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Comparison of compressive strength among three different intracanal post materials in primary anterior teeth: An *in vitro* study

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ABSTRACT

Objective: The objective of our study was to compare the fracture resistance and the mode of failure among three different post materials in primary anterior teeth. **Materials and Methods:** A total of sixty extracted primary anterior teeth were selected for the study. The samples were divided into three groups of twenty teeth each: Group I (Ribbond), Group II (Omega loop), and Group III (Glass fiber post). Pulp therapy was followed by intracanal post and crown buildup. The samples were mounted in self-cure acrylic and subjected to compressive strength test using universal testing machine (Instron). The maximum force at which the tooth fractured was recorded. **Results:** The values were subjected to one-way analysis of variance. The mean compressive strength values of Ribbond, omega loop, and glass fiber post were found to be 83.25 N, 61.60 N, and 75.55 N, respectively. The *P* value was found to be 0.220. **Conclusion:** Group I (Ribbond) showed the highest fracture resistance values followed by Group III (Glass fiber post) and Group II (Omega loop). Although there is difference in mean values, they were nonsignificant.

Key words: Intracanal post, primary teeth, Ribbond

INTRODUCTION

Primary anterior teeth are the most commonly affected teeth due to early childhood caries and trauma.[1] According to Huber *et al*., they are called the social six as they are the most prominent teeth in a smile.[2] Loss of primary anterior teeth leads to mastication problems, speech disorders such as difficulty in pronunciation, development of parafunctional habits, hesitation to play among the peer groups due to esthetic concerns, and also reduction in vertical facial height. Such children have problems with self-esteem, and they are psychologically distressed.[3] Intracanal post and core system were used to regain the lost tooth structure and bring back the original smile of the patient. Different kinds of materials have been used for intracanal reinforcement in primary teeth such as short composite posts, short wire posts, Ni-Cr coil spring posts, glass fiber posts, polyethylene fiber post/Ribbond, and metal screw posts.[3] The crown anatomy can be restored by direct composite buildup by incremental method or using celluloid strip crowns.[4] In this study, three post systems were used, namely, Omega loop, Glass fiber post, and Ribbond.

The use of omega loop as an intracanal retainer was introduced by Mortada and King in 2004 for primary teeth.[5] The technique of placing omega loops is quiet simple and less expensive. The introduction of fiber posts in the 1960s provided the dental profession an alternative treatment modality to cast/prefabricated

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posts, pins, and orthodontic wires. Glass fiber posts are commonly used in Pediatric Dentistry, thereby used as one of the post materials in our study.[6] Polyethylene fibers, a recently developed material (Ribbond), reported to have clinical advantage over the traditional intracanal post material. They were introduced into the market in 1992. These fibers improve the impact strength, modulus of elasticity, and flexural strength of composite materials.[7]

All the materials used as intracanal posts have their own advantages and disadvantages. Despite numerous clinical reports on primary teeth restoration, there is no enough information about the physical and mechanical properties of the post-supported restorations. In our study, the traditional materials and the recent materials were compared for their fracture resistance leaving behind the cost and technique sensitivity. The aim of this *in vitro* study was to compare the compressive strength among three different intracanal post materials in primary anterior teeth.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board, SRM University. The study was performed in the Department of Pedodontics and Preventive Dentistry, SRM Dental College, Ramapuram, Chennai, Tamil Nadu, India. A total of sixty single-rooted primary anterior teeth (central incisors, lateral incisors, and canines were included in the study) with initial physiological resorption not more than 2/3rd of the root were collected and included in the study. Teeth with more than 2/3rd of the roots resorbed and teeth with any evidence of crack or fracture were excluded. The central incisors, canines, and lateral incisors were equally distributed in three groups.

Preparation of samples

The samples were cleaned with 2% sodium hypochlorite and stored in physiological saline till the preparation. The samples were decoronated 1 mm coronal to cementoenamel junction using a diamond disc in a micro motor with saline as a coolant. Pulpectomy was done and obturated with zinc oxide eugenol paste leaving 4 mm of the canal space for post. One millimeter thickness glass ionomer cement (GIC) base was given to separate the obturating material from the post space. Care was taken to avoid smearing zinc oxide eugenol remnants on the walls of the post space. Three millimeters post space was measured using a Williams's periodontal probe.

All the samples were numbered from 1 to 60 and divided into three groups containing twenty samples each:

- Group I: Polyethylene fiber reinforced Composite (Ribbond)
- Group II: Omega loop – 0.7 mm orthodontic wire
- Group III: Prefabricated glass fiber-reinforced composite post.

For all the groups, canals were etched with 37% phosphoric acid (Ivoclar vivadent) and monobond N is a Ivaclor Vivadent product. It is suitable for all types of indirect restorative materials, easy storage, can be used along with glass and oxide ceramics, metal composites, FRC's according to manufacturer instructions (Multilink speed, Ivoclar vivadent).

Group I: (Polyethylene fiber-reinforced composite post/Ribbond)

The canals were etched, and bonding agent was applied. Dual-cure composite material was placed inside the post space; polyethylene fiber (Everstic, GC Corporation, Japan) was condensed into the space such that it extended 2 mm outside the canal and cured for 60 s [Figure 1].

Group II: Omega loop

The canals were etched, and bonding agent was applied. A 1.5 cm length of 0.7 mm round orthodontic stainless steel wire was bent using number 130 orthodontic pliers, into an omega-shaped loop according to Mortada and King.[5] Dual-cure composite material was placed inside the post space, and the omega loop was inserted and cured for 60 s. This wire comprised pulpal end and an incisal end. The pulpal ends of the wire were compressed together using a needle holder, and inserted into the canal. The pulpal end extended approximately 3 mm into the root canal so as to increase the overall retention of the wire; the incisal end projected 2–3 mm above the remaining structure; this provided better mechanical retention and support for restorative material [Figure 2].

Group III: Glass fiber reinforced composite resin post

The canals were etched, and bonding agent was applied. The post space was filled with dual-cure composite, 5 mm of prefabricated glass fiber post (DENTSPLY, Germany) was inserted, and post was luted extending 2 mm outside the canal [Figure 3]. Core buildup was done for all the sixty samples by incremental method using resin composite (DENTSPLY, Germany). The samples were mounted in self-cure acrylic resin blocks. The specimens were stored in 37°C sterile water solution for 72 h till subjected to testing. Testing

Figure 1: Ribbond post luted with dual cure composite

Figure 2: Omega loop post luted with dual cure composite

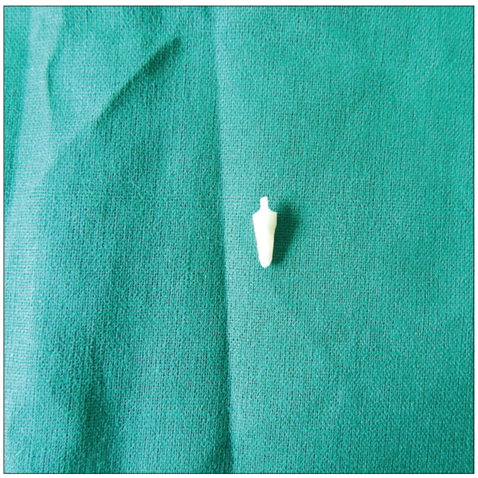

Figure 3: Glass fiber post luted with dual cure composite

Figure 4: The acrylic block loaded in universal testing machine at 148° angulation

was done with the help of universal testing machine (Instron). The acrylic resin block mounted with tooth was subjected to compressive load at the angulation of 148° at the speed of 0.5 mm/min. The maximum load at which the tooth fractured was recorded in Newton. Fracture at any point of the sample was recorded as failure of the post system [Figure 4]. The entire procedure was done by a single operator.

Statistical analysis

Data were subjected to statistical analysis using SPSS Software (version 19, SPSS Inc., Chicago, IL, USA). Intergroup comparison was done using one-way analysis of variance (ANOVA).

RESULTS

Table 1 shows the mean compressive strength values of Group 1, Group II, and Group III as 83.25 N, 61.60 N, and 75.55 N, respectively.

Table 1: Comparison of compressive strength between three groups (one-way analysis of variance)

Groups	*n*	Mean compressive strength	SD	*F*	*P*
Group I (Ribbond)	20	83.25	53.99	1.510	0.220
Group II (omega loop)	20	61.60	29.59		
Group III (glass fiber post)	20	75.55	31.23		

SD: Standard deviation

Group I (Ribbond) shows the highest fracture resistance, followed by Group III (Glass fiber post) and Group II (Omega loop). In Group I (Ribbond), the compressive strength values ranged between 35 N and 275 N. In Group II (omega loop), the values ranged between 28 N and 144 N. In Group III (Glass fiber post), the values ranged between 38 N and 158 N. Table 1 shows the one-way ANOVA which was done for the intergroup comparison. *P* value was found to be nonsignificant (0.220). Since *P* value is not significant, ANOVA is not followed by *post hoc* test.

DISCUSSION

The main advantage of a post and core system is to provide retention and stability for the crown. The advantages and disadvantages of all the three post systems are shown in Table 2. The material used as a post can affect the fracture resistance of the post and core system.[8] A simpler and effective method to use an omega loop was introduced by Mortada and King.[5] The greatest advantage is that the wire does not cause any internal stress in the root canal.

Glass fiber reinforced composite resin posts can be used as an alternative to the other post systems. The properties of fiber post depend on the nature of the fibers, interface strength, and geometry of reinforcement. In glass fiber post and composite core system, modulus of elasticity is similar to dentin, thereby improves the stress distribution between posts and dentin, thus resulting in better flexibility when load is applied. This property reduces the risk of root fracture.[6]

In our study, Ribbond showed the highest fracture resistance. The patented leno weave pattern is the characteristic feature of Ribbond fiber designed with a lock stitch feature that effectively transfers forces throughout the weave without stress transfer back into the resin. Ribbond's weave also provides excellent manageability characteristics.[7] As the fibers of Ribbond has no memory, it adapts to the contours of the teeth and dental arch easily. It is translucent, practically colorless and disappears within the composite posts or acrylic offering excellent esthetics.

In the present study, the tooth was decoronated 1 mm above the cementoenamel junction, to simulate a clinical condition of reduced amount of tooth structure. Thus, the compressive load was largely borne by the post and core. The similar concept was utilized by many authors.[8,9] Zinc oxide eugenol was the material of choice for obturation as it is the most common material. Alves and Vieira Rde and Viera and Ribeiro have concluded that the type of obturation material used for endodontic treatment does not interfere with mechanical properties of the post system.[10] The post space was carefully separated from zinc oxide eugenol giving 1 mm GIC base. This was done by many authors for better bonding of the post material.[9,11-13]

According to Pithan *et al*., 2003, the minimum post length should be 2–3 mm to give more support and retention to the crown.[12] In primary teeth, it should not interfere with root resorption and the physiological eruption of permanent teeth.[13] Hence, the length of the post was restricted to 3 mm. The present *in vitro* study has yielded the fracture resistance values between 28 N and 275 N. In contrast, permanent teeth studies have shown higher fracture resistance ranging from 400 N to 935 N. The high value was due to larger diameter of the permanent teeth.[14] The authors have insisted that the diameter of the tooth is one of the factors affecting fracture resistance. The authors have suggested that increase in diameter proportionately enhances the strength.[15]

According to Mountain *et al*. in 2010, the levels of bite force in primary anterior teeth ranged between

Table 2: Comparison of advantages and disadvantages of three post systems

Post systems	Advantages	Disadvantages
Omega loop	Conventional post Low cost Easy to fabricate Flexible, can be adjusted according to the internal diameter of the canal orifice	Bonding between the wire post and the tooth material is compromised Uniformity in the construction of the post is difficult The wire component has to be masked to improve esthetics If too tight, they can wedge the root, and if too loose, they can usually come out
Glass fiber post	Glass fibers embedded in a polymer matrix, which holds the fibers together Alternative to cast/prefabricated posts, pins, and orthodontic wires Available in different diameters	Appropriate size selection should be done Expensive compared to metal post
Ribbond	Recently developed material reported to have clinical advantage over the traditional intracanal post material Improved impact strength, modulus of elasticity, and flexural strength of composite materials The open and lace-like architecture of Ribbond allows it to adapt closely to the teeth	Expensive Technique sensitive

6.87 N to 140.09 N.[16] This range is similar to our compressive strength values which ranged between 28 N to 275 N. In contrast, Seraj *et al*.[13] have quoted higher values in cementum-extended composite post system which was 601 N. The authors explained that the higher value was due to ferrule effect. The wide range in fracture resistance values in our study was due to variation in sample sizes (incisors and canines were of different length and diameter). Future studies with similar samples (e.g. only central incisors) are needed to substantiate our results.

CONCLUSION

Within the limitations of the study, the following conclusions were made.

1. Group I (Ribbond) showed the highest fracture resistance values among the three test groups
2. Group II (Omega loop) showed the least fracture resistance values among the three test groups
3. The order of fracture resistance values was decreasing from Group I (Ribbond) followed by Group III (Glass fiber post) and Group II (Omega loop)
4. Although there is difference in mean values among the three groups, *P* value was nonsignificant (0.220)
5. *In vivo* studies with 1 year follow-up are needed to justify our results.

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Conflicts of interest

There are no conflicts of interest.

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