Effects of eugenol and non-eugenol endodontic fillers on short post retention, in primary anterior teeth: an *in vitro* study

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The aim of this study was to measure in vitro the tensile bond strength of short composite posts in anterior primary teeth filled with calcium hydroxide and eugenol-based endodontic filling materials. Means of tensile strength ranged from 2.66 to 3.56MPa. Statistical analysis (ANOVA) revealed that there were no statistically significant differences between the groups. It was concluded that the type of filling material used in the endodontic treatment did not interfere with the tensile strength.
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INTRODUCTION

Despite the reports showing decreasing in dental caries prevalence in the primary dentition worldwide, in some population groups it is highly prevalent.[1] Nursing caries in early childhood is still a very common disease, which causes a severe and rapid destruction and affects mainly the upper primary incisors. This disease mostly causes great crown destruction and generally causes pulpal involvement. Another common cause of crown destruction in anterior primary teeth is crown fractures due to dental trauma. For many years extraction was the treatment of choice for primary teeth severely destroyed. However, early loss of primary anterior teeth can cause local disturbances as loss of space, phonetic alterations, reduction of the masticatory capacity, parafunctional habits, which favor malocclusions and psychological problems affecting the self-steam of the child.[2,3] An adequate rehabilitation treatment, which solves functional and aesthetics is still a challenge because there are many techniques indicated, but these are poor in scientific evidence, mainly in physical properties, in special those concerning the use of posts and cores in primary anterior teeth. A previous *in vitro* study[4] analyzed the bond strength of posts in primary anterior teeth and showed that the type of the intra-canal post did not interfere with the bonding of composite resin cores. Hence this study was conducted to evaluate *in vitro* if calcium hydroxide and eugenol-based root filling materials would interfere on the tensile bond strength of composite resin posts and cores in anterior primary teeth and verify the type of failure at resin/dentin interface under tensile tests.

MATERIALS AND METHODS

Forty primary anterior teeth with at least 2/3 of root length, free of caries and with no previous endodontic treatment, extracted for other reasons were used. Teeth were collected from the UFSC Pediatric Department Human Tooth Bank and the UFSC Ethical Committee in human research approved the research.

Teeth were washed in running water and immersed in 10 vol. hydrogen peroxide solution for disinfection. When necessary root surfaces were cleaned with scalpers for removing remained debris. Measures for the root canal length were made by visual observation with a # 15 Flexo-file, which was introduced into the root canal until the point could be observed at the resorption area. Root canals were modeled with first series K-Flexo-files.

Modeling was done in the work length up to # 40 Flexo-file. Each one was used for 15 movements. At the end of each cycle of movements roots were irrigated with a 1% sodium hypochlorite. At the end of the root instrumentation teeth were stored in a saline solution, for 24 hours at 4ºC temperature. Then teeth were randomly divided into four groups (n=10).

In group I, a type I zinc oxide-eugenol cement (SS White) was used as filling material. It was manipulated

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according the UFSC protocol, which consisted in a mixing of 0.5g of zinc oxide powder with 0.4 ml of eugenol.

Roots from group II were filled with the Sealapex cement (Sybron Kerr), which is calcium hydroxide, based cement.

In group III, the UFSC paste was used. This paste is made of 0.3g of calcium hydroxide p.a. powder, 0.3g of zinc oxide and 2ml of olive oil.

Vitapex paste was used as filling material for group IV. The paste is composed of 40.4% of iodoform, 30% of calcium hydroxide and 22.4% of silicon. The filling materials were introduced into the root canals by a lentulo instrument cut 1 mm shorter than the length of the root. A final vertical condensation was made with cotton pallets. Then teeth were sealed with a glass ionomer cement (Vidrion, SS White).

Crowns were cut at approximately 1mm beyond cement-enamel junction with a # 3216 diamond bur (KG Sorensen). Then roots were stored in a humid environment at 37ºC for 48 hours. After this time 4mm of the filling material was removed with a # 3139 bur (KG Sorensen) and with a syringe (Centrix) a new layer of glass ionomer cement (Vidrion, SS White) was put. Roots were again stored in humidity at 37ºC for 24 hours. With a 3 mm # 3139 diamond bur (KG Sorensen) the glass ionomer was removed, so that the CIV layer had 1mm tick and the root cavity with 3 mm. Then the cavities were acid etched with a 37% phosphoric acid gel for 15 seconds, rinsed with a air/water spray for 15 seconds and dried with absorbent paper. Then two layers of the Single Bond adhesive (3M) were applied and each layer photo-cured for 10 seconds. With the composite resin Filtek Z250 (3M) all the root cavity was filled, in small increments, each one photo-cured for 40 seconds. A 10 mm core with the same resin was built.

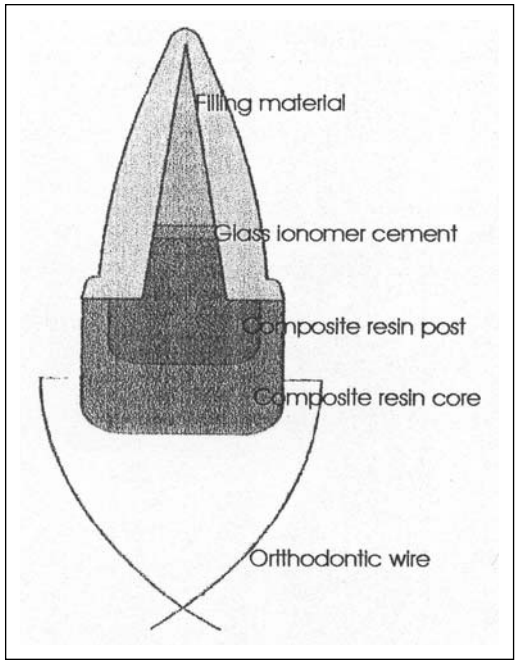

Figure 1. Illustrating the position of the various dental materials in an endodontically treated primary incisor.

A brace made from a 7mm orthodontic wire was inserted at 4mm above the cervical portion of the root to permit the tension tests, Figure 1. All specimens from all groups were inserted in acrylic blocks and the tensile strength tests were measured using a Universal testing machine (Instrom 4444) at a 4mm/mm speed. The tensile strength was calculated as the recorded failure tension removed the posts and cores. Data was expressed in Newton (N) and converted to Mega Pascal (MPa). The 40 values obtained, which corresponded to the bond strength of each specimen were statistically analyzed by ANOVA. The analyses of the type of failure were done under a stereomicroscope with 4X magnificence (Dimex MZS 200). The type of failure was classified in adhesive failure or cohesive to the material. Adhesive failure was considered when the dentin surface did not show any resin adhered to dentin and cohesive failure when there was presence of composite resin into the dentin.

RESULTS

In Table 1 the tensile strength results are presented. The means were 3.56, 2.69, 2.66 and 2.72MPa. These results were analyzed and the one-way analysis of variance (ANOVA) revealed that no statistically significant difference was found between the four groups ($p>0.05$). Analyzing the mean and the variability coefficient of the groups (Table 2) all groups showed good tensile strength with little variability among the specimens.

The Shapiro-Wilk test showed that they were regular (Table 1). The frequency of bond failure type is shown in Table 3 and it shows that the predominant failure pattern was cohesive to dentin (100% in group I, 50% in group II, 60% for group III and 90% for group IV). Cohesive fracture corresponds to 75% of the total of failures. The proportion test showed that there was a statistically significant difference between groups I and II ($p=0.0098$), while there was no statistical significant difference between the other groups.

Table 1. Tensile bond strength in Mpa for all groups.

Group #	Filling material	Mean	Standard deviation	p-Shapiro-Wilk
I	Zinc oxide-eugenol	3.56	1.03	0.4971
II	Sealapex	2.69	1.07	0.5677
III	UFSC paste	2.66	0.39	0.3057
IV	Vitapex	2.72	0.83	0.4631

Table 2. One-way analysis of variance of the tensile bond strength.

Variability	FD	SS	MS	F	P
Between groups	3	5.6759	1.8920	2.4808	0.0766
In groups	36	27.4552	0.7626	-	
Total	39	33.1311	-		

SS-Square sum
ED- Freedom degree
MS-Means sum

Table 3. Frequency of bond failure type.

Group No.	Filling Material	Type of Failure	
		Adhesive	Cohesive
I	Zinc oxide-eugenol	-10	
II	Sealapex	5	5
III	UFSC's paste	4	6
IV	Vitapex	1	9

DISCUSSION

Extensive crown destruction in primary anterior teeth, at an early age is not a rare clinical situation, mainly in those cases of nursing caries and crown fractures resulted from dental trauma. Severely damaged anterior teeth restorations are of difficult task in young children and sometimes intra-canal retention must be done. Rehabilitation of destroyed anterior teeth crowns are made using techniques that associate composite resins, intra-canal posts, biologic and metallic posts that are associated to composite resin crowns.[5-8]

The use of intra-canal posts was introduced around the 80's and shows advantages as no interference in the tooth resorption process, allows restorations with little dental reminiscent structure and good retention and aesthetics. In this *in vitro* study a composite resin post technique was used since according to Pithan, Vieira, Chain[4] the type of the intra-canal post does not interfere in the final retention of a resin restoration.

However, other the authors found a high percentage of adhesive failures when the filling material used in the endodontic treatment was an eugenol-based material. Some reports found in the literature[9,10,12] state that eugenol interferes in the resin polymerization, inhibiting free radicals, blocking the reactivity between the resin and dental tissues. The aim of this research was to evaluate if the filling material used in the endodontic treatment would affect the shear bond strength of the composite resin intra-canal post to root dentin.

Most of the research related to the use of these posts in primary teeth, are isolated reports of clinical cases with no scientific evidence regarding the physical properties. Results of this research showed 40MPa values of tensile bond strength. ANOVA did not show significant statistical difference between the groups ($p>0.05\%$) showing that the root filling materials did not influence in the composite resin intra-canal tensile bond strength of the post. Means of tension ranged from 2.66 (group III) to 3.56MPa (group I). These results are in accordance to those related in the dental literature where the tensile bond strength for primary dentin and composite resin ranged from 2 to 31 MPa.[13,14] These values are influenced by the methodology used, factors related to the tooth, as age, degree of mineralization and type of the test used.

Comparing the values found with those from Pithan, Vieira, Chain[4] group I that used zinc oxide eugenol as filling material, presented a mean traction resistance of 3.56MPa, while they found 2.8MPa. When the type of failure is considered, the group that used zinc oxide-eugenol cement as filling material showed higher adhesive resistance, with means of 3.56MPa, with 100% of cohesive failure. In all groups, cohesive failures were the most found, 75%, in accordance with those found by Sundsangian, Van Noort,[11] but different from those found by Pithan, Vieira, Chain.[4] Some studies[13,15] also did not find the influence of the eugenol on the bond strength of composite resins, as well as related to calcium hydroxide based filling materials.[13,16] This probably is related to the etching procedure, which removes all eugenol and calcium hydroxide content from the dentin, allowing an effective bonding between the dental adhesive and composite resin with the primary dentin. The type of bond failure most commonly found was cohesive to dentin. It suggests that the filling material does not interfere in the adhesion process and that there is a good bond between the adhesive system and the dentin canal walls.

Then clinical failures of this kind of restorations with this type of anchorage might be related not to the bonding system itself, but to the ability of the operator, mainly when done in children with low age and not adequate behavior, and using posts and cores made of composite resin (Filtek Z250, 3M). The samples were submitted to tension in a universal-testing machine (Instron, model 4444). Means of tensile strength ranged from 2.66 to 3.56MPa. Statistical analysis (ANOVA) revealed that there were no statistically significant differences between the groups. On the bases of the results of this *in vitro* study, it was concluded that the type of filling material used in the endodontic treatment did not interfere with the tensile strength and the most frequent type of failure was a cohesive to dentin type, corresponding to 75% of the sample.

SUMMARY

The aim of this study was to measure *in vitro* the tensile bond strength of short composite posts in anterior primary teeth filled with calcium hydroxide and eugenol-based endodontic filling materials. A total of 40 single rooted primary anterior teeth were selected for the study. All roots were endodontically treated and assigned to four groups according the type of root filling material. Group I was filled with Type- I zinc oxide-

eugenol cement; group II was filled with the Sealapex cement; in group III roots were filled with a calcium hydroxide paste and group IV with the Vitapex paste. Four mm of the canal was cleansed and a base of glass ionomer cement was put at the bottom of the prepared canal. The roots were then prepared to receive the intra-canal posts using a # 3139 diamond bur (KG Sorensen) used in a depth of 3mm of the length of the canal. All the prepared roots were acid etched with a 37% phosphoric acid gel for 15 seconds, rinsed, dried and the dentin adhesive Single Bond (3M) was applied. All groups received intra¬canal posts and cores made of composite resin (Filtek Z250, 3M). The samples were submitted to tension in a universal-testing machine (Instron, model 4444). Means of tensile strength ranged from 2.66 to 3.56Mpa. Statistical analysis (ANOVA) revealed that there were no statistically significant differences between the groups. On the bases of the results of this *in vitro* study it was concluded that the type of filling material used in the endodontic treatment did not interfere with the tensile strength and the most frequent type of failure was a cohesive to dentin type, corresponding to 75% of the sample.

CONCLUSIONS

According to the methodology used in this study, we can conclude that:

1. The type of filling material used in the endodontic treatment, either eugenol or calcium hydroxide based material did not influence in the tensile bond strength of Z250 composite resin posts and Single Bond adhesive to primary dentin.

2. The type of failure most found was cohesive to dentin (75%) and in the eugenol group cohesive failures were 100%, which indicates that bonding is not influenced by the type of the filling material.

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