

COMPARATIVE EVALUATION OF PULPAL RESPONSE TO TRI-ANTIBIOTIC PASTE AND ALLIUM SATIVUM WITH FORMACRESOL AS PULPOTOMY MEDICATION IN PRIMARY TEETH:AN IN VIVO STUDY

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ABSTRACT

Background:-To evaluate and compare Pulpal Response to Tri-antibiotic Paste and Allium Sativum with Formacresol as Pulpotomy Medication in Primary Teeth. **Materials and Methods:**-30 children in age group 7-9 years have bilateral primary teeth indicated for orthodontic serial extraction .children divided into two groups, (group I) included(15) children had bilateral primary teeth, the right side tooth treated with tri-antibiotic past (3 mix) (group IA) and left side tooth treated by formacresol (group IB) and (group II) included (15) children had bilateral primary teeth, the right side tooth treated with allium sativum oil (A. sativum) (group IIA) and left side tooth treated by formacresol (group IIB) . Each tooth was treated with standard pulpotomy procedure. . Patients were recalled after 15 and 30 days' time interval as a part of orthodontic treatment. Teeth in each group were extracted and were subjected to decalcification procedure for histopathological evaluation. **Results:-** In group(I A) Nearly normal pulpal architecture was observed. Another finding common to all experimental groups was the presence of inflammatory processes of different levels of severity. Moderate amount of inflammatory cell infiltration was noted about 50-60% in cases after 15 and 30 days. In addition the results of group (IB), (IIB) there was pulpal inflammation was prominently observed in all cases treated with formacresol. After 15 days about 33.3% of cases showed severe inflammation with lymphocytes and foamy macrophages while 66.6% showed moderate inflammatory infiltration. By the end of 14 days cases with severe pulpal inflammation were about 46.6%. Also, in group (IIA) there was pulpal inflammation was prominently observed in all cases treated with formacresol. After 15 days about 33.3% of cases showed severe inflammation with lymphocytes and foamy macrophages while 66.6% showed moderate inflammatory infiltration. By the end of 30 days cases with severe pulpal inflammation were about 46.6%.

Conclusion:- 1-Odontoblast remained vital in most cases treated with Both Tri-antibiotic paste and A. sativum . 2-Interal root resorption found in most specimens treated with formacresol .

Recommendations: Further clinical studies with long time evaluation periods should be done to investigate the effects of the three medicament on pulp tissues of primary teeth .

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INTRODUCTION

Currently, there are altered methods and trials for the managing the vital pulp of primary teeth, this is according to extension of damage and the nature of pathologic condition for pulpal tissues⁽¹⁾. Pulpotomy is a conservative technique used for removal of the infected coronal pulp tissue and preserve of the residual un-infected one with inert material^(1,2). A pulpotomy material should be bactericidal that is important for avoiding failures in the conservative endodontic treatment, spread of infection and further transferable of inflammatory processes to radicular pulp tissues⁽³⁾

Numerous pulpotomy materials were used for capping the radicular pulp, these include formocresol, glutaraldehyde,⁽⁴⁾ ferric sulfate, collagen material, and mineral trioxide aggregate⁽⁵⁾. Many estimated hazards of formocresol like; cytotoxicity, carcinogenicity, immunologic, biochemical, mutagenic, and teratogenic alterations in the host have been described.^(6,7) In addition, it produced enamel malformation in the permanent successors.⁽⁸⁾ On other hand, it was proved that the formocresol absorbed systemically from treated tooth.⁽⁹⁾ Furthermore, The tissue damages were occurred in many internal organs, especially in kidney and liver, and the amount of formocresol in the blood was directly proportional to the number of formocresol treated teeth.⁽¹⁰⁾ Hence, increased utilization of indigenous plant medicines in developing countries became a policy of WHO in the 1970s.⁽¹¹⁾

A need for natural medicament to substitute formocresol as a pulp dressing material comes to be vital. Generally, garlic has been used to treat many situations, including hypertension and many infectious diseases. It is used for reducing the cholesterol levels moreover, it has antineoplastic and antimicrobial effects.⁽¹²⁾

Idea of lesion sterilization and tissue repair (LSTR) by disinfection of dentinal, pulpal and periapical pathogens with application of

antibacterial medication that results in healing and repair of tissues. Metronidazole is primarily bactericidal agent that has been used for this purpose⁽¹³⁾. Certain bacteria resist metronidazole so; ciprofloxacin and minocycline were mixed with metronidazole to produce the 3Mix preparation⁽¹⁴⁾. Many trials proved the effectiveness of 3-mix as an oral bactericidal⁽¹⁵⁾, in addition it was used in primary teeth endodontic treatments^(13,16).

The bactericidal function of *Allium sativum* determined by allicin that is performed by the enzymatic activity of allinase (a cysteine sulfoxide lyase).⁽¹⁷⁾ Garlic has been prevent growth of several gram-positive and gram-negative bacteria.⁽¹⁸⁾ *Allium sativum* extract has been effected on numerous pathogenic bacteria, viruses, and fungi also, garlic extract has bactericidal action on multidrugresistant (MDR) strains of *Streptococcus mutans* that was found in human carious teeth.⁽¹⁹⁾

The present in vivo study was undertaken to evaluate and compare the pulp response of tri-antibiotic paste and *Allium sativum* with formocresol as pulpotomy medication in primary teeth.

Ethics:

The present study was approved from the Research Ethics Committee, Faculty of Dentistry, Suez Canal University code (198/2019).

MATERIALS AND METHODS

A randomized, controlled prospective clinical study was done at Pediatric Dentistry Department Outpatient clinic, Suez Canal University after obtaining an informed written consent from parents. A sample of 60 teeth from 30 children in age group 7-9 years have bilateral primary teeth which needed dental treatment due to deep caries and had at least two third of the root indicated for orthodontic serial extraction (confirmed by periapical x ray). Children divided into two groups, (group I) included(15) children had bilateral primary teeth,

the right side tooth treated with tri-antibiotic past (3 mix) (group IA) and left side tooth treated by formacresol* (group IB) and (group II) included (15) children had bilateral primary teeth, the right side tooth treated with allium sativum oil** (A. sativum) (group IIA) and left side tooth treated by formacresol (group IIB) . Each tooth was treated with standard pulpotomy procedure.

Inclusion criteria

- Healthy & cooperative child
- No previous history of taking antibiotic therapy for at least 2 weeks before operative procedure.
- No history of spontaneous pain
- No pathologic tooth mobility
- Normal gingival and periodontal condition
- Absence of furcal/periapical radiolucency (1)

Technique

Clinical and radiographic examinations were performed for each tooth before treatment. Teeth were anesthetized using Mepeccaine –L.A (local anesthetic solution containing 20 mg Mepivacaine hydrochloride . Rubber dam and high suction were used in pulpotomy procedure. Cavity outline was performed by sterile #330 high speed bur using water spray. Caries was removed by large spoon excavator. When pulpal exposure was occurred, the roof of pulp chamber removed by low speed round bur.

Hemostasis was achieved by applying pressure with moist cotton pellet with saline. If bleeding

did not stopped within 5 min, tooth was excluded from study. Then the test materials were applied as follow:-**Tri-antibiotic paste (IA):-** (15) Teeth in this group treated with freshly prepared mix of tri-antibiotic that was prepared as follow: a mixture of metronidazole***, ciprofloxacin**** and minocycline*****.

The drugs are ground into fine powder using sterilized mortar pestle. The powdered drugs were kept separately in amber-colored airtight containers. The fine powder was used up within a month. 3Mix paste was freshly prepared for each use. The same amount of each powdered drug (1:1:1) was mixed to form modified 3Mix powder. One part of propylene glycol (P) and the same volume of macrogol (M) were mixed to make (3 mix) paste.

-A.sativum group (II A): (15) teeth treated with freshly prepared mix of zinc oxide powder with one drop of allium sativum oil till reach suitable consistency (1:1 ratio by volume) to cover pulp stumps.**-Formcresol groups (IB) and (IIB):-** (30) Teeth treated by using sterile cotton pledget with formcresol for 3-5 min then, removed. Then pulp stumps were dressed with thick paste prepared by mixing zinc oxide***** powder with one drop of eugenol. Then all treated teeth were restored with glass ionomer cement*****. Patients were recalled after 15 and 30 days' time interval as a part of orthodontic treatment. Seven teeth from group (IA), Seven teeth from group (IIA) and (15) teeth from formacresol treated groups teeth were extracted after 15 days and then subjected to decalcification procedure. Eight teeth from group (IA), Eight teeth from group (IIA) and the other (15) teeth from formacresol treated groups

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** El Captin Company

*** Flagyl Avents

**** Ciprobay Bayer

***** Minocin Lederale

***** Meta Biomed

***** Medfill Promedica

were extracted after 30 days and then subjected to decalcification procedure.

Tissue fixation, decalcification, processing and paraffin embedding

For decalcified histology, all teeth were decalcified sequentially in 20% EDTA at 4 °C for approximately 5 weeks, until flexible by manual testing. The specimens then were routinely processed and embedded in paraffin. Serial sections were cut at 5 μ m thickness. Deparaffinize the sections by 2 changes of xylene for 10 minutes each. Re-hydrate in 2 changes of absolute alcohol, 5 minutes each. 95% alcohol for 2 minutes and 70% alcohol for 2 minutes. Wash briefly in distilled water. Stain in Harris hematoxylin solution for 8 minutes. Wash in running tap water for 5 minutes. Differentiate in 1% acid alcohol for 30 seconds. Wash running tap water for 1 minute. Bluing in 0.2% ammonia water or saturated lithium carbonate solution for 30 seconds to 1 minute. Wash in running tap water for 5 minutes. Rinse in 95% alcohol, 10 dips. Counterstain in eosin-phloxine solution for 30 seconds to 1 minute. Dehydrate through 95% alcohol, 2 changes of absolute alcohol, 5 minutes each. Clear in 2 changes of xylene, 5 minutes each. Mount with xylene based mounting medium for for conventional histological assessment using light microscope (Leica ICC50 HD). 20

Statistical analysis

The data were analyzed using version 20 of the SPSS. Qualitative data were compared using chi-squared statistics. Quantitative data were summarized using mean, standard deviation, and confidence interval and compared using Student's test and/or one way analysis of variance test. All P values were determined, and statistical significance was based on a P value of 0.05.

RESULTS

The sections were blindly evaluated by a histopathologist using the following criteria as indicated in Tables 1 to 8.

TABLE (1): Degree of pulpal inflammation

Score	Description
0	No inflammation
1	Mild inflammation
2	Moderate inflammation
3	Severe inflammation

TABLE (2): Degree of pulpal vascularity

Score	Description
1	Mild vascularity
2	Moderate vascularity
3	Severe vascularity

TABLE (3): Degree of pulpal fibrosis

Score	Description
0	No fibrosis
1	Mild fibrosis
2	Moderate fibrosis

TABLE (4): Quality of odontoblastic layer

Score	Description
1	Organized layer
2	Non-organized layer

TABLE (5): Internal root resorption

Score	Description
0	No resorption
1	Presence of resorption

TABLE (6): Presence of calcified structure in root canal

Score	Description
0	No calcified structures
1	Presence of calcified structures

TABLE (7): Presence of necrosis in root canal

Score	Description
0	No necrosis
1	Presence of necrosis

TABLE (8): Presence of dentin chips

Score	Description
0	No dentin chips
1	Presence of dentin chips

Histological evaluation

In Formocresol group

Pulpal inflammation was prominently observed in all cases treated with formacresol. After 15 days about 33.3% of cases showed severe inflammation with lymphocytes and foamy macrophages while 66.6% showed moderate inflammatory infiltration. By the end of 30 days cases with severe pulpal inflammation were about 46.6%. With formacresol treatment, pulpal vascularity varied from mild to moderate. After 15 days, 90% were mild, 10%

were moderate but after 30 days, mild cases were 80% and 20% showed moderate pulpal vascularity. Formation of collagen fibers was observed obviously. After 15 days, cases showed mild, moderate and severe fibrosis in pulp tissue 6.6, 33.3 and 60% respectively. But by the end of 30 days, cases showed mild, moderate and severe fibrosis in pulp tissue 6.6, 53.3 and 40% respectively. Odontoblastic layer was not intact throughout the dentine pulp complex. Ranging from 66.6 % to 83.3 % of cases showed disorganized odontoblastic layer after 15 and 30 days respectively (fig 1). Internal root resorption is the result of odontoclastic activity due to the precipitating factor as vascular changes in the pulp, inflammatory infiltration and formation of granulation tissue. Root resorption occurs in 66.6% and 80% of cases after 15 and 30 days respectively. Pulp stones were isolated and scattered after 15 days (60%) and after 30 days (73.3%). The resulting necrosis may have been due to excess formocresol in the cotton, which must have leaked and permeated into the surrounding tissue. Necrosis either partial or complete was noted in about 66.6% of cases. There was no reparative dentin formation in any area except in few cases (10%) showed fragments of dentin ships (fig 1, table 9).

In Tri antibiotic paste (TAP) group

Nearly normal pulpal architecture was observed. Another finding common to all experimental groups was the presence of inflammatory processes of different levels of severity. Moderate amount of inflammatory cell infiltration was noted about 50-60% in cases after 15 and 30 days. Blood vessels were prominent in most cases and pulp vascularity varied from moderate to severe. After 15days, 66.6% of cases showed moderate pulp vascularity while 33.3 % showed severe. At the end of 30 days, the results were 53.3% moderate and 46.6 % severe. The production of fibrous tissue was a prominent feature. The pulpal exposure sites were completely obstructed with more fibrous tissue formation

underlined by greater area of collagen hyalinization. The results were about (50-60% moderate, 50-40% severe). Nearly 70% of cases showed organized odontoblastic layer (fig 2).

In all cases of the study, only 26.6% of cases showed internal root resorption at the end of 30

days. Small pulp stones were observed in 33.3% of cases and 46.6% after 15 and 30 days respectively. Small area of necrosis (13-20%) of cases was noted. Regarding amount of hard tissue formation, dispersed dentin particles were visible about 20% of cases (fig 2, table 9).

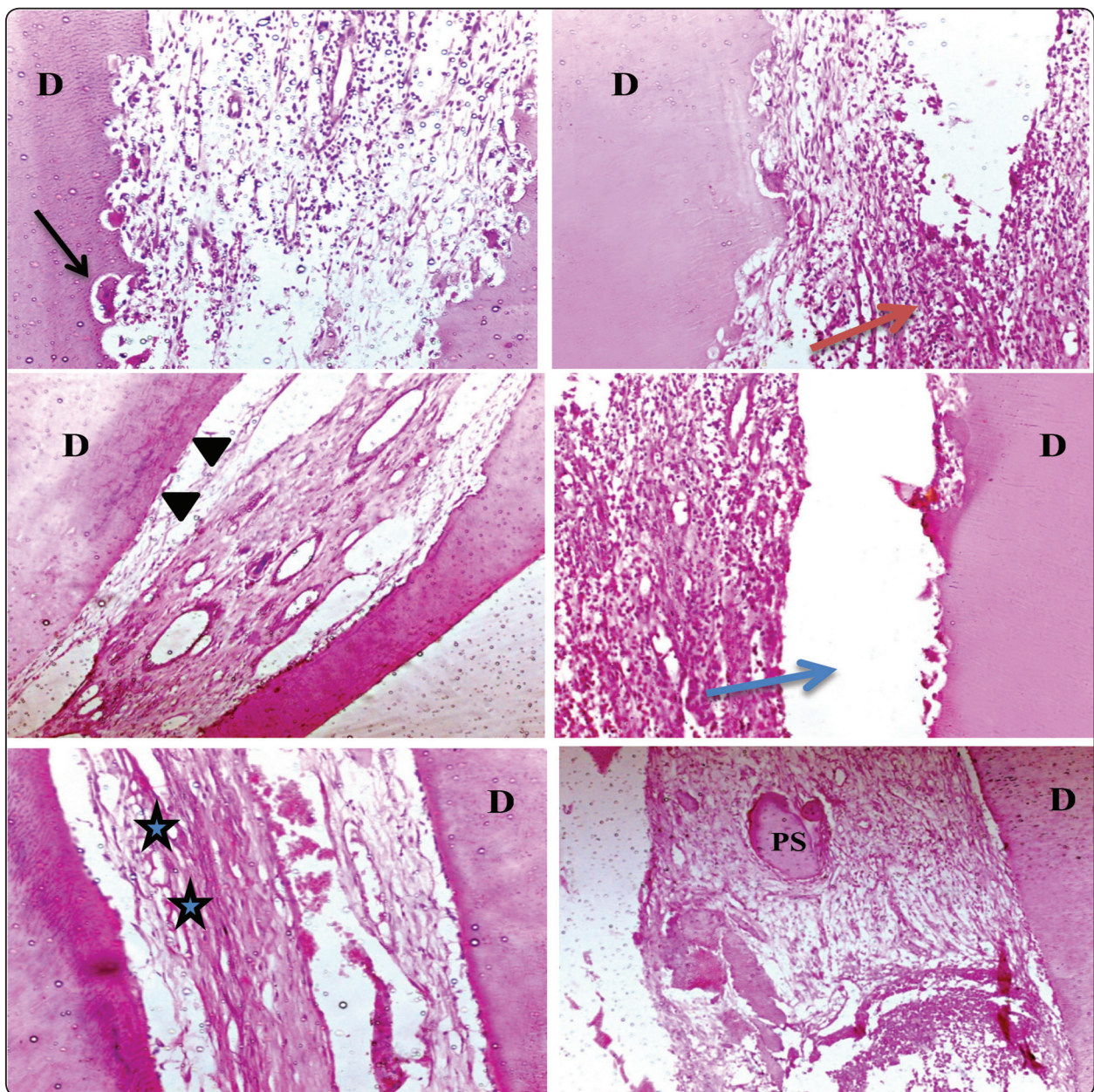


Fig. (1) Representative decalcified section of cases treated with formocresol showing (D) Dentin (PS) Pulp Stone, (black arrow) area of internal root resorption, (red arrow) pulpal inflammation, (arrow heads) disorganized odontoblastic layer, (blue arrow) area of necrosis, (Stars) area of pulp fibrosis. {H and E x 200}

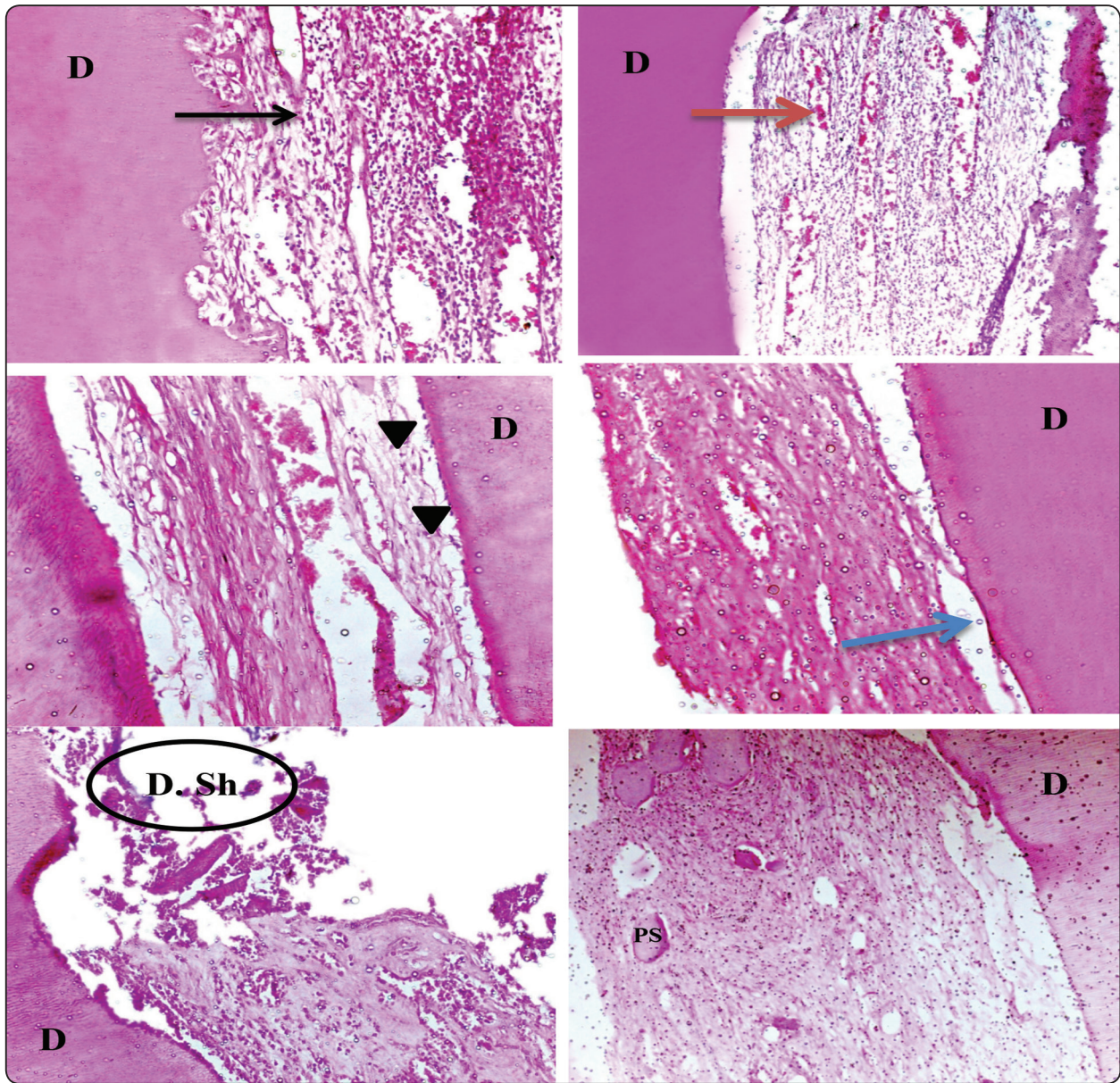


Fig. (2) Representative decalcified section of cases treated with Tri antibiotic paste (TAP) showing (D) Dentin, (PS) Pulp Stone, (D.Sh) dentin ships, (black arrow) area of pulpal inflammation, (red arrow) pulpal vasculature, (arrow heads) disorganized odontoblastic layer, (blue arrow) small area of necrosis. {H and E x 200}.

In Allium Sativum group

Mild pulpal inflammation was observed in 80 % of cases treated with Allium Sativum at the end of 30 days. Blood vessels were noted in all cases of Allium Sativum. After 30 days, about 86.6 % of cases showed moderate vascularity of pulp tissue, 6.6% of cases mild and 6.6 % of cases showed severe vascularity. Presence of collagen fibers were noted as dispersed fibers not well formed collagen

bundles. About 80 % of cases showed mild pulpal fibrosis after 30 days. The odontoblastic layer was well organized in about 73 % of cases treated with Allium Sativum (fig 3).

Internal root resorption was not a common feature that observed in case of Allium Sativum. Only 20% of cases showed a small focus of internal root resorption. Calcified pulp stones were rarely found in the pulp. At the end of 30 days, less than 15% of

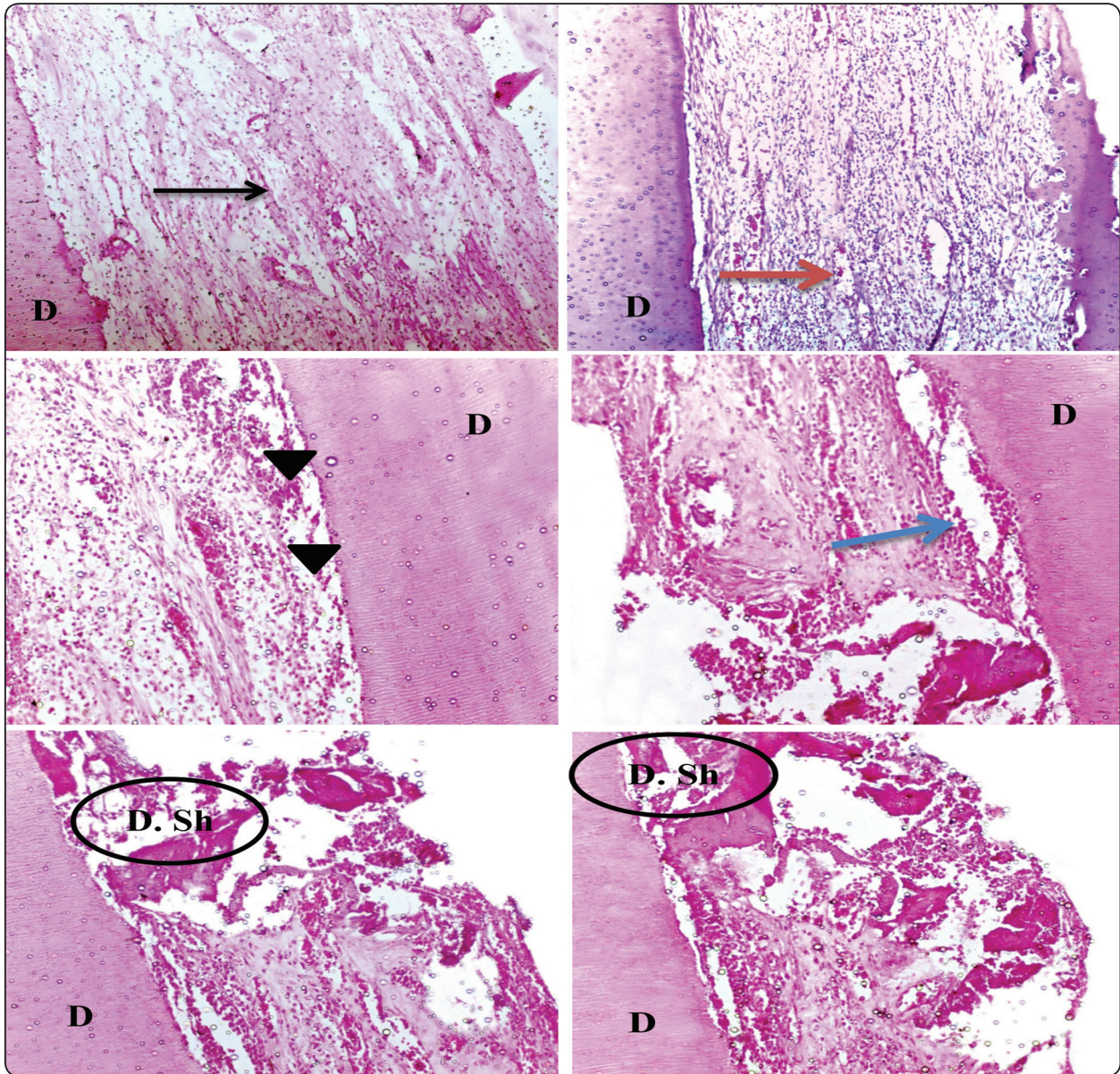


Fig. (3) Representative decalcified section of cases treated with Allium Sativum showing (D) Dentin, (D.Sh) dentin ships, (black arrow) small area of pulpal inflammation, (red arrow) pulpal vasculature, (arrow heads) odontoblastic layer, (blue arrow) small area of necrosis. {H and E x 200, last picture x400}.

cases showed scattered pulp stones. About 10% of all cases treated with Allium Sativum showed areas of necrosis after 30 days. Fragments of dentin were noted in about 33.3 % of cases treated with Allium Sativum at the end of 30 days (fig 3, table 9).

According to the results of the study, degree of pulpal inflammation, vascularity and fibrosis were significant between groups treated with formocresol, triantibiotic paste and allium sativum

(p value = 0.001). Results of destruction of odontoblastic layer were significant only between formocresol and allium sativum (p = 0.027). But there was no significant correlation in quality of odontoblastic layer between triantibiotic paste and allium sativum (p = 0.7). Internal root resorption, presence of pulp stones and necrosis results showed also significant correlation (p = 0.001, p = 0.012, p = 0.05 respectively) (table 10).

TABLE (9): Results of Formocresol, Triantibiotic paste and Allium Sativum groups

	F* (n = 30)		TAP** (n = 15)		AS*** (n = 15)	
	15 days	30 days	15 days	30 days	15 days	30days
1.Pulpal inflammation	10 moderate 5 severe	8 moderate 7 severe	3 mild 4 moderate	3 mild 5 moderate	7 mild	1 -ve 7 mild
2.Pulpal vascularity	13 mild 2 moderate	12 mild 3 moderate	6 moderate 1 severe	5 moderate 3 severe	3 mild 4 severe	1 mild 6 moderate 1 severe
3. Pulpal fibrosis	1 mild 8 moderate 6 severe	1 mild 8 moderate 6 severe	5 moderate 2 severe	5 moderate 3 severe	6 mild 1 moderate	5 mild 3 moderate
4. Odontoblastic layer	5 intact 10 not intact	2 intact 13 not intact	5 intact 2 not intact	5 intact 3 not intact	5 intact 2 not intact	6 intact 2 not intact
5.Internal root resorption	5 -ve 10 +ve	2 -ve 13 +ve	6 -ve 1 +ve	5 -ve 3 +ve	5 -ve 2 +ve	6 -ve 2 +ve
6. Pulp stones	6 -ve 9 +ve	3 -ve 12 +ve	6 -ve 1+ve	5 -ve 3 +ve	5 -ve 2 +ve	5 -ve 3 +ve
7.Necrosis	5 -ve 10 +ve	5 -ve 10 +ve	5 -ve 2 +ve	5 -ve 3 +ve	5 -ve 2 +ve	6 -ve 2 +ve
8. Dentin ships	12 -ve 3 +ve	11 -ve 4 +ve	6 -ve 1 +ve	5 -ve 3 +ve	5 -ve 2 +ve	6 -ve 2 +ve

TABLE (10): Correlation between Formocresol, Triantibiotic paste and Allium Sativum groups

		Range			Mean	±	S. D	F. test	p. value		
1.Pulpal inflammation	F	2	-	3	2.53	±	0.52	39.723	0.001*	P1	0.001*
	TAP	1	-	2	1.60	±	0.51			P2	0.001*
	AS	0	-	2	0.87	±	0.52			P3	0.001*
2.Pulpal vascularity	F	1	-	2	1.20	±	0.41	31.787	0.001*	P1	0.001*
	TAP	2	-	3	2.47	±	0.52			P2	0.001*
	AS	1	-	3	2.00	±	0.38			P3	0.006*
3. Pulpal fibrosis	F	1	-	3	2.33	±	0.62	26.616	0.001*	P1	0.489
	TAP	2	-	3	2.47	±	0.52			P2	0.001*
	AS	1	-	2	1.20	±	0.41			P3	0.001*
4. Odonto-blastic layer	F	1	-	2	1.67	±	0.49	3.014	0.060	P1	0.063
	TAP	1	-	2	1.33	±	0.49			P2	0.027*
	AS	1	-	2	1.27	±	0.46			P3	0.704
5. Internal root resorption	F	0	-	1	0.80	±	0.41	11.094	0.001*	P1	0.001*
	TAP	0	-	1	0.27	±	0.46			P2	0.001*
	AS	0	-	1	0.13	±	0.35			P3	0.378
6.Pulp stones	F	0	-	1	0.73	±	0.46	4.941	0.012*	P1	0.123
	TAP	0	-	1	0.47	±	0.52			P2	0.003*
	AS	0	-	1	0.20	±	0.41			P3	0.123
7.Necrosis	F	0	-	1	0.67	±	0.49	6.067	0.005*	P1	0.016*
	TAP	0	-	1	0.27	±	0.46			P2	0.002*
	AS	0	-	1	0.13	±	0.35			P3	0.408
8. Dentin ships	F	0	-	1	0.13	±	0.35	0.817	0.449	P1	0.408
	TAP	0	-	1	0.27	±	0.46			P2	0.216
	AS	0	-	1	0.33	±	0.49			P3	0.678

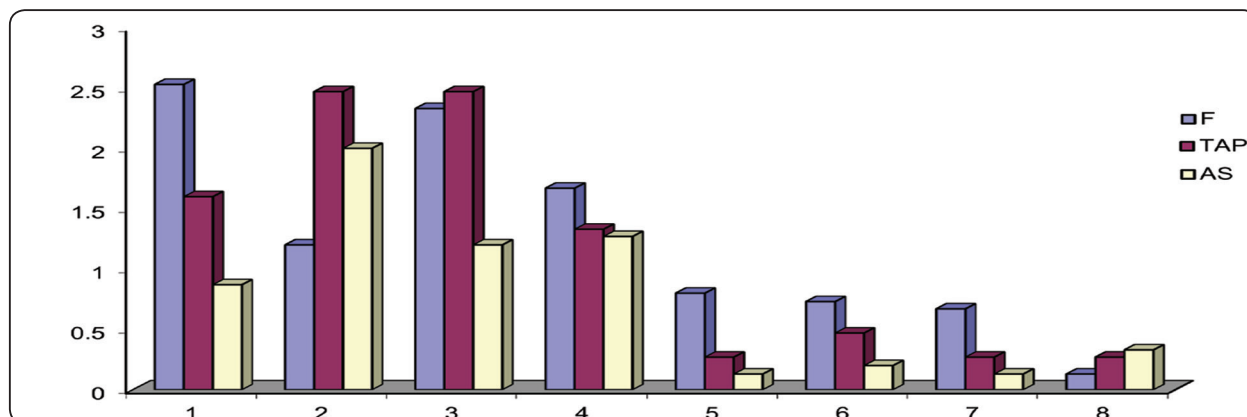


Fig 4: Correlation between Formocresol, Triantibiotic paste and Allium Sativum groups

*F (Formocresol group)

**TAP (Triantibiotic paste group)

***AS (Allium Sativum)

DISCUSSION

Clinical and radiographic evaluations of pulpotomies using mixture of three antibiotics have been estimated in numerous studies⁽²⁰⁾. Also, the effect of Allium sativum has been evaluated clinically and radiographically as pulpotomy medicament⁽²¹⁾. Studying the histologic response of pulp to mixture of three antibiotic and Allium sativum gives a better insight into their mechanisms of action and still are the most relevant. Until now, this study is the first one that histologically compare the effects of Formocresol, mixture of three antibiotic and Allium sativum on vital pulp tissues in primary teeth in vivo thus it can be considered a preliminary study.

The follow up periods of current study are limited to 15 and 30 days to evaluate the inflammatory responses of tested materials on vital pulp tissues which may be enough for this purpose. This disagree with Kakarla et al⁽²²⁾, who extracted primary teeth after one week and two weeks to histologically study the dental pulp response to collagen and pulp-otec as pulpotomy agents. In addition, this disagrees with Sivadas⁽²³⁾ et al., who evaluate and compare the pulp response of primary teeth in vitro to ferric sulphate and diode laser as pulpotomy agents at 4 weeks and at 6 weeks.

This study was a single blind in vivo study, where the oral pathologist was blind to not af-

fecting on histopathological results in agreement with Ratnakumari and Thomas⁽²⁴⁾ and Sivadas et al.,⁽²³⁾. Formocresol used in this study as pulpotomy material as a gold stander agent for this technique. This is inconsistent with Ratnakumari and Thomas⁽²⁴⁾ who used formocresol as a positive control group.

The results of current study revealed that there was moderate to severe inflammation in formocresol treated group and presence of severe pulpal fibrosis. These findings are in agreement with Omar et al.,⁽²⁵⁾. Moreover, there was internal root resorption in formocresol group and there were partial and complete necrosis in 66.6% of cases because it increases the inflammation of pulp tissues and formations of abscess⁽²⁶⁾. Reaction to formocresol may be attributed to numerous causes; trauma during removal of pulp tissues or cytotoxicity of materials⁽²⁷⁾.

On other hand, specimens treated with 3 mix showed mild to moderate pulpal inflammation about 50-60% of cases after 15 days and 30 days also, moderate to severe increasing in pulpal vascularity with greater infiltration of fibrous tissues specially collagen fibers that is attributed to disinfection of tissues which led to repair of damaged tissues⁽²⁸⁾. visibility of dispersed dentin particles in 20% of cases and nearly 70% treated cases showed organized odontoblastic layer that may be due to odontoblasts stimulation effects of (3 mix).

In this study, the pulp tissues in *Allium sativum* group showed mild inflammation after 15 and 30 days with mild to moderate pulpal fibrosis. Odontoblastic layer was intact and well organized in 73% of cases treated with *Allium sativum*, this indicated that the pulp tissues in state of reversible pulpitis which will initiate recovery of any damaged pulp tissues that resulted from infection or pulp tissue trauma. Those findings were in agreement with Mohammad and Baroudi⁽²⁹⁾ who concluded that *A. sativum* has favourable clinical results as pulpotomy material in primary molar that is due to anti-inflammatory and analgesic effects of it. These properties may be due to presence of ajoene and diallyl sulfide in *A. sativum* which inhibit prostaglandin⁽³⁰⁾. Moreover, Mohammad et al.⁽³¹⁾, concluded that *A. sativum* oil compromises a good healing potential, that makes the residual pulp tissues healthy and functioning.

The histological finding of current study confirmed that there were promising outcomes of tri-antibiotic paste and *A. sativum* when comparing them as vital pulpotomy medicaments for primary teeth with formacresol which induced internal resorption and pulp necrosis to pulp tissues. In addition they induced mild inflammatory reactions on pulp that makes pulp tissue capable to repair.

CONCLUSIONS

- 1- Tri-antibiotic paste induced mild to moderate pulp inflammatory reactions compared to formacresol which induce severe inflammatory cells infiltrations and pulp necrosis.
- 2- *A. sativum* induced mild pulp inflammatory reactions when compared with formacresol.
- 3- Odontoblast remained intact in most cases treated with Both Tri- antibiotic paste and *A. sativum* compared with formacresol.
- 4- Internal root resorption found in most specimens treated with formacresol compared to minimal amounts in tri-antibiotic paste and *A. sativum* treated groups.

RECOMMENDATIONS

- 1- Further clinical studies with long time evaluation periods should be done to investigate the effects of tri-antibiotic pastes on pulp of primary teeth to confirm its reparative effects on dental pulp.
- 2- Further clinical studies with long time evaluation periods should be done to investigate the effects of *A. sativum* on pulp tissues of primary teeth and to confirm its anti-inflammatory reaction.
- 3- Tri-antibiotic paste and *A. sativum* can replace formacresol as a vital pulpotomy medication in the future.

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