

Fracture Resistance of Maxillary Primary Anterior Restorations Using Grandio and Grandio Flow Composites with Two Different Types of Posts: An In Vitro Study

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Abstract

Background and Aim: There have been attempts to restore destroyed primary anterior teeth using a variety of post and core systems, which were able to solve just part of the problems related to this issue. Therefore, the present study aimed to investigate the fracture resistance of restorations supported with a variety of posts and cores in primary anterior teeth.

Materials and Methods: The present study was an in vitro experimental study on 40 extracted maxillary primary canine teeth. The teeth were divided into four groups: (I) Grandio Flow composite core and fiberglass post, (II) Grandio Flow composite core and Grandio Flow composite post, (III) Grandio composite core and fiberglass post and (IV) Grandio composite core and Grandio composite post. Then, the fracture resistance was compared among the four groups. One-way ANOVA was used to analyze the data.

Results: The mean fracture resistance was 398.2 ± 135.2 in group 1, 474.7 ± 100.8 in group 2, 374.3 ± 161.1 in group 3 and 364.4 ± 74.5 in group 4; these differences were not statistically significant ($P=0.182$).

Conclusion: The results of this study showed that the highest fracture resistance was observed in the Grandio Flow composite core and Grandio Flow composite post. Grandio composite core and Grandio composite post showed the lowest fracture resistance; but there were no statistically significant differences among the groups.

Key Words: Post and Core Technique, Composite Resins, Tooth, Deciduous

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Introduction

Early childhood caries (ECC) is a condition that can affect the maxillary anterior teeth and severely damage their structure. Early loss of deciduous teeth due to ECC can cause abnormal position of the tongue, neuromuscular imbalance, reduced force of chewing, problems in speech, development of parafunctional habits, mental problems (1,2), esthetic

problems (3) and decreased vertical height of the face requiring oral rehabilitation (4). Children with ECC often have slower growth rate compared with those without ECC (5). On the other hand, due to the lack of enamel and limitations in providing retention for composites, restoration of these teeth is challenging for dentists. During the recent years, many methods have been used to restore

the deciduous anterior teeth (6,7). However, extensive restorative treatment of deciduous anterior teeth of the upper jaw has always been problematic for

dentists due to the small size of their crown and relatively large space of dental pulp (2,6,8-10).

Some efforts have been made to restore these teeth using different types of posts. For this purpose, various posts were used in pediatric dentistry. However, each method was only partially able to solve the above-mentioned problems (4,11,12). To date, different types of posts have been introduced for use in pediatric restorative dentistry (2,4,11-20). Besides, literature review shows that based on reports by clinicians, restoration of anterior teeth without using posts did not provide the mechanical and physical properties of restorations supported by posts in the maxillary anterior teeth (1,4,11,12,21).

A brief look at the literature on using the post systems in pediatric restorative dentistry shows that there is no single approach and the results are sometimes different and contradictory such that in several studies, tensile strength (2,13,15,19) and fracture resistance (14-17,21,22) of restorations were evaluated and compared. Baghalian et al. (14) showed that split-ended fiber glass posts with composite cores had higher fracture resistance than other restorations, although this difference was not significant. In contrast, a study by Sharaf (21) indicated a significant difference in using composite restorations with fiber glass posts in restoring the deciduous incisor teeth.

Grandio Flow is a high-filler nanocomposite with a filler rate of 80% by weight. While maintaining the wettability, higher filler rate in a composite can play an important role in creating convenience and improving the mechanical properties of the composite. Grandio composite is also a universal composite with a filler rate of 87% by weight. This higher content of filler in Grandio composite provides a significantly hard surface, high tensile strength, relatively good transverse strength as well as high edge stability along with a distinctive abrasion resistance (22).

By an increase in parents' request to restore the

deciduous anterior teeth due to esthetic and functional considerations in children and difficulty in restoring these teeth due to the lack of enamel and limitations in creating retention for composite restorations (11), this study aimed to evaluate the efficacy of composite posts compared with fiber glass posts using Grandio and Grandio Flow composites by investigating the fracture resistance of restorations.

Materials and Methods

In this in-vitro study, 40 extracted deciduous maxillary canine teeth were selected with two-thirds of the root being intact without previous endodontic treatment and at least one-third intact cervical crown. The study was approved by the ethics committee of our university (IR.SBMU.RIDS.RES.1395.258). After extraction, the teeth were rinsed and maintained in 0.5% chloramine solution for 1 week. They were finally stored in saline solution until the testing time. The crowns of all teeth were sectioned transversely 1 mm above than cemento-enamel junction and the roots were kept in saline. Pulpectomy was done by a pediatric dentist and the roots were obturated to the orifice using Metapex (Metabiomed, Korea). The post space was created by removing Metapex from the coronal part of the canal and shaping the canal space by a straight fissure bur to create 4 mm of canal space without Metapex. The canal was dried with air and 1 mm of its space was dedicated to placing self-cure glass ionomer base (Fuji II; GC, Japan) and a space of 3 mm was considered for standard placement of the post in all samples. Forty teeth were randomly divided into 4 groups (n=10): (I) Grandio Flow composite core (Voco, Germany) and fiber glass post, (II) Grandio Flow composite core (Voco, Germany) and composite post, (III) Grandio composite core and fiber glass post, and (IV) Grandio composite core and composite post.

Post fabrication

In groups containing composite posts, the post space was etched with 35% phosphoric acid for 20 seconds and rinsed for 30 seconds. Afterward, it was dried with air; then, two

layers of Single Bond dentin bonding agent (3M ESPE, St. Paul, MN, USA) were applied in the canal and were light-cured for 30 seconds. Then, the post space was filled with Grandio Flow or Grandio composite resin and was cured for 40 seconds.

In groups containing fiber glass post, fiber glass post (TDV Dental, Brazil) with 21 mm length and 1.2 mm diameter was used. All the posts were cut from the back to reach 7 mm length; 3 mm of the post was placed inside the root canal and 5 mm inside the crown. The canal was etched with 30% phosphoric acid for 20 s and rinsed for 30 seconds. It was then dried with air spray. Two layers of bonding agent were applied and cured for 30 s and the posts were subsequently cemented using Grandio Flow composite.

Core fabrication

The teeth in all groups were etched for 20 seconds and rinsed for 30 seconds; all the groups were bonded and cured. The tooth crown in each group with composite and fiber glass post was restored by means of Grandio or Grandio Flow composite with a prefabricated crown with mesiodistal dimension of 4 mm and height of 4 mm.

Measurement of fracture resistance

All the specimens were mounted in self-cure acrylic resin (Dentsply, Konstanz, Germany) in a cylindrical mold in a way that the crown portion, especially the composite-dentin interface area, remained completely out of the acrylic resin. All the samples were incubated at 37°C for 24 hours and were then thermocycled for 3000 cycles (Dorsa, Tehran, Iran) between 5°C and 55°C in each water bath with a dwell time of 15 seconds and a transfer time of 15 seconds.

The fracture resistance was measured by a universal testing machine (Santam-STM20, Tehran, Iran). The dislodging force was generated with a crosshead speed of 0.5 mm/min using a 1000-N load cell, which can generate forces between 0.1 g to 100 kg. This force was applied in 148° angle relative to the longitudinal axis of the tooth in the middle area of the palatal surface as suggested by Baker et al

(6). The force that caused fracture was recorded in Newtons (N). The type of fracture was evaluated and recorded as adhesive failure (at the interface between the composite and the tooth structure), cohesive failure (within the composite structure) or mixed failure. The type of fracture was determined by visual inspection wherever possible; otherwise, a stereomicroscope (SZX 16; Olympus, Tokyo, Japan) was used.

Statistical analysis

The data were analyzed using SPSS 21 software (SPSS Inc., IL, USA). The quantitative data were expressed as mean ($\pm$ standard deviation) and the qualitative data as percentage. Normal distribution of fracture resistance values was investigated using the Kolmogorov-Smirnov test. Next, one-way ANOVA was used to analyze the data between the groups. Also, the Chi-square test was used to examine the correlation between the treatment group and fracture type.

Results

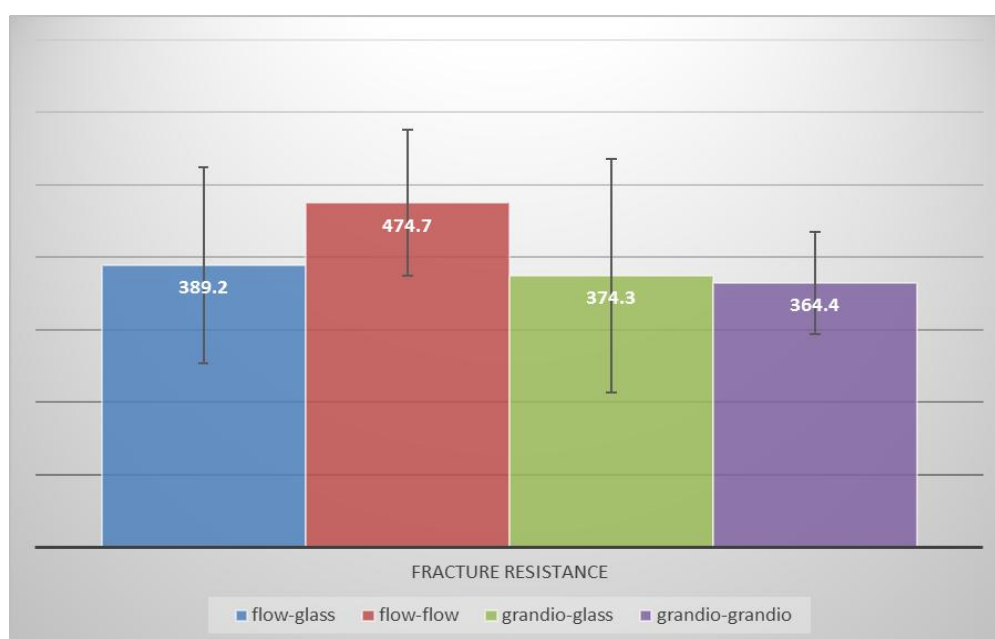
To investigate the normal distribution of fracture resistance data, the skewness and kurtosis were measured to be 0.367 and 0.917, respectively, showing that the fracture resistance data had a normal distribution; thus, a parametric test was used to compare the findings.

Table 1 shows the mean fracture resistance of the groups. One-way ANOVA showed that the difference between the mean fracture resistance was not statistically significant among the groups ($P=0.182$). The group with Grandio Flow composite core and Grandio Flow composite post had the highest fracture resistance (474.7 ± 100.8 N) and the group with Grandio composite core and Grandio composite post had the lowest fracture resistance (364.4 ± 74.5 N) (Fig. 1).

In terms of fracture type, the observations showed that the teeth had 3 types of fractures, i.e. mixed, adhesive and cohesive fractures, and the maximum frequency belonged to cohesive fracture (40%). The type of fracture is reported in Table 2.

Table 1. Mean and standard deviation of fracture resistance

Group	Mean (N)	Std. deviation
Flow-Glass	389.2	135.2
Flow-Flow	474.7	100.8
Grandio-Glass	374.3	161.1
Grandio-Grandio	364.4	74.5

**Figure 1.** Fracture Resistance of Different Groups**Table 2.** Fracture types

Group	Adhesive N(%)	Cohesive N(%)	Mixed N(%)
Glass fiber post- Grandio Flow core	3(30)	4(40)	3(30)
Grandio Flow post-Grandio Flow core	3(30)	5(50)	2(20)
Glass Fiber post- Grandio core	7(70)	3(30)	0
Grandio post- Grandio core	2(20)	4(40)	4(40)

Discussion

By an increase in parents' request to restore carious primary incisors due to esthetic and functional considerations in children and difficulty in restoring these teeth due to the lack of enamel and limitations in providing retention for composite restorations, the restoration of these teeth is challenging for dentists. Composite restorations are extensively used and usually need some intact tooth structure for micromechanical retention (23), which does not exist in severely damaged teeth. Using intracanal posts in endodontically treated roots can improve retention and enhance esthetics and function in severely decayed deciduous anterior teeth (19). To date, different types of posts have been introduced to the market in pediatric restorative dentistry. In various studies, the researchers have used prefabricated polyethylene posts (11,15), biological or dentin posts (2,4), fiber quartz posts (4) and fiber glass posts (13,15-17,19). This study aimed to evaluate the efficacy of composite posts and fiber glass posts using Grandio and Grandio Flow composites by examining the fracture resistance of the restorations for the first time.

The results of investigating the fracture resistance showed that the group with Grandio Flow composite core and Grandio Flow composite post had the highest fracture resistance, followed by the group with Grandio Flow composite core and fiber glass post. Also, the lowest fracture resistance was noted in the group with Grandio composite core and Grandio composite post. However, based on the statistical analysis, the difference in the mean fracture resistance of the four study groups was not significant.

The results of this study are, to some extent, similar to those of a study by Seraj et al (16). They showed that fiber quartz posts and fiber glass posts had higher fracture resistance than prefabricated fiber glass posts and composite posts, respectively. However, this difference was not significant. Also, the results of a study by Baghalian et al. (14) showed that the fracture resistance was higher in split-ended fiber glass posts, followed by composite posts, intact fiber

glass posts and γ -shaped orthodontic wire posts. However, there was no significant difference between the study groups in terms of fracture resistance, which is relatively similar to the results obtained in the present study. The results of our study combined with the afore-mentioned studies showed that using fiber posts did not improve the fracture resistance of the final restoration and considering the price of fiber posts, it seems that using fiber posts in primary incisors could not improve the quality of final restoration regarding the fracture resistance. Use of composite posts seems logical and enough for this purpose. On the other hand, the study by Sharaf (21) on three groups of composite restorations without post, composite restorations with flowable composite posts with extension to the pulpal space, and composite restorations with fiber glass posts showed that the fracture resistance was higher in the group of fiber glass post restoration, followed by restoration by flowable composite post with extension to the pulpal space, and composite restoration without a post. These results were partly inconsistent with the results of the present study (showing no significant difference among the groups). Considering the use of flowable composite core and flowable composite post in the study by Sharaf (21), this difference is justifiable. On the other hand, Pithan et al. (13) compared the tensile resistance in three groups of composite post and core, γ -shaped orthodontic wire post and composite core, and fiber glass post and composite core. The results showed that although the tensile strength was higher in the group of composite post and core and lower in the group of fiber glass post and composite core, the difference among the groups was not significant. These results are similar to our findings. Pinheiro et al, (2) also showed that the tensile strength in dentin post group was higher than other posts, and the composite posts also yielded higher tensile strength compared with γ -shaped orthodontic wire posts; however, the difference between the groups was not significant. The study by Memarpour et al, (15) also indicated that the mean tensile strength in

groups with short composite post with undercut was significantly higher than that in groups with short composite post, fiber glass post with resin cement and fiber polyethylene post with resin cement. There was a significant difference between short composite post with undercut and flowable composite groups. Although in their study the post and core differed from those in our study, lack of a significant difference among the study groups was similar to the results obtained in the present study. On the other hand, the findings of Gujar and Indushekar (19) indicated that the mean tensile strength was significantly higher for fiber glass post and composite core compared with γ -shaped orthodontic post and composite core. Moreover, the mean tensile strength was higher for γ -shaped orthodontic wire post and composite core compared with composite post and composite core.

The results of evaluation of fracture type also showed that in the three groups of Grandio Flow composite core and fiber glass post, Grandio Flow composite core and Grandio Flow composite post, and Grandio composite core and Grandio composite post, cohesive fracture had the highest frequency. In the group with Grandio composite core and fiber glass post, the adhesive fracture had the highest frequency. On the other hand, the results of statistical analysis showed that this difference was not statistically significant. In other words, there was no significant correlation between the presence of composite core and fracture type. These results are partly similar to those of Gujar and Indushekar (19). They showed that in the group with composite post and composite core, and in the group with γ -shaped orthodontic wire post and composite core, the bulk cohesive fracture had a higher frequency but the group with fiber glass post and composite core showed only adhesive fracture. Also, the study by Memarpour et al. (15) indicated that adhesive fracture had a higher frequency in groups with fiber post, which is similar to the results of the present study.

Conclusion

Considering the results of this study regarding

lack of a significant difference between the study groups in terms of fracture resistance, the convenience of work with flowable composites in the clinical setting, acceptable mechanical properties of Grandio Flow composites due to their higher filler volume and finally considering the fact that using glass fiber posts has additional costs, restoration of deciduous teeth using Grandio Flow composite as post and core can be considered as a suitable treatment option.

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