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Comparative Evaluation of Clinical and Radiographic Success of MTA and Propolis in Pulpotomy of Primary Molars

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ABSTRACT

Introduction: In this study, the results of using MTA and propolis in the pulpotomy of primary molar teeth are evaluated clinically and radiographically. **Methods and Methods**: A total of 25 healthy 4 to 8 year old children each having two carious primary molar teeth in one arch, based on inclusion criteria were selected. In each child, random assignment of the pulpotomy medicaments was done as follows: *Group I*, MTA in one side; *Group II*, Propolis in another side. All the pulpotomized teeth were evaluated at 3, 6, and 9 month clinically and radiographically, based on the scoring criteria system. Finally data was analyzed using GEE analysis. **Results:** Results showed that the effects of treatment and time on two scores were tested. Based on the results of this model, the chances of having clinical score 2, *versus* score 1 are about 2.7 times higher in MTA treatment than in propolis (P=0.001). Similarly, the chance of having a clinical score 2 relative to its one, at 9th month is approximately 6.8 times higher than the 3th month (P=0.000) and at 6th month is approximately 2.8 times higher than the 3th month (P=0.005). The chance of having higher scores of radiographies in treatment of propolis is approximately 6.5 times than that of MTA (P=0.000). Also, the chance of having higher scores of radiographic index at 6th month is approximately 5 times and at 9th month is approximately 27 times more than the 3th month (P=0.00). **Conclusions**: Based on the results of this experimental study, teeth treated with MTA showed more suitable clinical and radiographic results as compared to propolis at 9 months follow-up.

Keywords: Mineral Trioxide Aggregate; Primary Teeth; Propolis; Pulpotomy

Introduction

Maintaining the decayed or traumatized teeth before the development of permanent successors is very important issue, because of maintaining the integrity of the arch, preventing orthodontic problems due to space loss, prevention of functional disorders such as abnormal chewing and speaking , and maintaining the patient appearance and esthetic [1]. Pulpotomy is one of the most common ways to treat vital exposed pulps and symptom-free primary teeth [1]. The rational is based on the healing ability of the radicular pulp tissue following amputation of the affected/infected pulp [2].

A wide range of materials have been proposed for the pulpotomy of primary teeth. The ideal dressing material for the roots of the pulp should be bactericidal, harmless to the pulp and surrounding structure, promote pulp healing and not interfere with the physiological process of root resorption [3].

Formalin formulations have been used in the treatment of dental pulp since the early 20th century. Formocresol was first introduced by Buckley, and then its compounds were used in pulpotomy of primary molars [4]. But toxicity and mutagenic nature of formocresol specially caused by excessive consumption of it, have been encouraged researchers to try to find suitable alternatives for it [5].

MTA has been successfully used for the variety treatments of vital pulp therapies, apexification and help to continue root formation and repair of furcal perforations [6-9]. But barriers such as the high cost of this material and the complexity of its handling have limited its use as a common material [10]. In this regard, a number of natural substances have been

introduced as a substitute for commercially available products for vital pulp treatments. Propolis is one of these materials. Propolis is one of the six bee products, the main ingredients of which are resin and wax, which is collected by honey bee from gum of trees. The bee carries this material to its hive, where it adds other products, especially wax. Propolis has been claimed to have beneficial effects on human health [11]. This material was able to attract the attention of researchers, and thus studies have been formed around it. Propolis has been studied as intracanal drug, cariostatic agent, storage media for the maintenance of avulsed teeth and root canal irrigant because of its anti-inflammatory and immune regulatory properties.

Several *in vitro* and animal studies have been carried out on propolis in the field of dentistry [12-14]. Clinical studies (*in vivo*) on this substance are very limited as a substitute for pulpotomy of teeth. Therefore, the present study aimed to investigate and compare the clinical and radiographic effects of propolis and MTA as pulpotomy materials.

Table 1. Clinical and radiographic scoring criteria

Criteria for clinical and radiographic scoring		
Clinical score	**Clinical symptom**	**Definition**
1	Asymptomatic	Pathology: absent
		Normal functioning
		Mobility (physiological) ≤1 mm
2	Slight discomfort, short-lived	Pathology: questionable
		Percussion sensitivity
		Gingival inflammation (due to poor oral hygiene)
		Mobility (physiological) >1 mm, but <2 mm
3	Minor discomfort, short-lived	Pathology: initial changes present
		Gingival swelling (not due to poor oral hygiene)
		Mobility >2 mm, but < 3 mm
4	Major discomfort, long-lived Extract immediately	Pathology: late changes present
		Spontaneous pain
		Gingival swelling (not due to poor oral hygiene)
		Periodontal pocket formation (exudate)
		Sinus tract present
		Mobility ≥3 mm
		Premature tooth loss, due to pathology
Radiographic score	Radiographic finding	Definition
1	No changes present at 6 month follow-up*	Internal root canal form tapering from chamber to the apex
		Periodontal ligament (PDL)/periapical regions; normal width and trabeculation
2	Pathological changes of questionable clinical significance at 3 month follow-up*	External changes are not allowed (widened PDL) widening, abnormal inter-radicular trabeculation or variation in radiodensity
		Internal resorption acceptable (not perforated)
		Calcific metamorphosis is acceptable and defined as: uniformly thin root canal; shape (non-tapering); variation in radiodensity from canal to canal (one cloudier than the other)
3	Pathological changes present at 1 month follow-up*	External changes are present, but not large
		Mildly widened PDL
		Minor inter-radicular radiolucency with trabeculation still present
		Minor external root resorption; internal resorption changes are acceptable, but not if external change is also present (perforated form)
4	Pathological changes present extract immediately	Frank osseous radiolucency present

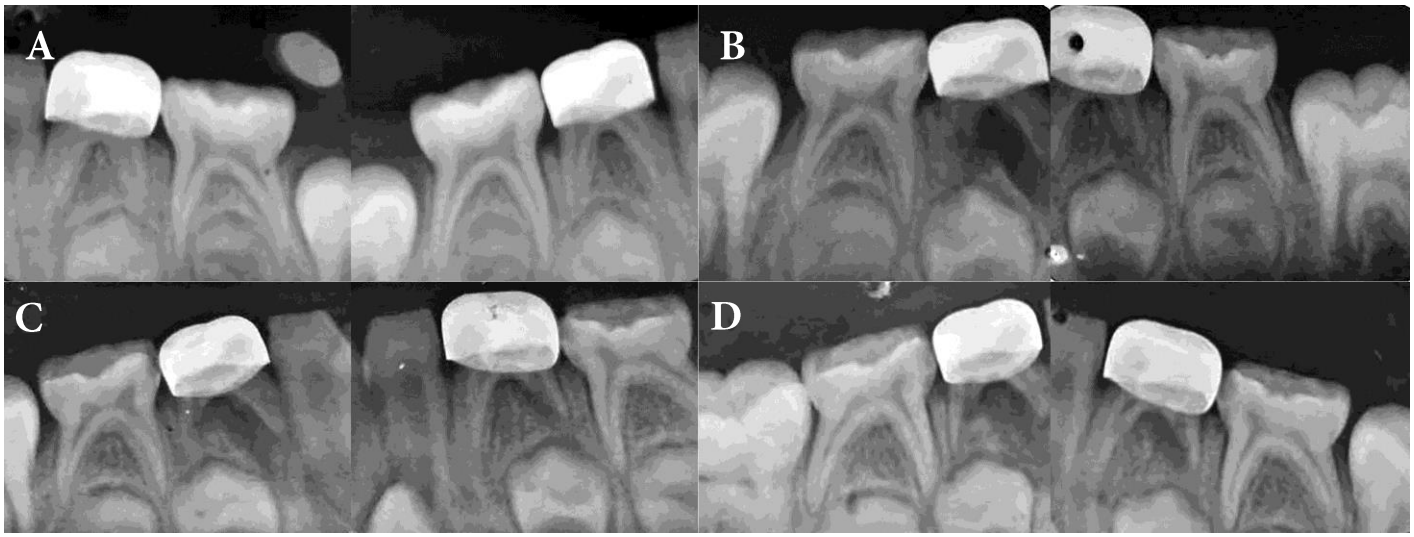

Figure 1. *A)* Radiographs taken at the end of pulpotomy procedure and restoring with SSC; Right: MTA, Left: propolis; *B)* Radiographs taken at the 3rd month after treatment; *C)* Radiographs taken at the 6th month after treatment; *D)* Radiographs taken at the 9th month after treatment

Materials and Methods

The study was conducted at the Department of Pediatric Dentistry, Faculty of Dental Sciences, Shahed University, Tehran, Iran. The study protocol was approved by the Ethical Committee of Shahed Dental University and ethics committee reference number: IR.Shahed.REC.1396.33.

The clinical procedure and associated risks and benefits were fully explained to the parents or legal guardian of the participants. The written informed consent form, with full description of the protocol, therapeutic material and potential risks to the parents or legal guardians of the participants, was given and, after obtaining consent form, the participants entered the therapeutic phase, evaluated clinically and radiographically at first visit.

In this study, 50 primary molars including 25 pairs (two pairs in one arch, split mouth) of 25 children aged 3-7 years who had inclusion criteria were selected and divided into two groups.

The inclusion criteria for this study were as follows; cooperative and systemically healthy patient with two restorable contralateral primary carious molars without painful pulpitis (except for pain during eating), normal mobility, presence of at least two thirds of root length and without pathologic findings radiographically. Exclusion criteria were; the history of systemic disease, presence of clinical and radiographic symptoms of pulpal degeneration, history of spontaneous or nocturnal pain, sensitivity to precaution and palpitations, swelling or fistula, PDL widening, internal or external root resorption, radiolucency of furcation, periapical radiolucency, primary teeth without permanent successor, and teeth that continue to bleed over 5 min after coronal pulp amputation.

With prior justification of the patient's parents the procedure started during two sessions. After dropping the coin and determining the treatment side, the procedure started by administration of local anesthesia and isolation with cotton roll. All caries were removed and accessed to the pulp chamber was created using a sterile No. 330 high speed bur with water spray and then a spoon excavator was used to cut coronal pulp. A moistened cotton pellet was applied to the pulp with gentle pressure for 2 to 3 min to achieve homeostasis. Then, MTA (Angelus, Londrina, PR, Brazil) was prepared according to the manufacturer's instructions, and put on pulp and compressed with a gentle wet cotton pellet to a thickness of about 2 to 3 mm. Finally, wet cotton was placed on it, and zinc oxide eugenol (ZOE) cement as a dressing was applied. Restoration of teeth with SSC was postponed until the next session for achieving MTA final setting. On the next day, after the pulpotomy in the opposite direction, the propolis (Propolis, Isfahan Honey, Iran) was used as a therapeutic agent. A portion of standard propolis powder was mixed with distilled water with a metal spatula on a clean slap to achieve a uniform consistency. The prepared mixture was then placed on a pulp and covered with zinc oxide cement and then restored with SSC.

The next session after giving anesthesia to the MTA-treated teeth (often an infiltrate and sometimes PDL), the cement and cotton on the MTA was removed, the MTA hardness was checked with the dental probe and ZOE cement was placed on it. At the end, tooth was restored by the SSC.

Participants were recalled for clinical and radiographic examination at 3rd, 6th and 9th months after treatment (Figures 1A to D). The teeth were examined by a blind observer

clinically and radiographically. The observer was introduced to the calibration process with clinical and radiographic criteria. The criteria based on Zurn and Seale [15] have been used to evaluate clinical and radiographic findings as in Table 1.

To compare the two treatments, the Generalized Estimation Equation (GEE) analysis was used considering $P<0.05$ as significant difference. To compare the clinical and radiographic findings with time for each treatment independently the Friedman test was used. Ultimately Wilcoxon test was used to compare each time with another as a paired difference test.

Results

In this study, 25 children were randomly divided into two groups. The results were categorized as follow:

Data from clinical and radiographic examination based on type of treatment and time was shown in Tables 2 and 3.

For MTA, as observed in clinical scoring table, the number of teeth with score 1 was higher than score 2 at all three times, but there was no significant difference between the results of Friedman test ($P=0.093$).

Friedman test for radiographic score showed that this treatment significantly affected the radiographic index over time ($P=0.000$). Comparison using Wilcoxon test showed that radiographic scores in MTA treatment were higher at month 6 than 3rd month, and in month 9 higher than 6th month; these differences were statistically significant ($P=0.002$).

Based on the clinical scoring table of propolis, except for the 3rd month, score 2 had the highest number of teeth in the rest of the time. Friedman test reported that the differences in clinical scoring of propolis were statistically significant. Wilcoxon test reported that clinical score is significantly higher in propolis treatment at month 6 than in the 3rd month ($P=0.011$). Also, in month 9 significantly higher than month 6 ($P=0.004$).

As seen in the propolis radiographic scoring table, Friedman test showed that propolis treatment significantly affected the radiographic index as well as MTA over time ($P=0.000$). A comparison with Wilcoxon test showed that radiographic score did not show significant difference in propolis treatment between 6th month and 3rd month ($P=0.058$), but at month 9, radiographic scoring was significantly higher compared to month 6 ($P=0.000$).

After reviewing each treatment independently over time, the results of two treatments were compared using GEE analysis. Due to the low number of cases in score 3 for clinical response and score 4 for the radiographic response, these two levels were combined with the last level for each response. In this way, Clinical Score has two levels and Radiographic Score has three levels in Tables 4 and 5. On the other hand, the followings are summarized in the tables: treatment side (side 1: right, side 2: left), and type of treatment (treatment 1: MTA, treatment 2: propolis).

The analysis results for the Clinical Score index is presented in Table 4. The analysis results for the Radiographic Score index is presented in Table 5.

Based on the results of this model, the chance of having Clinical Score 2 compared to Clinical Score 1 in treatment 2 was approximately 2.7 times more than treatment 1 ($P=0.001$). Similarly, the chance of having Clinical Score 2 at time 9 was approximately 6.8 times more than the time 3 ($P=0.000$) and at time 6 was approximately 2.8 times more than the time 3, which is statistically significant ($P=0.005$). Based on the results of two sides, there was no significant difference in this index ($P=0.096$).

Table 2. Clinical and radiographic scoring of MTA group

	Clinical score 1 N (%)	Clinical score 2 N (%)	Clinical score 3 N (%)	Clinical score 4 N (%)	Total
3rd month	18 (72)	7 (28)	0	0	25
6th month	15 (60)	10 (40)	0	0	25
9th month	13 (52)	12 (48)	0	0	25
	Radiographic score 1 N (%)	Radiographic score 2 N (%)	Radiographic score 3 N (%)	Radiographic score 4 N (%)	Total
3rd month	20 (80)	5 (20)	0	0	25
6th month	11 (44)	10 (40)	4 (16)	0	25
9th month	5 (20)	12 (48)	7 (28)	1 (4)	25

Table 3. Clinical and radiographic scoring of propolis group

	Clinical score 1 N (%)	Clinical score 2 N (%)	Clinical score 3 N (%)	Clinical score 4 N (%)	Total
3rd month	18 (72)	7 (28)	0	0	25
6th month	10 (40)	15 (60)	0	0	25
9th month	2 (8)	21 (84)	2 (8)	0	25
	Radiographic score 1 N (%)	Radiographic score 2 N (%)	Radiographic score 3 N (%)	Radiographic score 4 N (%)	Total
3rd month	11 (44)	8 (32)	6 (24)	0	25
6th month	5 (20)	15 (60)	5 (20)	0	25
9th month	0	3 (12)	14 (56)	8 (32)	25

The chance of having higher levels of radiographic score in treatment 2 was approximately 6.5 times more than treatment 1 (P=0.000). Also, the chance of having higher levels of radiographic score at time 6 was approximately 5 times more than time 3 and at time 9 was approximately 27 times more than time 3 (P=0.00). There is no significant difference in radiographic index in both sides (P=0.943).

Discussion

Pulpotomy of primary teeth is one of the most common treatments in pediatric dentistry. By performing the precise and proper treatment, the teeth can be rescued from pain, infection and other problems [16]. In recent years, the introduction of new bio-inductive and regenerative materials, such as MTA, has created a new transformation in the course of dental treatments [17, 18]. In order to overcome MTA constraints, such as handling features, price and setting time, natural products derived from the traditional medicine have been introduced as medicines in dental treatments. Propolis is a resinous substance that is collected by the bee and claimed to have many effects on human health. This material has been studied in various fields of dentistry [17-19]. In the present study, the results of using MTA and propolis in pulpotomy of primary teeth in clinical and radiographic conditions were evaluated. Both of these materials are biocompatible [12].

In statistical comparison, we concluded that MTA was significantly better in clinical and radiographic evaluation than propolis, because the probability of having Clinical Score 2 in propolis treatment was 2.7 times more than MTA and the chance of having higher scores of radiographic index in propolis treatment is approximately 6.5 times more than MTA group. The fact that MTA in the treatment of human molar teeth pulp treatment is superior to other materials clinically, radiographically and histologically is confirmed by other studies [20-30].

Table 4. Parameter Estimates Clinical

Parameter	Hypothesis test
Threshold	0.013
Propolis	0.001
MTA	.
9 months	0.000
6 months	0.005
3 months	.
Left side	0.096
Right side	.

In this randomized clinical trial, we used a standard propolis (Propolis, Isfahan honey, Iran). Its composition includes vegetable resins and wax and essential fatty acids, flower pollen and organic compounds and vitamins and its minerals includes silver, sodium and mercury, manganese and iron, calcium and vanadium and silica.

In this study, the powder was mixed with distilled water, similar to the study by Hugar *et al.* [31].

In the study of Kusum *et al.* [32] with 25 teeth as samples and the duration of the study (9 months with a 3-month interval), and the clinical and radiographic scoring criteria were similar to the present study, although at the end, the results are also similar but there were important details that could be considered as differences between the two studies.

In the study by Kusum *et al.* [32] in a clinical evaluation, MTA received 100% score 1 at all three times, while propolis in the 3rd and 6th months gained 100% score 1 and at 9 months only 84% had score 1, which was significantly lower than that of MTA. Radiographically, MTA's success rate was 92% for 9 months (Score 1 and 2) and for propolis 72%, which was statistically significant. As we can see, although in this study, similar to the present study, MTA is statistically superior to propolis (from both clinical and radiographic points of view), but the percentages obtained for score 1 are very different from the present study. One of the most important reasons for this is the different design of these two studies, the current study is done with split mouth design whereas Kusum *et al.* [32] did not, and the results of the treatment of MTA and propolis are related to two different groups of children. Therefore, the matching process has not been performed in that study, and this can make the results subject to serious differences. By presence of different conditions in different groups, such as the process of hygiene, diet, history and risk of caries in children, the outcome of the treatment will also be affected. The next important point that can clarify differences between results of two studies is that chemical composition of propolis made by honeybees varies in different regions. Propolis used in the study by Kusum *et al.* [32] was Indian and in our study was Iranian propolis.

Table 5. Parameter Estimates Radiographic

Parameter	Hypothesis test
Threshold	0.006
Propolis	0.000
MTA	.
9 months	0.000
6 months	0.000
3 months	.
Left side	0.943
Right side	.

In a study by Alolofi *et al.* [33], the results of pulpotomy with propolis and formocresol were compared radiographically and clinically in 20 children (split mouth) and during 12 months. In the 12th month, the success rate of formocresol and propolis was similar (88.2% clinical success and 73.3% radiographic success). In this study, like our study, the success rate of propolis from the perspective of both indicators (clinical and radiographic) has declined over time. The difference between two studies can be due to the difference in propolis composition (propolis of Egypt *versus* Iranian propolis). Propolis used in the study by Alolofi *et al.* [33] was an ethanolic extract and as a droplet added to zinc oxide powder (instead of eugenol) until an appropriate consistency was achieved. More importantly, the criteria for success and failure of treatment were different in the two studies and this can have a significant impact on treatment outcomes. However, despite the superiority of MTA on propolis in the present study, it is not unreasonable for propolis to be able to compete with formocresol, although this should be investigated in a new study.

In a preliminary study conducted by Noorollahian *et al.* [34], formocresol and Iranian propolis were used for pulpotomy of split mouth (as in the present study), in 13 children (number of samples were less than the present study) and was used in the 2-month duration (less than the present study). At the end of the 2-month study, 9 teeth from 13 treated teeth with propolis were remained, all of them treated with pulpectomy due to clinical and radiographic complications. The results of this study indicated the clear failure of propolis compared to formocresol after 2 months. Considering that the method of pulpotomy and study design was similar to our study, the only difference was the type of propolis used. In this study, the Iranian propolis gel was used in a thickness of 1-2 mm on the pulp and then covered by RM-GI and finally restored by the SSC. Probably propolis gel cannot keep its long-term contact with the pulp due to being washed and cleared from the area, and if this happens, the pulp is in contact with the RM-GI, which can have unpredictable consequences for the pulp and tooth structure.

Based on the results of the present study, although the MTA was superior to propolis in the pulpotomy of primary molars, but in clinical terms, propolis was considered acceptable therapeutic agent considering restrictions of MTA, including price and setting time issue, and propolis acted far beyond the authors' expectations.

Conclusion

According to the new methodology used in this study and based on the clinical and radiographic results, it could be concluded that MTA is a superior materialin pulpotomy of primary molars when compared with propolis and the differences were statistically significant.

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Conflict of Interest: 'None declared'.

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