

Clinical Evaluation of Root Resorption and its Correlation with Obturation Quality in Pulpectomized Deciduous Teeth with Different Obturating Materials: An *In vivo* Study

Abstract

Aims and Objectives: The aim was to evaluate the root resorption in pulpectomized deciduous teeth and its correlation with obturation quality using zinc oxide and eugenol (ZOE), Metapex and Endoflas at the interval of 6 and 12 months. **Materials and Methods:** A total of 150 infected primary mandibular molars were randomly and equally divided into three subgroups ($n = 50$ each): Group 1 (ZoE), Group 2 (Metapex), and Group 3 (Endoflas) based on the obturation material preferred. The teeth were clinically and radiographically evaluated at 6 and 12 months' postoperatively by another investigator who was blinded to the type of filling material that was used in each tooth. Kruskal–Wallis test, Mann–Whitney Test, and Wilcoxon Signed-Rank Test was used for statistical analysis. **Results:** When the obturation quality was assessed, the optimal filling was found in 78% of the cases while the rest have underfilling (9%) and overfilling (13%). The incidence of overfilling was higher in the cases with some root resorption. After 12 months, Group 2 showed maximum variation with the highest incidence (70%) of extensive resorption both interradicular and intraradicular (Grade 3 score) followed by Group 1 (26%) and Group 3 (16%), respectively. **Conclusion:** Among all the materials, Endoflas showed the highest success rate with least incidence of resorption both outside and within the root canal (hollow tube effect) whereas least success rate was observed with Metapex having the hollow tube effect in majority of the cases (70%) after the follow-up of 12 months.

Keywords: Deciduous teeth, hollow tube effect, obturation quality, root resorption

Introduction

Pulp therapy in deciduous teeth aims to preserve the tooth with an objective of resolution of infection and radiographic evidence of successful obturation leading to normal eruption of the succedaneous permanent teeth.

Since 1930, the most commonly used obturating material in deciduous teeth is zinc oxide and eugenol (ZOE) cement. In 1979, it was speculated that the resorption rate of ZOE and the root differed, resulting in small areas of ZOE paste possibly being retained. The retained material alters the path of eruption of permanent teeth in 20% of cases.^[1]

ZOE and Metapex though commonly used do not fulfill all the requirements of an ideal obturation material. Ramar and Mungara report a 95.1% success rate with Endoflas

with good healing ability, bone regeneration, and absence of an intraradicular washout.^[2] Fuks *et al.* reported 70% success clinical success rate with Endoflas with a 100% decrease in periapical radiolucency.^[3] Studies by Chawla *et al.* indicate a 100% radiographic success with 54.8% complete bone regeneration.^[4] Very little literature exists on the use of Endoflas as an effective obturation material alternative to ZOE and Metapex.

Hence, the aim of this clinical study was to evaluate the root resorption in pulpectomized deciduous teeth and its correlation with obturation quality using ZOE, Metapex, and Endoflas at the interval of 6 and 12 months.

Materials and Methods

The present study was planned and conducted in the after obtaining the ethical clearance from the Ethical Committee of the Institute. Clinical and radiographic

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diagnosis of 150 infected primary mandibular molars was obtained from 75 healthy children ranging in age from 3 to 7 years. Informed consent was obtained from all participating parents or legal guardians. 150 infected primary mandibular molars were randomly and equally divided into three subgroups ($n = 50$ each) based on the material preferred for obturation.

- Group 1 ($n = 50$): ZOE as an obturating material
- Group 2 ($n = 50$): Metapex as an obturating material
- Group 3 ($n = 50$): Endoflas as an obturating material.

The inclusion criteria were as follows:

1. Clinical characteristics determined by the presence of a deep carious lesion with pulp exposure, where the bleeding could not be stopped following removal of the coronal pulp tissue, spontaneous pain or chronic apical abscess, abnormal mobility not associated with normal exfoliation, pain on percussion, and fistula or abscess
2. Coronal radiographic characteristics defined by the radiographic evidence of a deep carious lesion or lesion with radiographic pulp exposure in the crown and
3. Radiographic appearances of the root and supportive structure that could be categorized into the following four groups:
 - a. No pathology (P1)
 - b. Discontinuity of lamina dura (P2)
 - c. Furcation involvement less than or equal to half of the shortest root in vertical measurement (P3) and
 - d. Furcation involving more than half of the shortest root (P4).

Teeth with at least one characteristic in each of the three criteria were included in the study.

The exclusion criteria were as follows:

1. Obliteration of the root canal
2. Internal resorption; and
3. Physiologic root resorption more than a third of its length.

Criteria for pulpectomy success

Consent to expose the needed radiographs was obtained after risks and benefits were discussed. Pulpectomy success was based on tooth assessment satisfying all the following criteria:

Clinical criteria

1. No gingival swelling or sinus tract 6 months or more postoperatively
2. No purulent exudate expressed from the gingival margin
3. No abnormal mobility other than mobility from normal exfoliation
4. No pain on postoperative checkup.

Radiographic criteria

1. No pathologic signs of external root resorption or continued resorption if any were present preoperatively

2. A bifurcation radiolucency resolved 6–12 months' postoperatively
3. No periapical radiolucency formation postoperatively
4. Absence of change or more discontinuity of lamina dura
5. Absence of change in size of radiolucent area.

The pulpectomized teeth were evaluated for preoperative apical root resorption and adequacy of endodontic fill. Preoperative root resorption was categorized as follows: (1) no root resorption, defined as a root showing no evidence of preoperative apical root resorption; (2) minimal resorption, meaning the root(s) had incipient root resorption of 1 mm or less at the apex; and (3) excess resorption, which was any root or part of a root with obvious apical root resorption of >1 mm. The quality of the root canal filling was defined as modification of Coll and Sadrian.^[1] Classification of the canal obturation based on the amount of filling:

- I. Underfilling: All the canals were filled more than 2 mm short of the apex
- II. Optimal filling: One or more of the canals having obturating material ending at the radiographic apex or up to 2 mm short of the apex
- III. Overfilling: Any canal showing obturating material outside the root.

These assessments were made by comparing the tooth's root(s) to adjacent and/or contralateral teeth, while a molar's roots also were compared to one another.

Before rating any of the pulpectomies, the two authors standardized their evaluation technique by analyzing five pulpectomies not included in the study. The evaluation consisted of each author reviewing the chart's treatment notes and all of the pre- and post-operative radiographs and photographs. Tooth ratings for each category were made and then compared. There was over 90% agreement. Cases, in which the ratings differed, were discussed until mutual agreement was reached or the lower of the two rankings was given.

Zinc oxide (Thailaisart Co, Saraburi, Thailand) and eugenol (Tien Yuan Chemical Co, Singapore), Metapex (Neo Dental, Tokyo, Japan) and Endoflas were allocated to their respective groups by block randomization. One pediatric dentist performed the single-visit pulpectomy together with stainless steel crown at the same visit. The teeth were clinically and radiographically evaluated at 6 and 12 months' postoperatively by another investigator who was blinded to the type of filling material that was used in each tooth. The treatment was judged to be successful when both the clinical and radiographic criteria were fulfilled.

Kruskal–Wallis test, Mann–Whitney test and Wilcoxon–Signed Rank test was used for statistical analysis. Statistical tests of significance were computed so that a $P \leq 0.05$ was considered statistically significant.

Results

All the samples were analyzed based on the root resorption and obturation quality [Table 1]. Majority of the selected cases have grade 1 score (no root resorption) preoperatively with only few of them (Grade 2 [20%] and Grade 3 [2%] score) showed some signs of resorption. When the obturation quality was assessed, the optimal filling was found in 78% of the cases while the rest have underfilling (9%) and overfilling (13%). The incidence of overfilling was higher in the cases with some root resorption. The incidence of grade 2 root resorption (minimal root resorption) was increased from 14% to 56% in Group 2 and from 24% to 32% in Group 3, respectively, whereas no change was observed in Group 1 at the end of 6 months. However, extensive root resorption (Grade 3 score) was increased from nil to 8% (Group 1) and nil to 14% (Group 2) with no change still found in Group 3 at the end of 6 months.

After 12 months, Group 2 showed maximum variation with the highest incidence (70%) of extensive resorption both interradicular and intraradicular (Grade 3 score) followed by Group 1 (26%) and Group 3 (16%), respectively [Table 2].

When the different groups were compared using Mann-Whitney test, statistically highly significant difference was found between different groups except between groups 1 and 3 at the end of 6 months and 12 months, respectively.

Discussion

Pulpectomy since long has created a dilemma in the view of the clinician owing to the tortuosity of the canals of a primary molar. The ideal root canal filling materials must be resorbable and have long-lasting antibacterial properties. The preparation of the root canal in a primary tooth is based mainly on chemical means rather than mechanical debridement. Among the various obturating materials available, ZOE is the one of the most widely used for primary tooth pulpectomies since its discovery by Bonastre and its subsequent use in dentistry by Chisholm.

A single-visit pulpectomy study was first reported on 39 infected primary molars filled with ZOE. After 16 months, 83% were judged successful. Barr *et al.* reported 82% success of ZOE pulpectomy with a 1-appointment formocresol technique after 40 months.^[5]

Coll *et al.* also reported a clinical success rate of more than 80% after 5 years. Primary teeth with minimal or no preoperative root resorption had significantly higher pulpectomy success than those with excessive (>1 mm) resorption. In the present study, the severity of the infection was rated by the extent of root resorption which is in accordance to Coll and Sadrian. They found the least success in the group with excessive root resorption, while all of the failed teeth in the present study were also in the most severe group. This may demonstrate that severe

preexisting infection has less chance to be resolved by the pulpectomy procedure.

The clinical and radiographic success rate of the ZOE group at 6 and 12 months, the ZOE success rate in the current study (70%) was close to previous studies, which reported success rates of 78%–87% with 6–90-month follow-ups. Each study was different, however, in sample selection, treatment procedure, and follow-up period.^[6]

Despite the high success rates, ZOE does not meet all criteria required for an ideal root canal filling material. The major drawback of ZOE is the excess material beyond the apex during filling procedures which can remain in the apical tissue during the process of physiologic root resorption, taking months or even years to resorb [Figure 1]. The ZOE cement fragments remained in the periapical area even after the exfoliation of pulpectomized tooth due to ZOE's resistance to foreign body giant cell resorption. Coll and Sadrian reported anterior crossbite, palatal eruption, and ectopic eruption of the succedaneous tooth following ZOE pulpectomy. Moreover, it has limited antibacterial efficacy.

Fast-resorbing materials (Iodoform pastes) have better resorbability and disinfectant properties than ZOE. Furthermore, Metapex when extruded into furcal or apical areas, can either get diffused or resorbed by macrophages, in as short a time as 1 or 2 weeks and causes no foreign body reaction, with success rate of 96% to 100% by Nurko *et al.*^[7] The clinical and radiographic success of pulpectomy with Metapex in primary teeth may be related to its antibacterial properties and the material's distinctive property of rapid resorption from periapical tissue.

Overfilled ZOE was found in 9 teeth (18%). Particles of the extruded ZOE were partially resorbed in 1 tooth, and complete retention was found in 8 teeth at 12 months. These findings are consistent with Barker and Lockett's report. The resorption of Metapex in the root canal in the present study, however, was observed in 28 teeth (56%) at 6 months to 35 teeth (70%) at 12 months. These findings were in accordance with Ozalp, Saroglu, and Sonmez who also reported the signs of metapex resorption within the root canal at 6–12 months, but the incidence of resorption was much higher in our study.^[8]

One of the properties of an ideal root canal filling material for a primary tooth should include the ability to resorb at the same rate as that of the root. In the present study, Metapex has been shown to resorb at a much faster rate than the root leading to the “hollow tube” appearance of well-obtured root canals after the follow-up of 6–12 months [Figure 2]. The reason may be the important ingredient calcium hydroxide, which has a tendency to get depleted from the canals earlier than the physiologic resorption of the roots despite its antiseptic and osteoinductive properties.^[9,10]

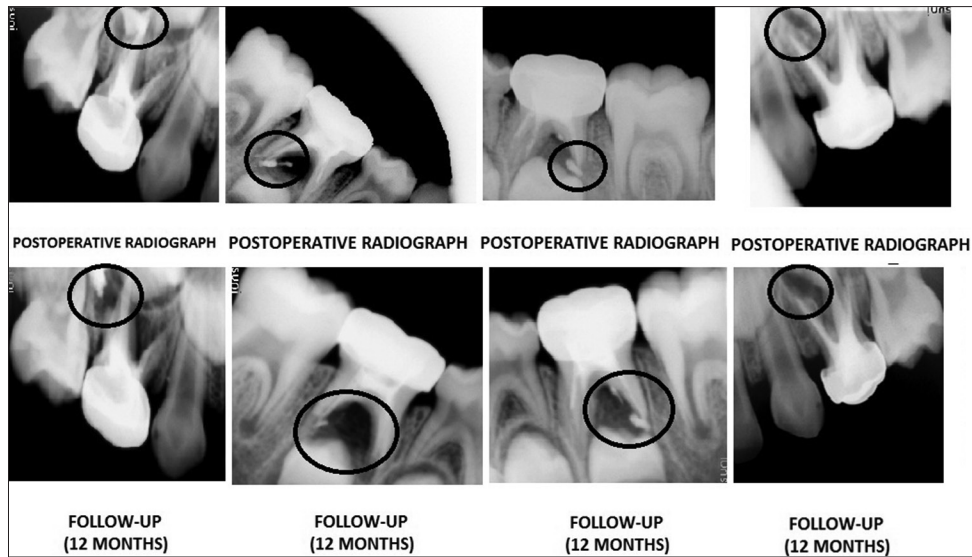


Figure 1: Radiographic assessment of root resorption after 12 months in pulpectomized deciduous teeth with Zinc-Oxide Eugenol as an obturation material

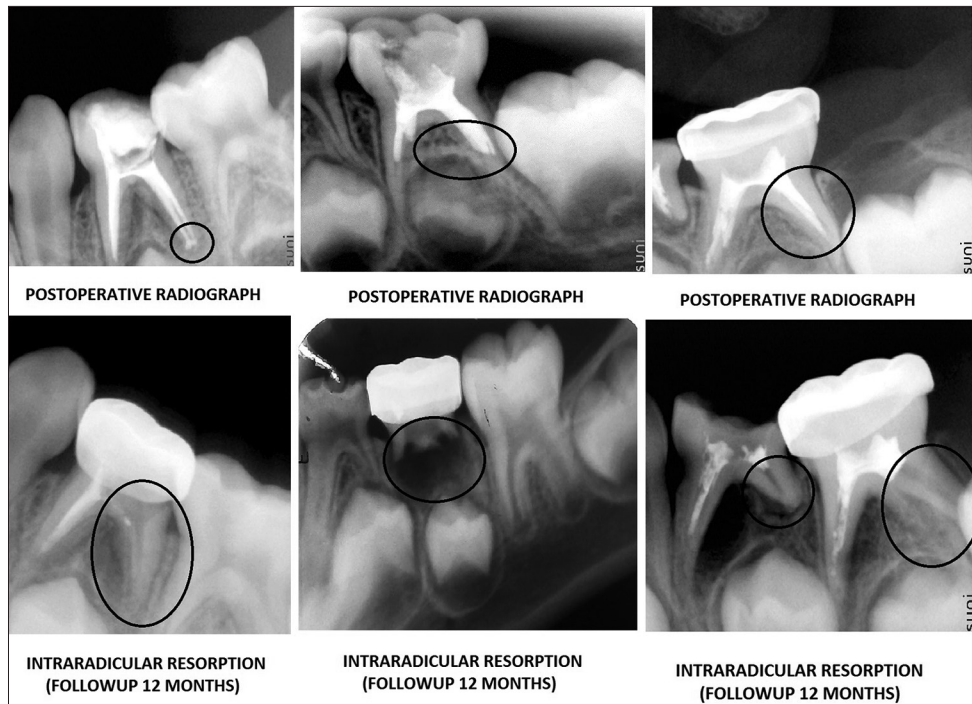


Figure 2: Radiographic assessment of root resorption after 12 months in pulpectomized deciduous teeth with Metapex as an obturation material

Endoflas showed the highest success rate (76%) among all the materials with the least incidence of resorption after the follow-up of 12 months [Figure 3]. These results are in continuous agreement with Ramar and Mungara reported healing ability, bone regeneration characteristics and resorption of excess Endoflas without hollow tube effect within the root canals.^[2]

The manufacturers of Endoflas paste (Sanlor and Cia. S. en C. S., Cali, Colombia) claims that it has a broad spectrum of antibacterial efficacy. The material is hydrophilic and can be used in mildly humid canals. It has

the ability to disinfect dentinal tubules and hard-to-reach accessory canals that cannot be disinfected or cleansed mechanically.^[11-13] In addition, the components of the material can be removed by phagocytosis making it resorbable. Fuks *et al.* 2002 observed that the Endoflas paste has the advantage of having the resorption limited to the excess material, which has been extruded. Resorption of the material does not occur within the canal. Thus, the material is neither resistant to resorption nor does it result in the hollow tube effect. Intriguingly, the material which had over extruded periapically and intraradicularly was resorbed within 7 days.^[14]

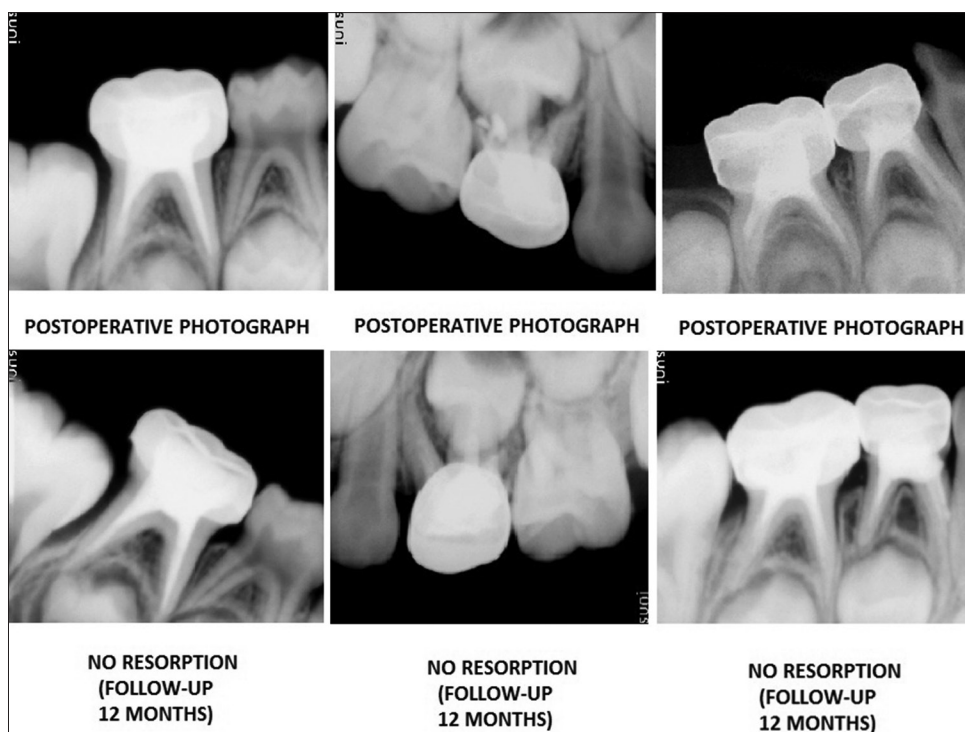


Figure 3: Radiographic assessment of root resorption after 12 months in pulpctomized deciduous teeth with Endoflas as an obturation material

Table 1: Intergroup comparison between the preoperative root resorption and obturation quality among different materials

Time	Grade	Group 1 (%)	Group 2 (%)	Group 3 (%)	Mean rank [#]	χ^2 [#]	P [#]
Preoperative resorption	Grade 1	39 (78)	39 (78)	38 (76)	75.17	4.169	0.124**
	Grade 2	8 (16)	7 (14)	12 (24)	69.29		
	Grade 3	3 (6)	4 (8)	-	82.04		
Obturation quality	Grade 1	4 (8)	5 (10)	5 (10)	80.00	2.290	0.318**
	Grade 2	37 (74)	38 (76)	42 (84)	75.97		
	Grade 3	9 (18)	7 (14)	-	70.53		

[#]Kruskal–Wallis test; **P<0.001; highly significant. Higher mean rank shows higher number of cases with higher grade

Table 2: Radiographic assessment of relative resorption of obturating material with respect to resorption of root after 12 months' follow-up

Radiographic resorption assessment	Group 1 (n=50), n (%)	Group 2 (n=50), n (%)	Group 3 (n=50), n (%)
Resorption of root greater than filling material**	22 (44)	3 (6)	8 (16)
Resorption of root equal to filling material**	20 (40)	10 (20)	40 (8)
Resorption of root less than filling material	4 (8)	35 (70)	-
No resorption	1 (2)	-	-

**P<0.001; Highly Significant

Limitations

- Even though the American Academy of Pediatric Dentistry’s guideline on pulp therapy states that the radiograph infectious process of pulpctomized teeth

should resolve in 6 months, this study’s results agreed with previous studies^[15,16] that, in some cases, more definitive assessments could be made at longer follow-up times

- It is noteworthy that this study used narrower criteria in sample selection. Only lower molars were used in an effort to eliminate the overlapping of permanent tooth buds onto primary molar roots and furcations and to enable the investigator to identify the radiographic pathology and healing more clearly
- Other studies have used both maxillary and mandibular primary molars.^[17-19] This could explain why our success rate was lower than other studies
- There was no long-term follow-up, however, on the impact of the early resorption of Metapex on the success or the proper eruption of succedaneous teeth. Long-term effects, however, need to be further studied
- This study’s design had the inherent limitations of any retrospective study. The assessment of root resorption, the

variable length of follow-up, timing of tooth exfoliation, and trauma diagnosis could lead to different interpretations.

Uniqueness of the work

- In a single clinical study, all the three pioneer obturating materials were clinically evaluated and compared with a follow-up of 6 and 12 months
- The important outcome was the failure of Metapex as an obturating material having the “hollow tube effect” in majority of the cases (70%) after the follow-up of 12 months
- Pulpectomy success rate also was related to the level of obturation. Those filled short of the apex or completely to the apex had a significantly greater success rate than those overfilled. The incidence of overfilling was higher in the cases with some root resorption.

Conclusion

Among all the materials, Endoflas showed the highest success rate with least incidence of resorption both outside and within the root canal whereas least success rate was observed with Metapex (Hollow-Tube Effect). The success of pulpectomy was related to the amount of preoperative root resorption. Teeth with excess resorption had significantly lower success rate than teeth without any or minimal preoperative root resorption.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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