Tensile bond strength of intracanal posts 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 three intracanal posts used in anterior primary teeth. A total of 45 single rooted primary anterior teeth were selected for the study and the crowns sectioned leaving 1mm above the cement-enamel junction. The roots were then assigned to three groups according the type of retention used. All roots were endodonticaly treated, a 4-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 intracanal posts using a # 4137 diamond bur (KG Sorensen) used in a depth of 3-mm 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. Group I received intracanal posts and cores made of composite resin (Filtek Z 250, 3M). Group II intracanal posts were made from a 0.6mm orthodontic wire bent as a Greek letter type (gamma), fixed with the Z 250 composite resin and cores were built with the same composite. Finally Group III received intracanal retention made of a fiber glass post (Fibrekor Post, Generic/Pentron) with 1.25mm diameter, fixed with Z 250 and cores were made like the other groups. The samples were submitted to tension in a universal-testing machine (Instron, model 4444). Statistical analysis (ANOVA) reveled that there were no statistically significant differences between the groups. On the basis of the results of this* in vitro *study it was concluded that the type of intracanal post did not interfere with the tensile strength and the most frequent type of failure was of adhesive type, corresponding to 74% of the sample.*

J Clin Pediatr Dent 27(1): 35-40, 2002

INTRODUCTION

Modern dentistry has a major goal of caries prevention. Pediatric dentistry takes an important role in this process because it has access to patients in early ages.

Baby bottle caries is still a very common disease affecting early childhood, which causes severe destruction of the crowns of teeth. Among the lesions that involve the primary dentition, dental traumatic injury is highly frequent.

For a long time the treatment of choice for primary teeth that were severely destroyed by both caries and trauma, was extraction. However, premature loss of these teeth can cause mastication and phonetic alterations, lack of development of the pre-maxilla leading to malocclusions, establishing para-functional habits and psychological problems affecting the self steam of the child.[1-4] Then, restoration and maintenance of these teeth should be recognized despite that it is a great challenge to restore them with durable restorations in those cases with a severe crown destruction. In those larger lesions where little dental structure is left, conventional restorative procedures have been unsatisfactory and result in the use of prosthodontics appliances.[4,5] In case of severe destruction it is necessary to perform intracanal retention, which allows building a post and core and then cementing an artificial crown. These posts can be built several ways, composite resin posts, the use of orthodontic pins, and biological or natural posts.[1,6-,11]

No study to date has examined the various procedures of these restorations regarding physical and mechanical properties. Hence this study was conducted to evaluate *in vitro* tensile strength of intracanal posts and cores in anterior primary teeth.

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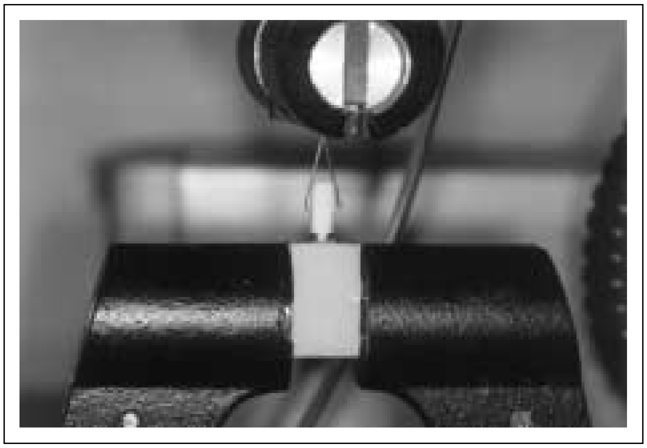


Figure 1. Specimen positioned for tensile bond strength tests.

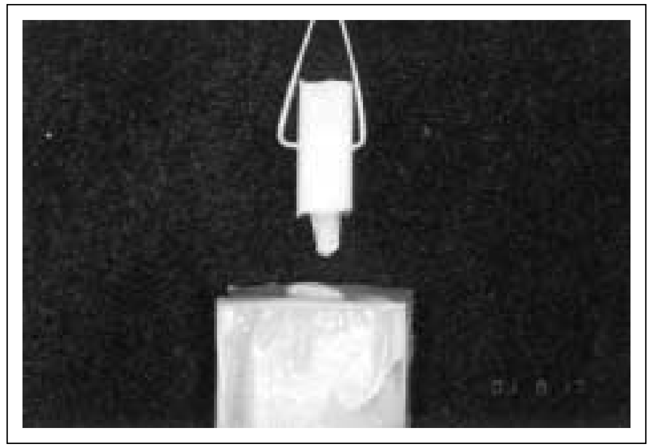
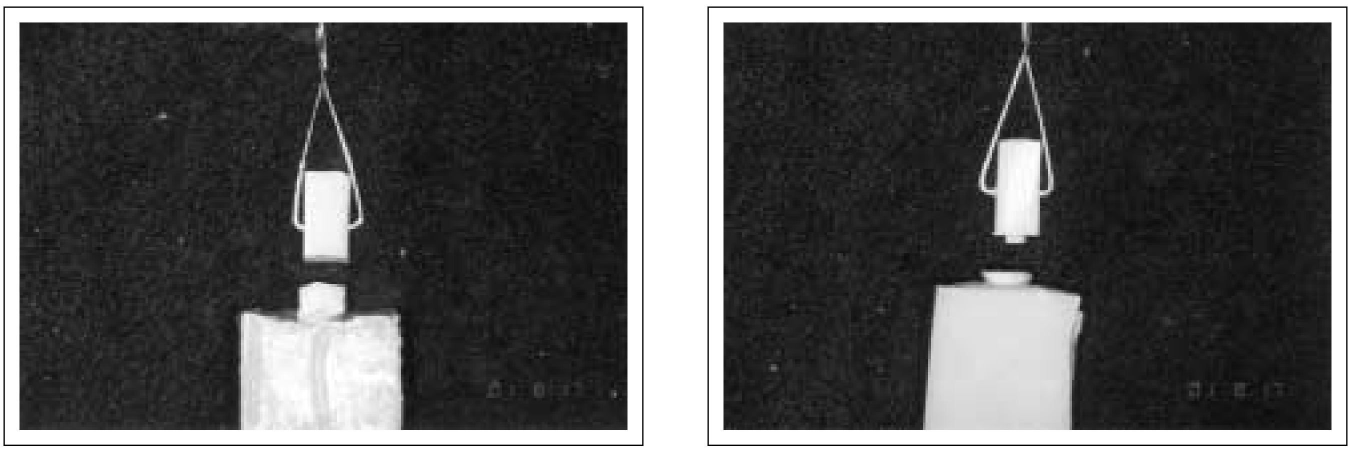


Figure 2 . Adhesive failure with the total removing of the post and core with no composite resin inside the canal cavity.



a) Fracture of the core **b) Fracture of the post**

Figure 3. Cohesive failure, bulk fracture of the post and/or core.

MATERIAL AND METHODS

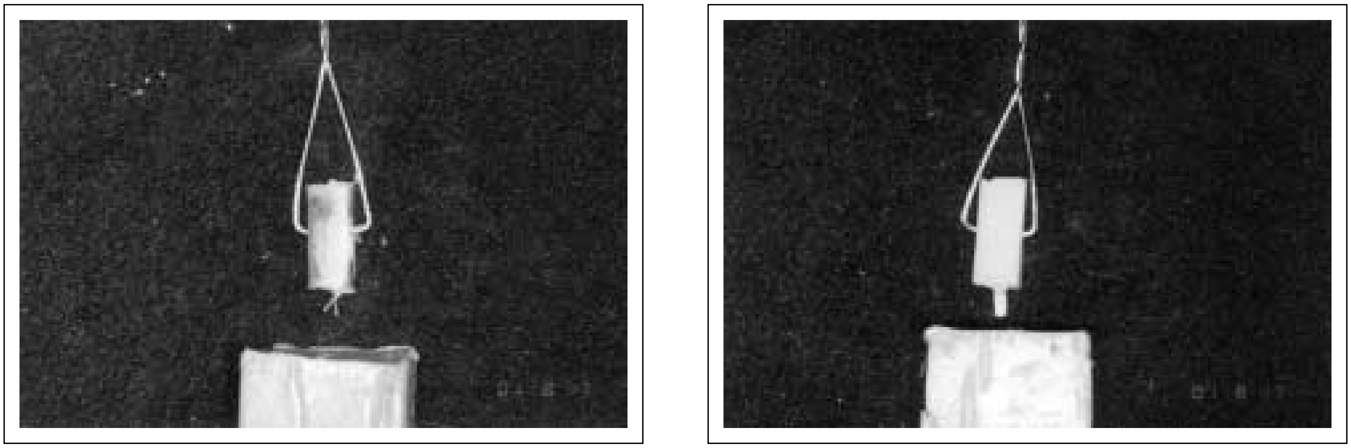
Forty-five (45) extracted anterior primary teeth were selected with at least 2/3 of the root length, free of caries and with no previous endodontic treatment. The crowns were sectioned at 1mm above the enamel-cement junction and the roots were stored in saline solution at 4ºC. Teeth were endodonticaly treated and a filling of eugenol zinc oxide paste was used. After 48 hours approximately, 4mm of the filling paste was removed using a # 3133 burr (KG Sorensen, Brazil). A base of glass ionomer cement (Vidrion, SS White, Brazil) was used to isolate the filling material from the rest of the cavity. A # 4137 burr (KG Sorensen, Brazil) was used to prepare the root cavity remaining with 3mm of length approximately. Then the prepared cavity was acid etched for 15 seconds with a 37% phosphoric acid gel, rinsed, dried and two coats of a dentin adhesive. Single Bond (3M, USA) was applied according the instructions of the manufacturer.

The specimens were then ramdonly assigned to three groups of 16 teeth each.

Root cavities in group I were filled with the composite resin Filtek Z 250 (3M). The resin was inserted in 1mm increments, each one being light cured for 40 seconds. Then a 4 mm length and 10 mm high core was built with the same composite resin used for the post. A brace made from a 7mm orthodontic wire was inserted at 4mm above the cervical portion of the root to permit the tension tests.

In group II the intracanal retention was done with a 0.6 mm orthodontic wire bent in a Greek letter form "gamma" adapted under pressure inside the root cavity and fixed with a composite resin (Filtek Z 250, 3M). Core was built as the same way as in group I. Specimens of the group III received an intracanal retention built from a fiber glass pin (Fibrekor Post, Generic/Pentron) with 1.25 mm in diameter fixed into the canal cavity with the same composite resin used in the other groups.

All specimens from all groups were inserted in acrylic blocks and the tensile strength tests were measured using an universal testing machine (Instron, model 4444)



a) Failure at orthodontic wire/resin interface **b) Failure of the resin post**

Figure 4. Cohesive fracture of the intra canal retention but with resin remaining inside the canal cavity.

at a speed of 4mm/min (Figure 1). The tensile strength was calculated as the recorded failure tension removed the posts and cores. The tensile strengths were expressed in MPa. Results were statistically evaluated using one-way analysis of variance (ANOVA). The mode of fracture was investigated. Each specimen was examined by one investigator using a stereomicroscope (Dimex, MZS-200, Mexico) to determine whether the bond failure was: a) adhesive failure with the total removal of the post and core with no composite resin inside the canal cavity (Figure 2), b) cohesive failure bulk fracture of the post and/or core (Figures 3 a, b), c) cohesive fracture of the intracanal retention, but with resin remaining inside the canal cavity (Figures 4 a, b).

RESULTS

The tensile strength results are presented in Table 1. The means were very similar, 2.81, 2.67 and 2.48. ANOVA revealed that no statistically significant difference was found between the three intracanal retention techniques.

In Table 2 the results of the one-way analysis of variance are presented. Analyzing the mean and the groups variability coefficient, group I showed good tensile strength, but high variability among the specimens showing that they were irregular. Group II also presented satisfactory tensile strength, but with high variability and finally group III, presented the lowest strength and highest variability (higher than the two other groups). The mode of fracture is presented in Table 3 and it shows that the predominant failure pattern was adhesive (47% for group I, 93% for group II and 80% for group III). Adhesive fracture corresponds to 73.3% of the total of failures.

The proportion test showed that there was a statistically significant difference between groups I and II (Z= 2.47 and p=0.132). Group II showed more adhesive failures, while group I showed the same amount of adhesive and cohesive failures. The differences between groups I and II were not statistically significant (Z= 1.55 and p= 0.1213) and finally the comparison between groups II and III showed no differences among them (Z= 1.07 and p= 0.2827).

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

Group #	Technique	Mean	Standard deviation	Range
I	Resin post	2.81	±0.84	1.28-4.71
II	Wire post	2.67	±0.80	1.50-4.32
III	Fiberglass post	2.48	±1.49	1.25-6.19

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

Variability	SS	FD	MS	"F"	"P"
Between groups	1017.097	2	508.5486	0.3525	0.7050
In groups	60584.75	42	1442.494		
Total	61601.85	44			

SS- Square sum
FD- Freedon degree
MS- Means sum

Table 3. Frequency of bond failure type.

Group #	Technique	Type of failure
I	Resin post	a a b a a a a a b b b b b b b*
II	Wire post	a a a a a a a a a a a c a a a a
III	Fiberglass post	a a a a a a a a a a a a b c b

Mode of bonding fracture:
- a= adhesive failure with the total removing of the post and core
- b= cohesive failure of the post and core
- c= cohesive fracture of the intracanal retention

DISCUSSION

Problems related to trauma and dental caries of the primary anterior teeth cause a series of disturbances according the age of the child, extension of the lesion and personal and family expectations.[1,12,13] Leaving these teeth with no treatment runs contrary to all preventive principles, since if there is active lesion, cariogenic microorganisms continue to grow resulting in higher risk for the rest of the dentition.[12] In the opposite attitude, early extraction of these teeth can lead to several problems causing phonetic and mastication alterations and in the development of the stomatognatic system. Hence, the maintenance of the dental elements is of the major importance because it is necessary to preserve the primary dentition integrity until its physiological exfoliation.

Severally damaged anterior teeth restorations are of difficult task mainly in young children and sometimes intracanal retention must be done. In the literature there are many clinical reports describing rehabilitation and follow-up of anterior primary teeth restorations, but none related to physical and mechanical properties of these restorations mainly those where intracanal retention is needed. For these reasons and considering the importance of knowing the biomechanical behavior of this technique this study was conducted to test three-intracanal retention technique for anterior deciduous teeth. The resin short post technique and the use of orthodontic wires were chosen because these techniques are commonly used in Pediatric Dentistry and the fiberglass posts are used in permanent teeth with good results.

The mean tensile strength found in group I was 2.81 MPa. Rifikin,[14] Judd *et al*.[9] and Mendes, Portela, Gleiser[15] in clinical case reports show various success treatments, but the follow-up is too short, less than a year which is difficult to preview the maintenance until normal exfoliation time. The use of orthodontic wires bent in a Greek letter form "gamma" is another option for intracanal retention.

In group II the mean tensile strength was 2.67 MPa. Romano, Imparato[10] have shown unsatisfactory results with this technique. However Parrela, Sagretti, Guedes-Pinto[1] reported 76% of success using this technique after 10 months (n=25) restoring anterior teeth with crowns totally destroyed. In the present study this technique showed to be technical and operator dependent and more difficult to adapt the bent orthodontic wire to the root cavity. Therefore, considering that there was no significant statistical difference between the groups this technique should not be commonly used.

The results from group III where the mean tensile strength was 2.48 MPa despite that there was no significant statistical difference from the others, this group showed a higher specimen variability and lower tensile strength. The costs of the material used in this technique are higher and for this reason it should be indicated for special clinical cases.

The type of bond failure most commonly found was adhesive. It suggests that the major factor was bonding between the adhesive system and the canal walls no matter the type of the intracanal retention used. Then clinical failures of anterior restorations with this type of anchorage might be related not to the type of retention system, but to failure in bonding to canal walls. The interaction between these walls and the adhesive system should be further studied. The presence of eugenol in the root canal filling paste would be a factor that could interfere in bonding. According to Damasceno, Rocha, Lima, Alves[16] eugenol interferes with polymerization of the resin materials. More clinical and laboratory studies should be done on techniques to restore severely destroyed primary anterior teeth. Further, these restorations should remain functional and aesthetically acceptable until normal physiological exfoliation.

CONCLUSION

On the basis of this *in vitro* study we conclude that:

1. There was no significant statistical difference in tensile bond strength between the three techniques used and therefore composite resin short posts should be indicated because it is easier and simpler technique.
2. The most frequent mode of bonding failure was adhesive being bonding to canal walls of major influence and not the type of intracanal retention.

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