

CLINICAL AND RADIOGRAPHIC EVALUATION OF DIFFERENT OBTURATING MATERIALS AS BIOLOGICAL BARRIER IN QUALITY OF OBTURATION OF PULPECTOMIZED PRIMARY ANTERIOR TEETH

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ABSTRACT

Objective: To evaluate the effect of Absorbable Gelatin Sponge (AGS) and Colla cote as a biological barrier in pulpectomized primary anterior teeth. **Subjects and methods:** This study was undertaken on 36 primary anterior teeth indicated for pulpectomy. The teeth were classified randomly according to the used obturation materials (Metapex, Metapex/AGS, and Metapex/Colla Cote) into 3 equal groups. All teeth were evaluated clinical and radiographic to assess the quality of obturation. **Results:** All pulpectomized teeth in Metapex and Metapex/Colla Cote groups, showed materials extrusion beyond the apex at immediate post-operative. While after three months of follow-up, all extruded materials beyond the apex were resorbed. However, all teeth in Metapex/AGS group, at immediate and three months showed no extrusion beyond the apex. **Conclusion:** The addition of AGS to Metapex can increase the viscosity of the Metapex, which in turn decreases the tendency of Metapex extrusion and post-operative periapical inflammation and pain, thus increasing the success rate chances.

KEYWORDS: Primary teeth, pulpectomy, obturation, Metapex, Absorbable gelatin sponge, Colla cote.

INTRODUCTION

Primary dentition has extreme functional and morphological importance for children's growth. Functionally, primary anterior teeth contribute to mastication development, guide the incisive function and support the phonation progress. Morphologically, the maintenance of primary arch integrity strongly influences the maintenance of arches' length, influencing permanent dentition development and guiding successor teeth eruption⁽¹⁻³⁾.

Preservation of the primary tooth is the best space maintenance for its successor, and resolution of the pathological process can be achieved. However, the complex morphology of the root canal system in deciduous teeth makes it difficult to achieve proper cleansing by mechanical instrumentation and irrigation of the canals⁽⁴⁾. So, to increase the success rate of the endodontic treatment, substances with antimicrobial properties are frequently used as root canal filling materials in primary teeth⁽⁵⁾.

The success of endodontic therapy depends

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on many factors like biomechanical preparation, adequate irrigation, and obturation with a 3 D fluid-tight seal. For biomechanical preparation, there have been dramatic changes in protocol and armamentarium. However, not enough progress has been made in obturation techniques in primary teeth. The greatest challenge in primary tooth pulpectomy is obturating the canals. The complex nature of the root canal morphology of primary teeth and the consistency of the available obturation materials make it difficult to achieve optimum obturation⁽⁶⁾.

The ideal obturating technique should ensure a good apical seal without underfilling or overfilling⁽⁷⁻⁸⁾. Traditionally, zinc oxide eugenol (ZOE) had been the material of choice for filling root canals of primary teeth due to ease of handling, operator feasibility, and cost-effectiveness. However, ZOE has been unanimously criticized by several authors due to the detrimental effects caused by the residual particles on the permanent successor tooth germ⁽⁹⁾.

Metapex contains calcium hydroxide 30.3% and iodoform 40.4% along with silicone oily base 22.4%. The iodoform is a known bactericide that is released from the sealer and suppresses any residual bacteria in the canal or periapical region, while calcium hydroxide has a biocompatible antibacterial activity, induction of mineralized tissue formation, activation of alkaline phosphatase and collagen synthesis, and ability to produce hydrolysis of bacterial endotoxin. These components of Metapex made it the most popular filling material for primary teeth over ZOE⁽¹⁰⁾.

However, Metapex does not have adequate handling properties and tends to extrude beyond the apex due to its viscosity, which is not under the control of the clinician. Moreover, the thick and inflexible plastic disposable tips of these commercially available pastes raise serious doubt as to the expression of the material in the narrow apical third. To achieve optimum obturation, the operator ends up applying more pressure on the syringe, resulting in over obturation⁽¹¹⁾.

Thus, it becomes essential to provide an apical barrier to minimize this extrusion such as (Colla Cote), which is a white pliable biocompatible sponge obtained from bovine collagen. It is an absorbable collagen barrier that diminishes extravasation of root canal filling material during pulpectomy of primary anterior teeth, but does not completely prevent extruding the Metapex through the canals⁽¹²⁾.

Absorbable gelatin sponge (AGS) is a unique material commonly used in surgical fields to achieve hemostasis. It is sterile and biologically inactive⁽¹³⁻¹⁴⁾. The use of Metapex manipulated with minute particles of AGS to adjust the viscosity of the paste is a novel approach for obturation in primary teeth. The addition of AGS to Metapex causes a “tamponade effect”, which reduces the tendency of Metapex to extrude beyond the root apex. Root canal obturation using a modified filling paste-like AGS is effective in obtaining optimum obturation in primary teeth⁽¹⁵⁾. Up to our knowledge, there is a paucity of studies that investigate such materials, so this study was conducted to evaluate the effect of Absorbable gelatin sponge and Colla Cote as a biological barrier in pulpectomized primary anterior teeth.

SUBJECTS AND METHODS

Study design and population: This study was a clinical and radiographic study Outpatients clinic department of Pedodontics and public health faculty of Dental Medicine, Al-Azhar University.

Sample size: based on a previous study sample size of 12 in each group has an 80% power to detect an increase of 0.38 with a significance level (alpha) of 0.05 (two-tailed) and 95% confidence intervals. In 60% (the power) of those experiments, the P-value will be less than 0.05 (two-tailed). In the remaining 40% of the experiments, the increase was deemed “not statistically significant”. Report created by GraphPad StatMate 2.

Clinical Study:

This study consists of groups of primary anterior teeth between the age of 3-5 years children were selected from the outpatient clinic department of Pedodontics and Public health Faculty of Dental Medicine, Al- Azhar University.

Eligibility Criteria ⁽¹⁶⁾

Inclusion criteria: Children within the age of 3-5 years, children and parents' acceptance and cooperation, non-vital primary anterior teeth that need to be maintained in the arch and primary anterior teeth indicated for pulpectomy without root resorption.

Exclusion criteria: Evidence of internal root resorption, presence of periapical radiolucency, and tooth close to the normal shedding.

Patient classification:

The selected teeth were classified according to obturating materials into three equal groups; each group was formed of the 12 teeth, as follows:

1. **Group (A):** pulpectomized teeth received Metapex as filling material.
2. **Group (B):** the teeth in this group received a mix of Metapex with AGS.
3. **Group (C):** the teeth roots in this group were filled apically with Colla Cote and then Metapex.

Intervention

Pulpectomy procedure ⁽¹⁶⁾

1. Tooth isolation with rubber dam isolation after local anesthesia administration
2. The necrotic pulp tissue was removed using a spoon excavator & barbed broaches and root canal and the cavity outline form was established.
3. The root length was determined using a diagnostic radiograph and the root canal was prepared 2-3 mm short than the radiographic apex.

4. Copious irrigations with 5% NaOCl and normal saline were carried out to aid in removing debris.
5. The canals were dried with sterile paper points and the obturating material was filled using a pre-packed syringe.

Root canal obturation

1. **Group A:** Metapex (META-BIOMED CO., LTD South Korea) was introduced directly into the prepared root canals from the pre-packed syringe. The tip was placed into the canal, as close to the apex as possible. The paste was pressed down into the canals, slowly withdrawing the syringe till it flowed back into the pulp chamber and the syringe will then completely withdrawn. A moist cotton pellet was used to lightly tap the material into the canals.
2. **Group B:** A strip of Metapex with approximate dimensions of 2 mm × 2 mm × 10 mm was dispensed on a sterile glass slab directly from the syringe without the carrier tip. AGS (GELITA MEDICAL GmbH Eberbach, Germany) of dimensions 2 mm × 2 mm × 5 mm was minced with a surgical blade and mixed with the dispensed Metapex on the glass slab with a stainless-steel spatula until a thick, uniform, and homogenous mix was obtained. An endodontic plugger of appropriate size was used to pack this mix into the canal in the apical third. Consecutive increments were added until the canal was assumed to be adequately filled and a moist cotton pellet was used to lightly tap the material into the canals.
3. **Group C:** Colla Cote (Botiss biomaterials GmbH Hauptstraße 28/155806 Zossen/Germany) is a type I bovine collagen. After the canal prepared part, a 2-mm square piece of Colla Cote was then placed into the canal and condensed to the final working length via the endodontic plugger, and the obturation was performed with Metapex.

The success rate criteria ⁽¹⁷⁾

Clinical criteria:

Absence of spontaneous pain, absence of tenderness to percussion, no abnormal mobility, and absence of swelling and sinus or fistula

Radiographic criteria:

No material extruded beyond the apex, no evidence of pathologic root resorption, and no apical radiolucent areas.

If any item in the previously mentioned criteria of success was not fulfilled, the case was considered a failure. According to tooth condition, the failed teeth retreated with suitable primary teeth therapy (Fig. 1).

Statistical Analysis

The significant differences between any two groups were assessed by Student's *t*-test. The differences between multiple groups were assessed by one-way analysis of variance (ANOVA) followed by Fisher's exact test. Values of $P \leq 0.05$ were considered significant. These analyses were done using SPSS 22.0 statistical software.

Ethical consideration

This study was approved by the Ethical Committee (EC Ref NO. 548/3120) of the faculty of Dental Medicine, Boys, Cairo, Al-Azhar University. Written parental informed consent was obtained as prescribed by national guidelines before they were included in the study.

RESULTS

Table (1) represents sample distribution based on the number of children and number of teeth treated. The ages of enrolled children (36) in this study were 3-5y. old. The mean ages of children for groups A, b & C were 4.33 ± 0.4924 , 4.50 ± 0.42 & 4.33 ± 0.492 years old respectively. On comparing, it was found that there were statistically non-significant differences [$P > 0.05$] between the three groups regarding the mean of age. However, twenty children (55%) of the enrolled children were females, their ages average $4.57 \pm .49765$ years while sixteen out of them (45%) were males and their ages were $4.39 \pm .63819$ y. It was found that there is no significant difference ($p = 0.314$) between the ages of the males and females. Moreover, it was found that there was no statistically significant difference between gender distributions in the three groups.

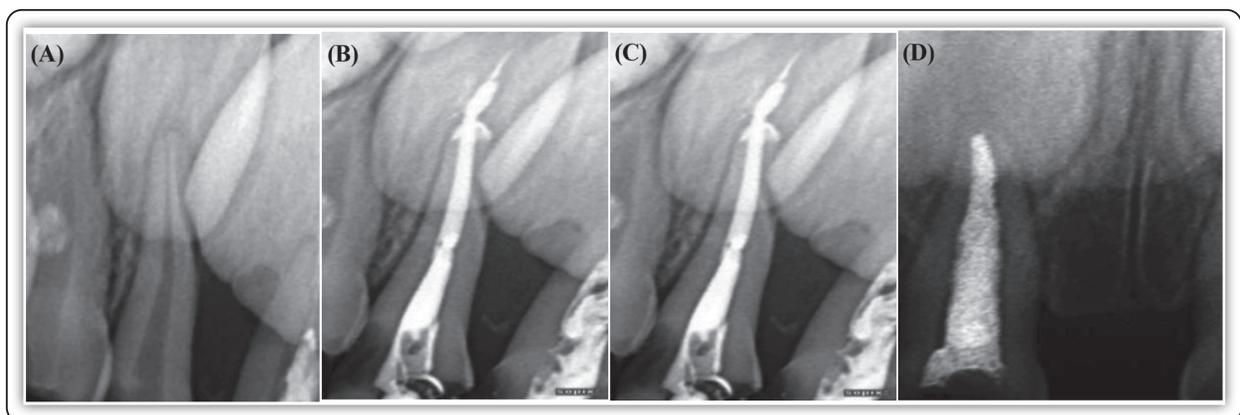


FIG (1) Metapex/Colla Cote pulpectomy (A) Pre-operative and initial length (B) Immediate post-operative (C) 1week follow-up (D) After 3 months follow-up

TABLE (1): Comparison between the three studied groups regarding age and gender

Character	Group A	Group B	Group C	Sig.
Age	4.33± 0.4924	4.50± 0.42	4.33±0.492	p1=0.373 p2=1.0 p3=1.0
Gender	4 (33.3%)	8 (66.7%)	4 (33.3%)	p1=0.102 p2=1.0 p3=0.102
Male no (%)				
Female no (%)	8 (66.7%)	4 (33.3%)	8 (66.7%)	p1=0.102 p2=1.0 p3=0.102

F: ANOVA-test

P1: the difference between group A & group B P2: the difference between group A & group C P3: the difference between group B & group C

Clinical evaluation:

The presence of pain, tenderness, tooth mobility, and swelling were assessed preoperative, immediately postoperative, and after 3 months of the treatment.

1. Pain

Regarding tooth pain, table 2 demonstrated that:

All children's teeth in Group (A) suffered from pain immediately post-treatment. While after one week follow up the number of teeth decreased to 8 primary anterior teeth and at three months follow up all teeth did not suffer from any pain.

Only four teeth suffered from pain in (B) immediately post-treatment. However, at one week and three months follow up all primary anterior teeth did not suffer from any pain.

In group (C) immediate post-operative, all primary anterior teeth suffered pain, while at one-week follow-up 4 primary anterior teeth suffered

from pain, and at three months follow up no one tooth suffered from any pain.

2. Tenderness

Regarding tenderness Table (2) showed that:

In group (A) at immediate time post-treatment, all primary anterior teeth suffered from tenderness, while at one week follow up 8 primary anterior teeth suffered from tenderness. However, at three months interval, all primary anterior teeth did not suffer from tenderness.

In group (B), only 4 primary anterior teeth suffered from tenderness, while at one week and three months follow up all primary anterior teeth did not suffer from tenderness.

In group (C), 8 primary anterior teeth suffered tenderness, while at one week follow up 4 teeth suffered from tenderness, and at three months follow up all primary anterior teeth did not suffer from tenderness.

TABLE (2): Comparison between the three studied groups concerning pain and tenderness at different times.

Character	Intervals	Criteria presence	Group A	Group B	Group C	Sig.
Pain	Immediate	No	0 (0.0%)	8 (66.7%)	12 (100.0%)	P1=0.000
		Yes	12(100.0%)	4 (33.3%)	0 (0.0%)	p2=1.000
						p3=0.000
	1 week	No	4 (33.3%)	12 (100.0%)	8 (66.7%)	p1=0.001
		Yes	8 (66.7%)	0 (0.0%)	4 (33.3%)	p2=0.001
						p3=0.106
	3 months	No	12 (100.0%)	12 (100.0%)	12 (100.0%)	p1=1.000
		Yes	0 (0.0%)	0 (0.0%)	0 (0.0%)	p2=1.000
						p3=1.000
Tenderness	Immediate	No	0 (0.0%)	8 (66.7%)	4 (33.3%)	p1=0.000
		Yes	12 (100.0%)	4 (33.3%)	8 (66.7%)	p2=0.05
						p3=0.05
	1 week	No	4 (33.3%)	12 (100.0%)	8 (66.7%)	P1=0.000
		Yes	8 (66.7%)	0 (0.0%)	4 (33.3%)	p2=0.05
						p3=0.05
	3 months	No	12 (100.0%)	12 (100.0%)	12 (100.0%)	p1=1.000
		Yes	0 (0.0%)	0 (0.0%)	0 (0.0%)	p2=1.000
						p3=1.000

p1, Comparison between group (A) and group (B)

p2, Comparison between group (A) and group (C)

p3, Comparison between group (B) and group (C)

1. Tooth mobility

Regarding tooth mobility, Table (3) that:

In up (A) at immediate post-treatment interval 5 primary anterior teeth suffered from tooth mobility, while at one week 4 follow up primary anterior teeth suffered from mobility and at three months follow up all primary anterior teeth did not suffer from mobility.

In group (B) at the immediate interval, only 4 primary anterior teeth suffered from tooth mobility, while at one week and three months follow up all primary anterior teeth did not suffer from mobility.

In group (C) at the immediate interval, only 4 primary anterior teeth suffered from mobility, while at one week and three months follow up all primary

anterior teeth did not suffer from mobility.

2. Swelling

Table (3) regarding swelling it was found that:

In group (A) at the immediate interval, only 4 primary anterior teeth suffered from swelling, while at one week and three months follow up no one tooth suffered from swelling.

In group (B) however, all primary anterior teeth at immediate, one week, and three months follow up did not suffer from swelling.

In group (C) at the immediate interval, 4 primary anterior teeth suffered from swelling, while at one week and three months follow up all primary anterior teeth showed no swelling.

TABLE (3) Comparison between the three studied groups regarding mobility and swelling at different periods.

Character	Intervals	Criteria presence	Group A	Group B	Group C	Sig.
Mobility	Immediate	No	7 (58.3%)	8 (66.7%)	7 (58.3%)	p 1 = 0 . 6 9
		Yes	5 (41.7%)	5 (41.7%)	4 (33.3%)	p 2 = 1 . 0 0 p3=0.69
	1 week	No	8(66.7%)	12 (100.0%)	12 (100.0%)	p 1 = 0 . 0 5
		Yes	4 (33.3%)	0 (0.0%)	0 (0.0%)	p 2 = 0 . 0 5 p3=1.00
	3 months	No	12 (100.0%)	12 (100.0%)	12 (100.0%)	p 1 = 1 . 0 0
		Yes	0 (0.0%)	0 (0.0%)	0 (0.0%)	p 2 = 1 . 0 0 p3=1.00
Swelling	Immediate	No	8 (66.7%)	12 (100.0%)	8 (66.7%)	p1=0.05
		Yes	4(33.3%)	0(0.0%)	4(33.3)	p=0.05 p=1.00
	1 week	No	12 (100.0%)	12 (100.0%)	12(100.0%)	p 1 = 1 . 0 0
		Yes	0 (0.0%)	0 (0.0%)	0 (0.0%)	p 2 = 1 . 0 0 p3=1.00
	3 months	No	12 (100.0%)	12 (100.0%)	12 (100.0%)	p 1 = 1 . 0 0
		Yes	0 (0.0%)	0 (0.0%)	0 (0.0%)	p 2 = 1 . 0 0 p3=1.00

*ANOVA-test**P1: the difference between group A & group B**P2: the difference between group A & group C**P3: the difference between group B & group C***Radiographic evaluation**

Table (4) the cases were considered successful radiographically when demonstrated no signs of radiolucency, or resorption, nor the materials were extruded beyond the apex.

Regarding periapical radiographic x-ray, it was found that:

In group (A) immediate post-operative, all filled primary anterior teeth showed the Metapex material extrusion beyond the apex, while at three months follow up all materials that extruded beyond the apex were resorbed.

In group (B) at immediate and three months, all

primary anterior teeth did not extrude beyond the apex.

Group (C) at immediate post-operative, all primary anterior teeth showed the materials were extruded beyond the apex, while at three months follow up all materials that extruded beyond the apex were resorbed.

The pulpectomies were considered successful radiographically when there is no internal root resorption or periapical radiolucency. All filled teeth in groups (A), (B) & (C) showed no internal root resorption or per apical radiolucency throughout the study periods. Hence there are no significant differences between all groups at the three intervals (Tab.5).

TABLE (4): Comparison between the three studied groups according to material extruded beyond the apex and different periods.

Character	Intervals	Group A	Group B	Group C	P
Immediate	Optimum obturation	0 (0.0%)	12 (100.0%)	4 (33.3%)	P1=0.000 p2=0.000 p3=0.007
3 months	Optimum obturation	12 (100.0%)	12 (100.0%)	12 (100.0%)	p1=1.000 p2=1.000 p3=1.000

TABLE (5): Comparison between the three studied groups refers to the radiographic success rate.

Character	Group A	Group B	Group C	Sig.
Evidence of internal root resorption	0 (0.0%)	0 (0.0%)	0 (0.0%)	Ns
Presence of peri-apical radiolucency	0 (0.0%)	0 (0.0%)	0 (0.0%)	Ns

DISCUSSION

Endodontic treatment has significantly evolved in the past 20 years. New equipment and techniques to treat root canal systems are continually being introduced into the market, and researchers are striving to create innovative products. The success of endodontic therapy depends on many factors as biomechanical preparation, adequate irrigation, and obturation with a 3D fluid tight seal. For biomechanical preparation, there have been dramatic changes in protocol and armamentarium. However, not much progress has been made in obturation techniques in primary teeth. The greatest challenge in primary tooth pulpectomy is canals' obturation. The complex nature of the root canal morphology of primary teeth and the consistency of the available obturation materials make it difficult to achieve optimum obturation. The ideal obturating technique should ensure a good apical seal without underfilling or overfilling⁽¹⁶⁻¹⁸⁾.

Metapex is the most popular obturating material used for pulpectomy of primary teeth because it has many advantages such as, it has no toxic effect on

permanent successor tooth, good antiseptic action, adhering well to the canal walls, does not set to a hard mass, resorption occurring at a slightly faster rate than root, radiopaque so better radiographic visibility. But due to its low viscosity, it extruded beyond the apex resulting in over obturation, this leads to some negative effects such as pain, tenderness, mobility, and swelling. In addition, it causes discoloration of teeth because it contains iodoform which is characterized by rapid elimination by organism leaves behind empty spaces inside the root canal, which may undermine the success of the endodontic therapy⁽¹⁷⁾.

To achieve optimum obturation, it becomes essential to either provide an apical barrier to minimize this extrusion or to increase the viscosity of the existing material to such a degree that there is minimal or no extrusion. Literature is scarce concerning the modification of obturation materials or techniques in the primary teeth. In this context, it becomes imperative to identify a potentially ideal material that can ensure a good apical seal. Coll Cote which is a type1 of bovine collagen used as a biological barrier and is also used as a scaffold for

bone growth and so can apply to the wound. Colla Cote diminishes extravasation of root canal filling material during pulpectomy of primary anterior teeth, but does not completely prevent extruding the Metapex through the canals⁽¹⁹⁾.

Absorbable gelatin sponge (AGS) is a unique material commonly used in surgical fields to achieve hemostasis. It is sterile and biologically inactive^(20, 21). The use of Metapex manipulated with AGS to adjust the viscosity of the paste is a novel approach for obturation in primary teeth. The present study evaluated different obturating materials as biological barriers in the quality of obturation of pulpectomized primary anterior teeth, clinical, and radiographic.

At immediate post-operative intervals: group (A) showed no tooth had clinical success; this result may be due to the material extruding beyond the apex which was obvious by the periapical radiograph. While after 1 week the clinical success increased to 33%, this is due to partial absorption of extruded Metapex beyond the apex. After 3 months of follow-up, the periapical radiographs showed complete absorption of the extruded material hence the clinical and radiographic success rates were 100%. These results were in agreement with the study of Nurko and Garcia-Godoy 1999⁽²²⁾ who reported that resorption of extruded Metapex took from 1 to 2 weeks up to 2 to 3 months. Also, these results came compatible with Kakade et al., 2019⁽²³⁾ who evaluated the quality of obturation in root canals filled with iodoform-calcium hydroxide (Metapex) premixed paste which exhibited 38.88% optimum obturation.

At immediate post-operative intervals: group (B) showed (66.7%) clinical success. This high success rate may be referred to the fact that the material did not extrude beyond the apex, which was confirmed by a periapical radiograph. These results were compatible with Kakade et al., 2019⁽²³⁾ who evaluated the quality of obturation in root canals filled with iodoform-calcium hydroxide (Metapex) premixed paste and Metapex with AGS (MAGS) in

primary molars. There was a statistically significant difference between Metapex and MAGS groups in achieving optimum obturation ($P < .001$). MAGS and Metapex exhibited 86.65% and 38.88% optimum obturation respectively. The overfilling of root canals effectively reduced from 38.88% to 4.44.

At immediate post-operative intervals: group (C) showed zero clinical success rate, this result can be attributed to extrusion of the material beyond the apex in all teeth, observed by periapical radiograph. While after 1 week follow up the clinical success was raised to 66.7% and after 3 months follow up the clinical success was 100% due to the complete absorption of material being extruded beyond the apex, which was confirmed by periapical radiograph. These results were compatible with Johnson et al., 2006⁽²⁴⁾ who advocated the plugging of Colla Cote in the apical 3rd. In their findings, they reported an overfill in only 16% of Colla Cote-treated root canals and 42% of non-Colla Cote-treated canals.

In the present study, we altered the viscosity of Metapex using AGS to control the extrusion of material beyond the apex. The results of these novel techniques were quite striking, Immediate, there was a statistically significant difference in mean Material extruded beyond the apex. Metapex/AGS showed 100% optimum obturation. Metapex and Metapex / Colla Cote showed a higher mean Material extruded beyond the apex 12 (100.0%) and 8 (66.7%) respectively.

Brar et al., 2019⁽²⁵⁾ 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. The least success rate was observed with Metapex having the hollow tube effect in the majority of the cases (70%) after the follow-up of 12 months. Overfilling with Metapex is due to the thinner consistency of the premixed paste which is dictated by the manufacturer. While this may allow the material to fill the narrow and tortuous canals, it also results in extrusion of the material beyond the apex, lateral canal, or through strip

perforations. Teeth with such anatomical variations or procedural errors, when obturated with Metapex/AGS exhibited a highly controlled extrusion of the paste, thus averting the overspill of the material into the peri-radicular area. A probable reason for these results could be the “tamponade effect” caused by the mixture of Metapex and AGS at the apex of the tooth. When Metapex / AGS comes into contact with periapical fluid, the AGS in the mixture swells up by absorbing the fluid, resulting in the proposed tamponade seal, thus preventing extrusion of material into the periapical region. Restricting the obturation material to the radiographic apex while effectively filling the root canals of primary teeth with a biocompatible material is the need of the hour. The quality of filling in root canals of primary teeth is dependent on factors like obturating technique, viscosity, consistency of obturation material, length and curvature of root canals, and size of the apex^(25,26). Considering these factors, using the incremental technique, we infer that Metapex/AGS gives the optimum obturation due to the tamponade effect.

CONCLUSION

1. The addition of AGS and cola cote to Metapex considerably alters the viscosity of the material, which in turn decreases Metapex extrusion hence increasing the success rate, especially in the early periods of follow-up.
2. Optimum obturations without extrusion have increased the quality of fillings and thus they have greater chances of success in endodontic treatment in children.
3. Although Metapex mix with both AGS and Cola Cote are promising materials, specially AGS that showed maximum optimum obturations in primary teeth but longer and wider sample investigations of Metapex mix with AGS and cola cote are required to investigate their implications on the periodontium and underlying successor tooth germ.

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