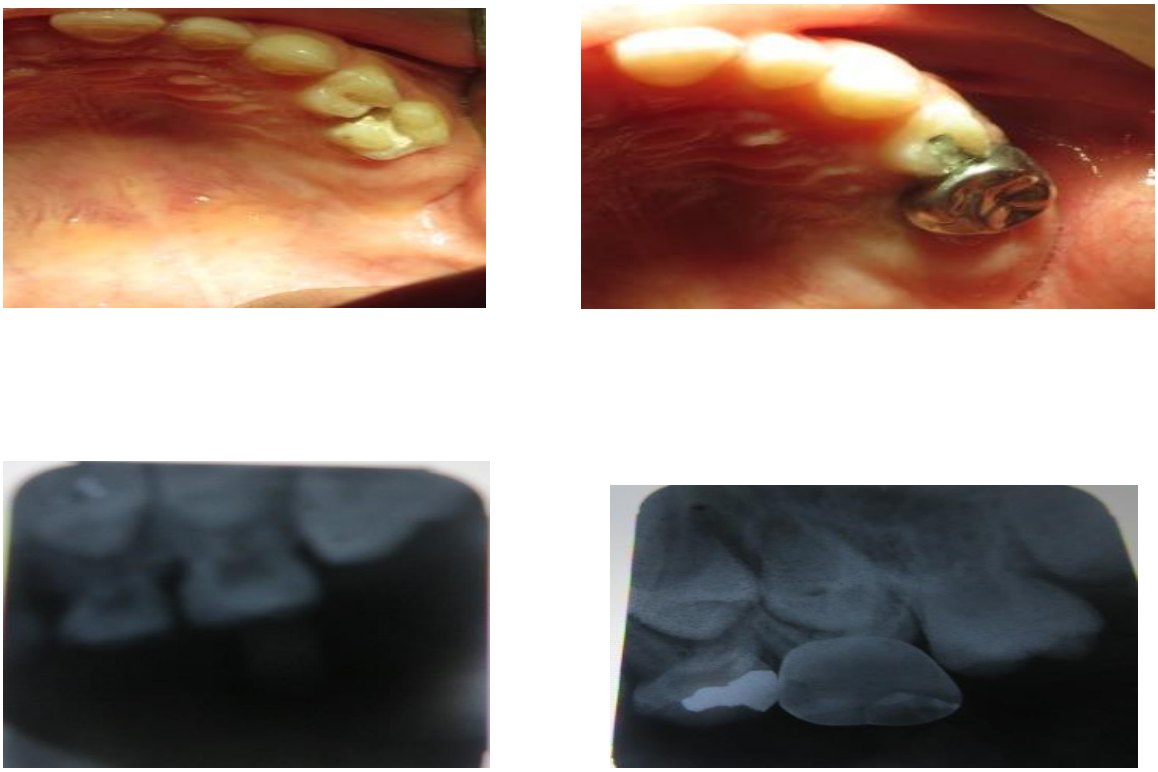
Eighty children aged 5–7 years need pulpotomy of one primary molar were recruited. The selection of cases depend on certain criteria as the presence of a deep caries with no clinically or radiographically signs and symptoms ,

tenderness to percussion or spontaneous pain, either internal or external root resorption, swelling or sinus tracts, widened periodontal ligament space and furcal/periapical radiolucency[15]. After coronal pulp amputation, normal radicular pulp tissue was essential to the tooth to be participated in the study. It is essential to enhance hemostasis evident with moist cotton pellet pressure in less than 5 minutes[16].

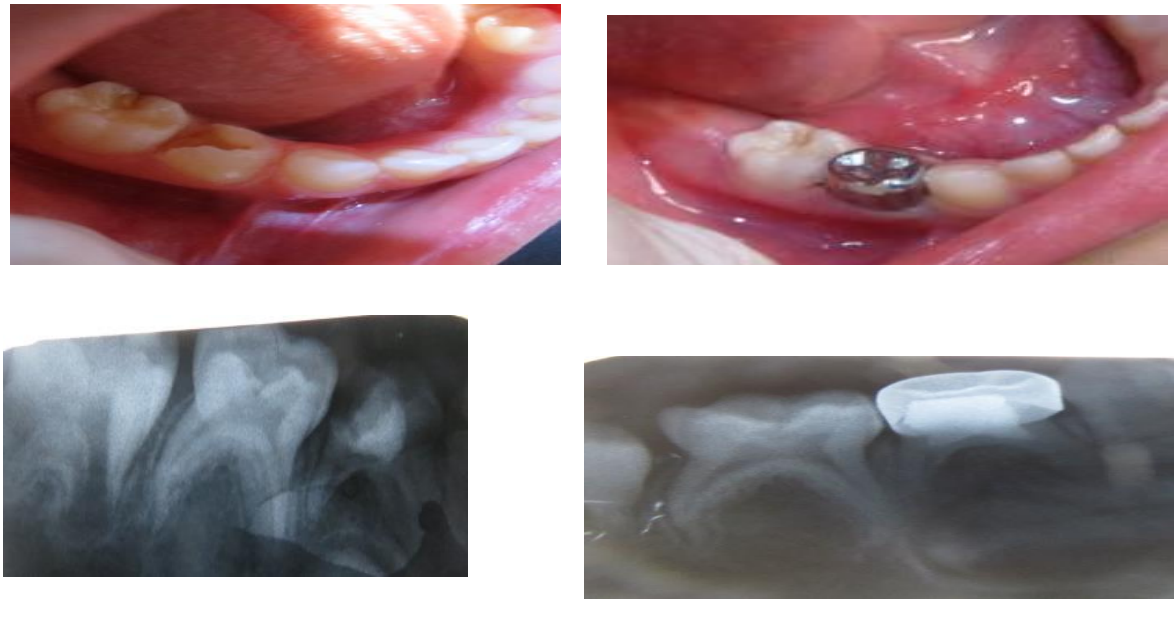
2.4. Clinical Procedure

Periapical radiographs were taken pre and post operatively to assess the Periradicular tissues. Topical anesthetic was applied before the injection then mandibular block anesthesia was administrated. After isolation of the tooth with rubber dam, all caries was removed then the roof of the pulp chamber was cut by high-speed bur and water spray. Sharp spoon excavator was used to remove the coronal pulp, Hemorrhage was controlled by cotton pellet moistened with saline applied under pressure for 3-5 minutes[17]. The tooth was excluded from the study immediately if bleeding restart during placement of the medication,[18]. A thick layer of the dressing material was applied either MTA (White Proroot, Dentsply, Tulsa Dental, USA) [19] or Biodentine™, (Septodont, St. Maur-desFossés, France)[20] in the pulp chambers. The dressing material over the wound was gently pressed using a moistened cotton pellet to be in direct contact with the pulp tissue. Then, for the two groups, glass ionomer cement (Kavitan Pro, Spofa Dental) was placed over the materials, and stainless-steel crowns (3M ESPE, St. USA) was used for final restoration. Evaluations were performed one, 6, 9 and 12 months[21].

The criteria for clinical success were the absence of all of the following: Tenderness to percussion, swelling, fistulation, spontaneous pain and pathological mobility while The criteria for radiographic success were the absence of all of the following: Postoperative radiographic pathology as external or internal root resorption; furcal or periapical radiolucency and widened periodontal ligament spaces[15].



Pre and postoperative radiograph with clinical images for second primary molar MTA pulpotomy restored with stainless steel crown



Pre and postoperative radiograph with clinical images for first primary molar Biodentine pulpotomy restored with stainless steel crown

Results

The sample consisted of 80 children aged 5–7 years who were allocated to two balanced groups, 40 children each. Both groups were age matched (mean age of the MTA group was 5.6 ± 0.83, while in the Biodentine was 5.4 ± 0.72; with no significant difference (*p*=.253).

Clinical success rate was 100% in both groups after 1- and 6- months follow-up period, while the rate of success was 90% for each group by the end of follow up period (one year). There was no statistically significant difference in the clinical success rate throughout the study. The treatment failure rate by the end of one year follow up was 4/40 (10%) in both groups (Table 1).

In twelve months, 4 cases were failed in the MTA group (10%) showed furcal radiolucency. two of them was loose with external root resorption, while in the other two, fistula was formed with one of them showed internal root resorption. Three cases of four showed widening in periodontal ligament and only one the patient was complaining from pain and tenderness.

In the nine months, furcal radiolucency was revealed with widening in the periodontal ligament and internal root resorption in one tooth of Biodentine group (2.5%). Three teeth failed later at twelve months, clinically the teeth were tender and loose with external resorption in one of them and internal root resorption in the other; all of them had furcal radiolucency radiographically. There were no statistically significant differences in the causes of failure between both groups (Table 2).

Table 1. Success in the two studied groups

	MTA Group (n=40)		**Biodentine Group (n=40)**		**Significance test**
Time of Follow-up	Success n (%)	Failure n (%)	Success n (%)	Failure n (%)	
At one month	40 (100%)	0	40 (100%)	0	
At six months	40 (100%)	0	40 (100%)	0	
At nine months	40 (100%)	0	39 (97.5%)	1 (2.5%)	Z=1.006 *p*=.312 NS
At twelve months	36 (90%)	4 (10%)	36 (90%)	3 (7.5%)	Z=0.360 *p*=.718 NS

Z: Z test for comparison of two independent proportion[22]. *p*: *p*-value

Table 2. Causes of failure in the MTA and Biodentine groups

	MTA Group (n=40)	**Biodentine Group (n=40)**	**Significance test**
Pain and tenderness	1 (2.5%)	3 (7.5%)	Z=1.026 *p*=.303 NS
Furcal radiolucency	4 (10.0%)	4 (10.0%)	NA
External root resorption	2 (5.0%)	1 (2.50%)	Z=0.588 *p*=.555 NS
Internal root resorption	1 (2.5%)	2 (5%)	Z=0.588 *p*=.555 NS
Widening Of Periodontal Ligament	3 (7.5%)	2 (5.0%)	Z=0.461 *p*=.645 NS
Fistula Formation	2 (5.0%)	2 (5.0%)	NA
Total number of failures	4 (10.0%)	4 (10.0%)	NA

Z: Z test for comparison of two independent proportion[22].
NA: Non-applicable statistics (due to exact match)
p: p value

Discussion

Many medicaments as formacresol, laser, electrosurgery, ferric sulfate and glutaraldehyde have been utilized with varying degrees of clinical and radiographic success in pulp therapy[23]. Formocresol was the gold standard but recently, the WHO classified formacresol carcinogenic agent[24]. At the same time, many studies reveal no significant difference between different medicaments and Formocresol[25]. These conflicts induce dental professionals to search out another standard medicament for vital pulp therapy.

Mineral trioxide aggregate (MTA) introduced for pulpotomy as a reliable biocompatible material which has a good sealing ability and induce hard tissue formation, In the other hand it is difficult in handling, need a long time to set and produce teeth discoloration [26]. Biodentine is a new material similar to MTA used for pulpotomy, bioactive,

biocompatible, give good sealing ability and by induction of cell differentiation stimulate odontoblasts and reparative dentin to induce apposition of reactionary dentin[27]. It handles with a creamy texture and sets completely within 12 minutes giving a very high pH = 12 which enable it to give a bacteriostatic effect [28].

This study was introduced to compare the clinical and radiographic outcomes of MTA versus Biodentine when used as pulpotomy dresses in primary molars. The American Academy of Pediatric Dentistry guidelines 2020 [29] were followed in cases selection for pulpotomy. The null-hypothesis of this study was accepted as the present study showed no clinical or radiographical statistically significant difference between MTA and Biodentine when used in pulpotomy of primary teeth, these was in agreement with other studies [30,31]. Both materials revealed the same rate of clinical success 90%, which are in consistent with previous studies on the effect of MTA and Biodentine on pulp treatments [30, 31,32].

During the first six months of follow up no clinical or radiographic failures were revealed. the careful selection of cases according to American Academy of Pediatric Dentistry guidelines 2020 may be the main cause. the case that represented bleeding from the root stump was excluded and no caries or pulp remnants were left within the pulp chamber, finally, fit crowns were selected for preserving treatment and standardization of the last final restoration. Regarding the mode of failure, there was no statistically significant difference in the radiographic findings between the two groups. The sudden failure in four cases of MTA group at 12 months was questionable. These may be attributed to MTA solubility as if there is an increase in water-powder ratio, release of calcium from MTA increases which led to its solubility by time [33].

Internal Root Resorption was revealed in 2 cases of Biodentine group and one case of MTA group, Although Biodentine and MTA stimulate bone or dentin matrix formation by inducing cytokine release. These may be attributed to the cytokine function which depends on tissue receptor type. High alkalinity of both materials stimulates pulp odontoclast rather than the odontoblast cells leading to IRR[34].

More cases of IRR were happened in Biodentine group which may be attributed to the rapid setting of the Biodentine. Rapid setting cause increase in the pH of the material and irritation to the pulp tissue. Longer time of setting taken by MTA may allow gradual increase in the pH of the material and thus did not produce irritation effect on the pulp tissue[35].

Conclusion

Either MTA or Biodentine in pulpotomy of primary teeth in this result produce the same results and the difference between them was not statistically significant either clinically or radiographically.

Disclosure

no conflicts of interest in this work.

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