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Comparing the bonding strengths among three types of intra radical posts using push-out test: Laboratory study

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Abstract
Background: One of the major challenges that face any pediatric dentist is restoration the highly dilapidated primary anterior teeth**.** Conventionally, endodontic treatment must be performed before the restoration procedure. The root canal filling materials tend to prevent the adhesion between the synthetic resin, the restorative material, and dental surfaces. Several studies have confirmed that there are no negative effects of Eugenol on the bonding strength of fibrous posts which have been fixed with resinous compounds.
The aim of this study: Evaluating the effect of different materials used in filling the root canal on the bonding strength using three types of posts in the primary anterior teeth.
Materials and methods: The sample consisted of 135 extracted anterior canines. Vertical sections were made on the longitudinal axis of the tooth until reaching 1 mm higher than the cementoenamel junction. A complete pulpectomy was performed for all of the sample teeth. the sample was divided into three main groups, each of them contains 45 teeth according to the filling material type, group 1: Metapex, group 2: Zinc oxide and Eugenol paste immediately, Group3: Zinc oxide and Eugenol paste after 1 week, also, three types of posts were used to construct the teeth (short composite posts SCP, glass fiber posts GFP with flow composite, glass fiber posts with risen cement). All teeth were kept in Saline solution before the push-out test was performed by the Mechanical Test Machine. The results were statistically studied with both ANOVA and Bonferroni test.
Results: The values of the bonding strength were greater when using METAPEX than when using Zinc oxide and Eugenol paste before and after solidification in all groups of posts, but with significant differences only in the short composite posts group (SCP).
Conclusion: The use of zinc oxide and Eugenol paste as a root canal filling material resulted in a clear decrease in the attachment strength values of the various intra radical posts in the primary anterior teeth.

Keywords: Primary teeth, dental caries, metapex, zinc oxide, eugenol paste, post and core technique, composite resin

Introduction
Even though parents prefer to restore their children's primary anterior teeth rather than replace them with devices after the extraction, the process of repairing them remains a challenge for pediatric dentists [1]. Because the available materials in this field are still not sufficient, and usually the children who need these treatments are uncooperative. Also, the primary teeth crowns are usually short and narrow, and the process of bonding with primary teeth is more difficult than in permanent teeth. Therefore, many of these teeth are not restorable and extraction may be indicated [2].
This problem is most often seen in kids with bottle feeding caries as it particularly includes the upper anterior teeth [3]. This caries can lead to many complications and problems, including cosmetic problems, speech problems (where speech develops in children between the age of 1 -3 years), in addition to the emergence of abnormal tongue habits that may also lead to the development of malocclusion [4].
Accordingly, appropriate restoration should be made to these teeth, which have lost a large portion of its dental tissue. Many methods have been developed over the years to increase the stability of these restorations, such as short composite posts, fibrous posts such as polyethylene and glass fiber posts, metal posts, orthodontic wrist posts in the form of Alfa or Omega or half Omega [5, 7].

Conventional procedures include endodontic treatment of the primary, severely dilapidated, anterior teeth must be performed before beginning any restorative or compensative procedure [8].

In 1930 Zinc oxide and Eugenol paste were introduced by SWEET as the first root canal filling material for the primary teeth, and it is also called ZOE paste which is one of the most used materials in the root canal filling for primary teeth [9].

Similarly, several studies have been published in Korea and Japan on the use of a mixture of Calcium and Iodoform water as a root canal filling for primary teeth under the name (Vitapex) or Metapex, and according to the results of Machida, the criteria for this mixture were close to Ideal material standards for the root canal filling for primary teeth [10].

The root canal filling materials tend to prevent the adhesion between resin materials and dental surfaces [11].

Several studies confirmed the presence of negative effects of eugenol on the bonding strength of fiber posts which has been bond by resinous compounds [12, 13]. However, other studies denied the existence of these effects [14]. The effect of eugenol on the bonding strength of the intra radical posts is not yet clear [11].

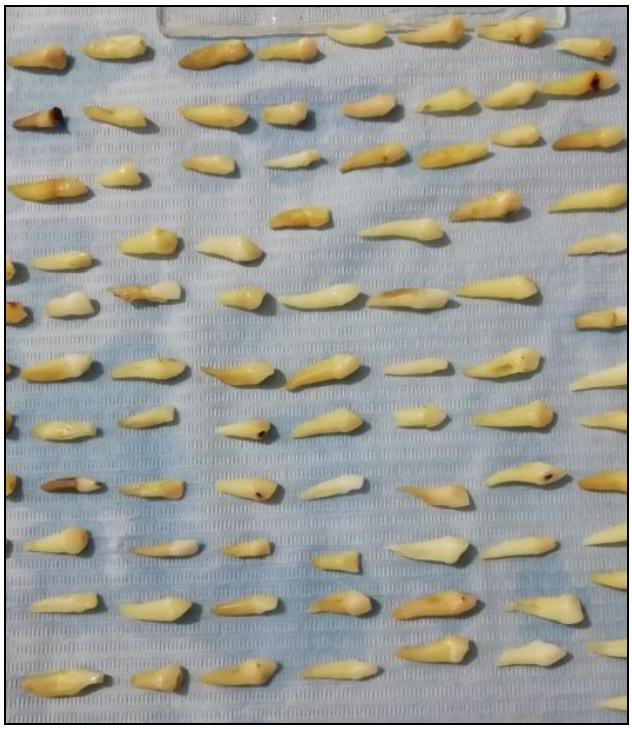
The aim of the research

Evaluating the effect of different materials used in root canal filling of the primary anterior teeth on the bonding strength of three types of posts using the push-out test.

Materials and methods

Study design: A comparative laboratory study to evaluate the bonding strength using the push-out test for different intra-radical posts on the primary anterior teeth depending on the filing material type used in the root canal.

Sample size: The research sample consisted of 135 primary anterior canines that were divided into three equal main groups according to the used filling material (METAPEX material, Zinc oxide Eugenol paste before curing, Zinc oxide Eugenol paste one week after curing) - Figure 1, also, three types of posts were used to construct the teeth (short composite posts SCP, glass fiber posts GFP with flow composite, glass fiber posts with risen cement).



Part of the study sample.

Fig 1: Part of the study sample

Research procedure

Teeth preparation: After washing, cleaning, and disinfection (using chloramine solution), all caries were removed from the teeth, using a spherical bur on a slow speed rotation.

Vertical sections were made on the longitudinal axis of the tooth using a high-speed turbine grip with water cooling until reaching 1 mm above the cementoenamel junction (CEJ).

The dental pulp was removed and then the filing and expansion process began for all the sample teeth with abundant irrigation using the saline solution between each file and the other, until reaching file 45 at the apical foramen, considering that the root canal of the primary anterior teeth is wider than the root canal of the primary posterior teeth.

4 mm of the coronal portion of the root canal filling was removed by a spherical bur on a handgrip at slow speed, and the root canal filling material was isolated from the allocated distance for the post building with a 1 mm layer of flowable composite. Accordingly, the distance allocated for the post building is approximately 3 mm.

The push-out test procedure: Initially, cold acrylic models were made to fix the sample teeth on them. After making the models, circular holes were made on each acrylic model so that the diameter of the hole is slightly greater than the diameter of the post in order not to impede the movement of the post outside the tooth.

Then each of the teeth of the sample was fixed temporarily perpendicular to the acrylic model and in a way that suits the pre-made holes for the possibility of a correction in case of need, then the permanent fixation was made using cold acryl

and the thickness did not exceed 3 mm.
After obtaining the teeth fixed on the acrylic models, vertical sections were made on the longitudinal axis of the tooth starting from the tooth apex and in slices form with a less than 1 mm thickness and so on until reaching the beginning of the required post (from the apex) – Figure 2.
thus, we have obtained one slide with a 3 mm thickness fixed within the acrylic model, which represents the length of the post, and then the cross-section piston heads and the rounded head that has been attached to the universal testing machine were directed so that it is placed at the apical end of the post and goes directly to the center of it, then load test was applied at 1 mm/min speed until the post has fully extruded and values were recorded for each sample using newton measure – Figure 3.

Fig 2: After making cross-sections on the longitudinal axis of the tooth until reaching the post

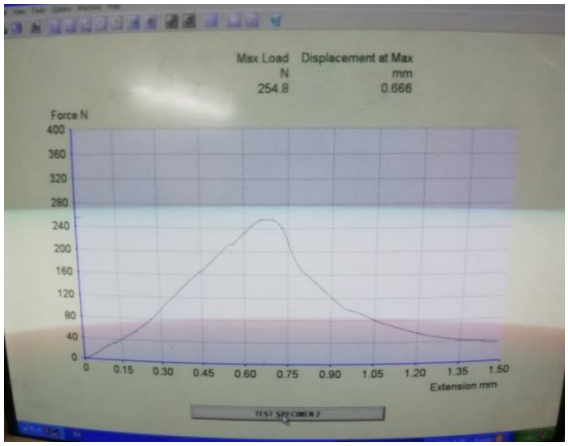


Fig 3: One of the values recorded on the computer in Newton.

Results

1. Sample distribution according to the root canal filling material

(Table N. 1) represent the distribution of the sample according to the type of the root canal filling material, where the sample is 135 teeth and was divided equally into 3 groups according to the root canal filling material.

Studying the effect of the root canal filling material on the values of the bonding strength to the push-out test according to the type of the used post

A one-sided contrast analysis test (ANOVA) was performed to study the significance of differences in the strength of the bonding force with the push-out test between the three groups of the root canal filling material studied (METAPEX, Zinc oxide and Eugenol before curing, Zinc oxide and Eugenol after one week of curing) in the study sample.
(Table N. 2) shows the mean, the standard deviation, the standard error, and the significance of the differences for the values of the bonding force with the push-out test according to the used material and the type of post used.
The results showed that there were no statistically significant differences in both the glass fiber post group GFP which fixed with the flow compost (P = 0.148) and the glass fiber post group GFP which fixed with resin cement (P = 0.091), while the differences were statistically significant in the short composite post group SCP (0.041). (Table N. 2)
To find out which of the groups of the root canal filling material differs fundamentally from the other two groups in the values of the bonding strength using the push-out test, a binary comparison was made using the Bonferroni method to study the significant difference in the values of the bonding strength with the push-out test between the three groups of used root canal filling material (METAPEX, Zinc oxide, and Eugenol before curing, Zinc oxide and Eugenol after one week of curing) in the short composite post group of the study sample.
(Table N. 3) shows the results of the binary comparison Bonferroni method to study the significance of the bilateral differences in the values of the bonding strength with the push-out test between the three groups of used root canal filling material (METAPEX, Zinc oxide Eugenol before curing, Zinc oxide and Eugenol after one week of curing) in the short composite post group of the study sample.
(Table N. 3) shows that there are statistically significant differences when comparing the values of the bonding strength of the push-out test (mg/ml) between the METAPEX group and the zinc oxide and eugenol ZOE before curing (P = 0.043). Statistically significant differences (P = 0.238, 1.000), respectively.

Discussion

The bonding strength of the resin compounds to the dental surfaces and the posts inside the root can be affected by the type of the root canal filling material [15]. Many studies have evaluated the effect of the root canal filling material and their compounds on the stability of the posts within the root, where the results showed a decrease in the stability of these posts which were fixed to resin cement in the canals that were filled with filling materials containing eugenol [16, 17].
In this study, the values of bonding strength when using METAPEX were greater compared to using zinc oxide and eugenol ZOE before curing and after curing, but without significant statistical differences.
However, in the push-out test it was found that the values of the bonding strength were greater when using METAPEX compared to the zinc oxide and eugenol ZOE before curing, with significant statistical differences, but no significant differences when comparing the zinc oxide and eugenol ZOE after curing.
The results of this study agree with another study which compared the effect of the application of calcium hydroxide and zinc oxide and eugenol ZOE as filling material of the root canal on the strength of the posts bonding with the dentin surfaces of the root canal and found that the bonding strength was greater and with significant statistical differences when using calcium hydroxide Compared to the use of zinc oxide and eugenol ZOE [13].

More studies confirmed and supported these results, as they found negative effects of eugenol on resin compounds because eugenol had caused a change in the chemical and physical properties of these resin compounds [15, 18].

The results of our study also agree with another study which studied the effect of three types of root filling materials (AH-plus resin, zinc oxide, and eugenol ZOE, the Metapex) on the bonding strength of the push-out test on 50 posts that has been fixed by the resin cement. It was observed that the values of the bonding strength of the posts were at their lowest level when using zinc oxide and eugenol ZOE as a root canal filling material compared to other filling materials [19].

Besides, a decrease in the bonding strength of resin adhesion systems when primary cement was used between sessions that contained eugenol [17].

Chelation reaction was also found when zinc oxide was mixed with eugenol, as the molecules formed from the zinc oxide absorbed in a model of zinc eugenols make the release of eugenol possible [19].

Also, due to the presence of fluids within the dentin ducts, the previous reaction can become reversible and this means the release of eugenol and its concentration in the surface between the tooth and the resin compounds, which leads to a decrease in the values of the bonding strength of the different posts [20]. Cohen also noted that eugenol negatively affects the curing process of resin compounds [21].

The results of our studies also coincided with the results of (Alfredo 2006) who compared the use of zinc oxide and eugenol ZOE as a root canal filling material and not using it on the bonding strength with the tensile test of 24 root posts that were fixed to the two bonding systems, the first: zinc phosphate cement and the second: resin cement, and they noticed a very significant negative effect of eugenol on the curing of the resin compounds [20].

This was confirmed by Tjan and his colleagues, where they observed a direct negative effect of eugenol on the resin-based materials, and recommended not to use the materials that contain in its composition on eugenol with resin cemen [22].

According to the results of this study, it was found that the values of the bonding strength with the push-out test when using zinc oxide and eugenol ZOE after curing were greater than when using ZOE paste before curing but no significant statistical differences were found.

This can be explained by the fact that it was found in some studies that when the post fixing process took place a week after the endodontic filling with zinc oxide and eugenol ZOE, a clear decrease in the negative effects of eugenol on the resin compounds was observed (but it did not disappear at all) compared to fixing the post immediately after the endodontic filling with zinc oxide and eugenol ZOE [18, 23].

Also, Vano M 2006 compared the bonding strength of the intra root posts if they were fixed to three time periods (immediately after the root canal filling, after 24 hours, after 7 days), the result of the study concluded that the longer the fixed posts were delayed the greater the strength of the bonding between the post and the dentin [18].

However, the immediate restoration process has many benefits, including reducing the risk of Coronally edge leakage, and restoration takes place in the same session and this is what is seen when restoring primary anterior teeth in young children under general anesthesia that usually requires one session [12].

Boone and colleagues also found in their study that there was no effect of the root canal filling material type on the stability of the intra radical posts [24].

The difference in results with other studies can be explained by the following work method; the sample, the root canals preparing method, irrigation time and technique preserving sample period, the technique of applying the resin, the period between the filling the root canal and fixing the post, the length of the post [26, 25, 14].

The stability and fixity of the post within the root with the periodontal tissues depend on many factors, including Anatomical characteristics of the tooth, length, and shape of the post, type of the root canal filling material, technique of preparing the location of the post, and the physical and chemical properties of the materials used for fixin [27].

Conclusions

Within the limits of this study and the results obtained, the following can be concluded:

- There is a relationship between the type of root canal filling material and the values of the bonding strength of the different intra root posts.
- The values of the bonding strength of the root posts when applying Metapex were greater than when applying zinc oxide and eugenol before curing.
- A slight improvement in the bonding strength values of the root posts was observed when applying Metapex compared to the application of zinc oxide and eugenol after curing.
- A slight improvement in the bonding strength values of the root posts was observed when applying zinc oxide and eugenol after curing compared to applying zinc oxide and eugenol before curing.
- Eugenol has negative effects on the bonding strength of resin compounds.

Table 1: Shows the distribution of the sample according to the type of the root canal filling material

the root canal filling material	Number of teeth	Percentage
METAPEX	45	33,3%
zinc oxide and eugenol ZOE before curing	45	33,3%
zinc oxide and eugenol ZOE after one week of curing	45	33,3%
Total	135	100%

Table 2: Significant difference between the different filling materials

post type	filling material	Number of teeth	mean	standard deviation	standard error	P-value	significance
Short composite post	METAPEX	15	261,80	115,38	29,79	0.041	significant differences
	zinc oxide and eugenol ZOE before curing	15	183,12	69,69	17,99		
	zinc oxide and eugenol ZOE after	15	206,44	55,93	14,44		

	one week of curing						
Glass fiber postfixed by flow composite	METAPEX	15	208.75	62.49	16.13	0.148	no significant differences
	zinc oxide and eugenol ZOE before curing	15	155.51	60.31	15.57		
	zinc oxide and eugenol ZOE after one week of curing	15	189.86	94.05	24.28		
Glass fiber post fixed by resin cement	METAPEX	15	225.93	69.63	17.98	0.091	no significant differences
	zinc oxide and eugenol ZOE before curing	15	170.83	49.21	12.71		
	zinc oxide and eugenol ZOE after one week of curing	15	219.88	94.53	24.41		

Table 3: Bonferroni correction test to study the significant difference between different materials

post type	filling material (I)	filling material (J)	difference between the two means (I-J)	standard error	P-value	Significance
Short composite post	METAPEX	zinc oxide and eugenol ZOE before curing	78.68	30.77	0.043	significant
		zinc oxide and eugenol ZOE after one week of curing	55.36	30.77	0.238	Not significant
	zinc oxide and eugenol ZOE before curing	zinc oxide and eugenol ZOE after one week of curing	-23.32	30.77	1.000	Not significant

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