

Clinical and Radiographic Evaluation of *Allium sativum* Oil (Garlic Oil) in Comparison with Formocresol in Primary Molar Pulpotomy

Mehrdad Kahvand¹, Majid Mehran², Roza Haghgoo², Taraneh Faghihi²

¹Department of Pediatric Dentistry, Qom Dental University, Qom,
²Department of Pediatric Dentistry, Dental School, Shahed University, Tehran, Iran

ABSTRACT

Background: Given the side effects of formocresol as a common substance in dental pulpotomy, its substitution with a safe substance seems mandatory. **Aim:** To compare the clinical and radiographic success of *Allium sativum* oil and formocresol in the pulpotomy of the primary molars. **Materials and Methods:** A randomized, split-mouth, double-blind, controlled clinical trial was conducted on children with at least two asymptomatic primary molars requiring pulpotomy. A total of 90 teeth were examined in this study. They were randomly divided into two groups: the *A. sativum* (ALL) group ($n = 45$) and the formocresol (FC) group ($n = 45$). After pulpotomy, *A. sativum* oil was applied to the radicular pulp in the ALL groups and formocresol in the FC group. The pulp chamber was then filled with reinforced Zinc oxide Eugenol and finally restored by a stainless steel crown. Three and six months after the intervention, the teeth were evaluated by a colleague based on a modified criteria system. The results were analyzed using Wilcoxon's test. **Results:** The clinical success rate was 100% in both groups after 3 and 6 months. The radiographic success rate in the ALL group and the FC group after 3 and 6 months was 82.2% and 80% and 88.9% and 84.4%, respectively. The difference between the two groups was not statistically significant ($P = 0.46$). **Conclusion:** According to the results of this study, *A. sativum* oil can be used in the pulpotomy of the primary molars.

KEYWORDS: *Allium sativum* oil, formocresol, primary molar, pulpotomy

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INTRODUCTION

Pulpotomy is a common treatment for pulp exposure caused by extensive caries in asymptomatic primary teeth. The basis of this treatment is the reparability of the radicular pulp after the removal of the inflamed tissue.^[1] Pulpotomy is performed via different materials and techniques.^[2-5]

One of the most challenging subjects in pediatric dentistry is choosing the ideal bactericide agent for pulp treatment that has properties such as stimulating the repair of the remaining intact pulp and preventing root resorption.^[6]

Formocresol is the most common material for the pulpotomy of the primary teeth. The common combination of formocresol used in the pulpotomy of the primary teeth is 19% formaldehyde, 35% cresol,

glycerin, and water.^[7] Studies have reported a success rate of 70%–95% for pulpotomy with formocresol.^[8,9] However, there are many concerns regarding the local and systemic side effects that could be caused by the use of this substance, such as cytotoxicity, mutagenicity, and carcinogenicity, the possibility of the drug passing through the apical strain, and the disturbances in enamel formation in the permanent successor teeth.^[10] Given these disadvantages, using a healthier substance in pulp treatment seems necessary.

In recent decades, the use of natural products has grown significantly in dentistry.^[11-15] Garlic, with

Address for correspondence: Dr. Taraneh Faghihi,
N71, Italia Street, Vesal Av, Tehran, Iran.
E-mail: trnfaghihi@gmail.com

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the scientific name *Allium sativum*, has been used extensively in medical fields.^[10] Garlic has antimicrobial and antioxidant effects^[16-18] and regulates the immune system^[19] and can contribute to wound healing.^[20] This characteristic is due to its main components, that is, allicin as well as thiosulfonates. Garlic is also effective in a wide range of gram-positive and gram-negative bacteria.^[16,17] The use of garlic in dentistry involves the use of garlic solution as a root canal detergent^[21] and mouthwash.^[16,17] In one study, garlic oil was used in the pulpotomy of the primary teeth, and its clinical and radiographic success rate was reported as 90%.^[10] In another study, the histological success rate of garlic oil in pulpotomy was higher than that of formocresol.^[22]

This study was therefore designed to evaluate the side effects of formocresol and the desirable properties of garlic. For this purpose, the clinical and radiographic differences between formocresol and garlic oil are compared in the pulpotomy of the first and second primary molars in children.

MATERIALS AND METHODS

This randomized, split-mouth, double-blind, controlled clinical trial was conducted in 2018 at the Department of Pediatric and Preventive Dentistry of Shahed University, Tehran, Iran. A sample size of 90 teeth was determined as the minimum sample size required according to similar studies.^[23]

Therefore, a total of 45 pairs of primary molars from patients aged 3–10 years were chosen. Before the start of the study, consent forms were filled out by the participating children's parents. The study protocol was approved by the Ethics Committee of Shahed University (IR.Shahed.REC.1396.88).

The inclusion criteria consisted of being systemically healthy, not having taken antibiotics in the past 14 days, showing sufficient cooperation, a complete medical history, and clinical and radiographic examination, having at least two asymptomatic decayed primary molars and pulp exposure during cavity preparation. Children with clinical symptoms (such as spontaneous pain, soft tissue swelling, fistula, mobility, and tenderness) or radiographic symptoms (such as internal and external pathologic resorption, periapical radiolucency, or calcific degeneration of the pulp) or physiological resorption of more than one-third of the root and children who were uncooperative were excluded from the study.

All the selected teeth were randomly divided into two groups receiving different medications and each group contained 45 samples. Randomization was performed using the coin toss technique.

Periapical radiographic F-speed film was taken before the procedure using the bisecting angle technique. Treatment was performed by a pediatric dentistry resident.

Anesthesia was induced (lidocaine, 2% and epinephrine, 1/100,000). The tooth sample was isolated after 10 min. All the caries were removed and a sterile, high-speed, round bur (no. 330) (Teeskavan, Tehran, Iran) was used with water spray for coronal access preparation. The roof of the pulp chamber was removed using a safe end-cutting bur. A spoon excavator was used for coronal pulp amputation. After rinsing with saline, one or more sterile cotton pellets moistened with distilled water were placed over the pulp stumps, and gentle pressure was applied for 5 min for obtaining hemostasis.

The pulp stumps of the molars were randomly dressed with a cotton pellet that was made damp with *A. sativum* oil (Noshad Company, Registration number: 1228208638 IRC, Tehran, Iran) for 1 min on one side, and with formocresol (SSA, Produits Dentaires, Switzerland) (Dentsply) also for 1 min on the other side.

The access cavity was sealed with a thick mixture of Zinc oxide Eugenol cement (Kemdent, Swindon, England) followed by stainless steel crown. Cementation was performed using a glass ionomer (GC1, Tokyo, Japan, luting cement). The molars were then clinically and radiographically evaluated after 3 and 6 months with the help of a colleague who was blinded to the groups and based on the criteria proposed by Zurn and Seale^[24] [Table 1].

Data were analyzed using the Wilcoxon signed-rank test. The statistical analysis software was the Statistical Package for the Social Sciences (SPSS) for Windows, version 16 (IBM, Armonk, New York).

RESULTS

In this study, 90 teeth were randomly divided into two groups. The 44 teeth were of girls and 46 teeth of boys. The mean age was 5.43 years in both groups [Table 2]. Data from clinical and radiographic examination based on the type of treatment and time are shown in [Tables 3 and 4]. For both formocresol and *A. sativum* as observed in clinical scoring table, all the teeth scored 1. According to radiographic scoring criteria, in both groups score 1 was higher.

In the 3-month and 6-month follow-up, the clinical success rate was 100% in both groups. The radiographic success rate in the *A. sativum* group was 82.2% after 3 months and 80% after 6 months, and in the formocresol group, after 3- and 6-month follow-ups, it was 88.9% and 84.4%,

Table 1: Clinical and radiographic scoring criteria

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 interradiolar 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 interradiolar 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

respectively. No significant differences were reported between the two groups ($P = 0.46$) [Tables 3 and 4].

DISCUSSION

Pulpotomy is the most common treatment for primary teeth with pulp involvement because of caries. This method helps maintain the integrity and function of the dental system.^[11] Formocresol, which is a common devitalizing material for pulpotomy, has undesirable side effects, such as cytotoxicity, mutagenicity, and carcinogenicity,^[10] and replacing it with a safe material seems rational. This study was conducted to compare the clinical and radiographic success rate of garlic and formocresol to determine the effectiveness of this novel

material for pulpotomy of human primary molars. On the basis of this split-mouth design, each patient received pulpotomy with the two materials. Moreover, the treatment procedure, 3-, and 6-month follow-ups were performed blindly.

According to the results obtained in this study, interestingly, the clinical success rate of both materials were 100% in 3- and 6-month follow-ups. Radiographic success rate of FC group was higher in both periods but the difference was not significant.

To choose a pulpotomy agent, several characteristics should be considered, such as antibacterial activity, handling process, and dentinogenesis.^[25]

Table 2: Information of participants of the study

	N	Mean age	Minimum age	Maximum age	Type of tooth
Female	22	5.9	4	8	20 FPM/24 SPM
Male	23	4.97	3	8	18 FPM/28 SPM
Total	45	5.43	3	8	38 FPM/52 SPM

FPM = first primary molar, SPM = second primary molar

Table 3: Clinical and radiographic scoring of FC group

	Clinical score 1	Clinical score 2	Clinical score 3	Clinical score 4	Total
3rd month	45 (100%)	0	0	0	45
6th month	45 (100%)	0	0	0	45
	Radiographic score 1	Radiographic score 2	Radiographic score 3	Radiographic score 4	Total
3rd month	40 (88.9%)	5 (11.1%)	0	0	45
6th month	38 (84.4%)	5 (11.1%)	2 (4.4%)	0	45

Table 2: In 3- and 6-month follow-up, clinical success rate of FC group was 100% and radiographic success rate was 88.9% and 84.4%, respectively

Table 4: Clinical and radiographic scoring of ALL group

	Clinical score 1	Clinical score 2	Clinical score 3	Clinical score 4	Total
3rd month	45 (100%)	0	0	0	45
6th month	45 (100%)	0	0	0	45
	Radiographic score 1	Radiographic score 2	Radiographic score 3	Radiographic score 4	Total
3rd month	37 (82.2%)	8 (17.8%)	0	0	45
6th month	36 (80%)	7 (15.6%)	2 (4.4%)	0	45

Table 3: In 3- and 6-month follow-up, clinical success rate of ALL was 100% and radiographic success rate was 82.2% and 80%, respectively.

The favorable treatment outcome for *A. sativum* oil in comparison with FC in this trial is its low cytotoxicity and antibacterial effect.

Therefore, garlic can be a suitable herbal alternative for formocresol, and pharmacological studies have proven the different properties of garlic, such as anti-inflammatory, analgesic, anticoagulant, antioxidant, antimicrobial, and wound-healing properties.

The effect of garlic on dental pulp and its antimicrobial-induced wound healing, antioxidant, immune system regulation, and anti-inflammatory properties appear to be due to the properties of its active components. Many researchers have proven the antimicrobial, antifungal, and antiviral properties of garlic.^[26]

Garlic is effective on a wide range of gram-positive and gram-negative bacteria. Components including diallyl monosulfide, diallyl disulfide, diallyl trisulfide, and diallyl tetrasulfide are associated with the antimicrobial and antifungal properties of garlic.^[27]

On the basis of animal studies, the absence of microorganisms is the most important determinant of pulp recovery.^[28,29]

Garlic extract has recently been reported to have antibacterial effects on *Streptococcus mutans*,

Streptococcus sobrinus, *Porphyromonas gingivalis*, and *Prevotella intermedia*, which are the major bacteria responsible for dental caries and periodontitis.

On the basis of human studies, components including dimethyl sulfone, phenols, and flavonoids are associated with an induced wound healing,^[30] which can help preserve the radicular pulp.^[31]

Garlic extract has strong antioxidant and anti-inflammatory effects. The high polyphenol and flavonoid content of garlic are responsible for its antioxidant potential, and antioxidant agents are essential for the synthesis of collagen, angiogenesis, and the inhibition of inflammation.

According to medical studies, garlic also inhibits the production of T helper 1 cells and inflammatory cytokines.^[32]

As an antioxidant, garlic protects the endothelial cells of the blood vessels from the oxidative stress induced by H₂O₂, which results in a continuous angiogenesis that is necessary for wound healing.^[33]

As an immune regulator with anti-inflammatory effects, garlic has components, such as allicin and ajoene, which might inhibit the synthesis of nitric oxide in macrophages. Nitrogen oxide is a pro-inflammatory mediator produced by macrophages. It

inhibits the inflammatory cytokines and prostaglandins by suppressing cyclooxygenase and 5-lipoxygenase enzymes.^[10]

This suggested material is considered new in comparison to routinely used pulpotomy medicaments, therefore only few studies have been conducted on the effect of garlic oil on dental pulp. In one study, Mohammad *et al.*^[10] compared the effect of formocresol and garlic oil in the pulpotomy of the primary teeth and found no significant differences in their success rates. These results are consistent with the present findings. Nonetheless, the sample size of this study is twice as higher than that of the study by Mohammad *et al.*, who also added a mixture of garlic oil to Zonalin paste, which appears to have had a positive effect on the results. This study, however, examined only the effect of garlic oil on the pulp and did not add any substances to Zonalin.

In another study, Mohammad *et al.*^[22] compared the histological effect of garlic and formocresol in the pulp treatment of permanent teeth, but the results of that study cannot be compared with the present findings because of the differences in permanent and primary dentition pulp.

In a third study, Mohammad and Baroudi^[34] assessed the potentials of *A. sativum* as a new medication for non-vital pulpotomy of the primary teeth and showed higher success rates with it.

The strengths of this study include its larger sample size compared to the discussed studies, its refraining from mixing garlic oil with Zonalin to maintain the original properties of garlic, and also using the Zurn and Seale^[24] criteria for rating the clinical and radiographic findings.

The limitations of the study include choosing the patients based on certain eligibility criteria.

This study compared the clinical and radiographic success rate of garlic oil with formocresol. Future studies, however, are recommended to compare the success rate of pulpotomy with garlic versus formocresol using histological assessments. The success rate of pulpotomy with garlic is also recommended to be examined over longer follow-up periods.

In addition, substance used in the control group can be replaced by Mineral trioxide aggregate.

CONCLUSION

Because of the results of this study, clinical and radiographic results of *A. sativum* oil were far beyond our expectations and according to formocresol disadvantages, garlic oil is an acceptable alternative.

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Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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