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Short fiber-reinforced composite in cementation of fiber-reinforced composite post

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Abstract

Objectives: The aim of this *in vitro* study was to investigate bonding of resin composites of two kinds used as luting cement for fiber-reinforced composite post.

Methods: Two different composites were tested; light-cure flowable short fiber-reinforced composite (SFRC) everX Flow (Dentin, GC) and dual-cure composite Gradia Core (GC). Four groups were made with everX Flow and four with Gradia Core. Two different prefabricated fiber-reinforced composite (FRC) posts (diameter 1.6 mm) were used, GC-post (GC) and Snowpost (Abrasive Technology). Posts were conditioned with two different primers, either Ceramic Primer (GC) or G-multiprimer (GC). After conditioning, the posts were placed in the resin composites and pressed between two glass plates along the long axis of the post into thickness of 1.6 mm and then light-polymerized. The post-composite plates were cut to micro-tensile strength test specimens (1.6mm x 1.6mm x 18mm). Eight different test groups were made (n= 7 per group). Micro-tensile bond strength of the specimens were measured and fracture types were categorized.

Results: Both composite groups (everX Flow and Gradia Core) had similar bond strength values being between 7.5-13.5 MPa. No significant difference in the tensile strength between post and cement material was found between the groups ($p>0.05$).

The fracture types showed significant differences between the post groups ($p<0.001$) varying from adhesive to cohesive in type.

Conclusion: EverX Flow revealed similar bonding properties to FRC post than Gradia Core and could alternatively be used as a cement material with fiber-reinforced composite post if light curing of the everX Flow can be confirmed.

Key words: Fiber-reinforced composite, Short fiber-reinforced composite, Flowable short fiber-reinforced composite, Fiber-reinforced composite post, composite luting cement.

Introduction

The restoration of largely damaged teeth continues to be a challenge in dentistry. Short fiber-reinforced composite (SFRC) has been introduced as base material in large cavities and in restorations where post and core restorations are needed. The use of SFRC has increased in recent years[1]. Instead of using particulate fillers in a composite resin matrix, randomly oriented short E-glass fibers are used, which promotes the materials mechanical properties for instance fracture toughness, flexural strength and load bearing capacity[2-5]. In large cavities SFRC is changing the form of fracture from vertical to horizontal thus securing the root from vertical fracture and resulting in more repairable fractures[6]. Garoushi et al. determined the physical properties of SFRC in comparison to different commercial PFCs. SFRC differed significantly in its physical properties and showed superior fracture toughness, flexural strength and modulus, compared to other tested bulk-fill or conventional PFC materials[7]. Tsujimoto et al. evaluated mechanical properties and bond durability of SFRC[8]. In their studies shear fatigue strength of the adhesive system with SFRC was significantly higher than that of PFC composite resins tested. They highlighted the enhanced fracture toughness and bond durability of SFRC with universal adhesive. SFRC also has significantly lower volumetric shrinkage, which means that shrinkage stress and microleakage are lower. Also, microcracking risk decreases[9,10].

Fiber-reinforced composite (FRC) posts are used in endodontically treated teeth with extensive dentin loss[11-13]. FRC posts have shown similar or better survival rate and less severe complications compared to metal posts[14-16]. FRC posts are biomechanically suitable to dentin, relatively easy to use, cost-effective and esthetical. However, they have been criticized because of their poor bonding abilities to resin cement, core materials and dentin[17-22]. Studies have shown that bond strength between individually formed FRC posts and resin luting cement is higher than that of prefabricated FRC post and resin luting cement[19-21]. Successful bonding and a durable cementation of the post is a critical factor in clinical outcome[23].

Therefore, the aim of this *in vitro* study was to investigate bonding of resin composites of two kinds used as luting cement for fiber-reinforced composite post. The purpose was to evaluate if SFRC could be used as luting cement in post cementation and therefore offer advanced solutions and better clinical outcome because of its better physical properties.

Materials and Methods

In this in vitro study two different composites were tested; light-cure flowable short fiber-reinforced composite (SFRC) everX Flow (Dentin, GC, Japan) and dual-cure composite Gradia Core (GC, Japan) (Table 1) (Figure 1).

Table 1. The tested composite materials used as luting cement.

Material	**Type of material**	**Lot**	**Composition**
everX Flow (GC)	Light-cure flowable short fiber-reinforced composite	2204261	Silanated short e-glass fibers (ø 6µm and length 100µm) and barium glass fillers (0.7µm), bis-EMA, TEGDMA and UDMA
Gradia Core (GC)	Dual-cure composite	2212121	Methacrylic acid ester, fluoro-alumino-silicate glass, silicon dioxide

Figure 1. The tested composite materials used as luting cement: everX Flow and Gradia Core.

Four groups were made with everX Flow and four with Gradia Core. Two different prefabricated fiber-reinforced composite (FRC) posts (both with diameter 1.6 mm) were used; GC Fiber Post (GC, Japan) and Snowpost (Abrasive Technology, United States) (Table 2). Posts were coated with two different primers; either Ceramic Primer (GC, Japan) or G-multiprimer (GC, Japan) (Table 3).

Table 2. The tested FRC post materials.

Material	**Type of material**	**Composition**	**Post diameter (mm)**	**Lot**
GC Fiber Post (GC)	Prefabricated FRC post	Glass fibers, dimethacrylate matrix	1.60	A-40577
Snowpost (Abrasive Technology)	Prefabricated FRC post	silica-zirconia fibers, resin matrix	1.60	2023-1166696

Table 3. The primers used for coating the posts.

Material	Type of material	Lot	Composition
GC G-multi primer	Luting agent	2210131	Vinyl silane, phosphoric methacrylate monomer, methacrylate acid ester, ethyl alcohol
Gc ceramic primer II	Luting agent	2210061	Vinyl silane, phosphoric methacrylate monomer, triphosphoric ester monomer, methacrylate acid ester, ethyl alcohol

After coating, the posts were placed in the resin composites and pressed along the long axis of the post into thickness of 1.6 mm between two glass plates and then light-polymerized for 20 seconds on 9 points with 3M ESPE Elipar S10 (Figure 2). The post-composite plates were cut to micro-tensile specimen (1.6 mm x 1.6 mm x 18 mm). Eight different FRC groups were made (n= 7 per group). Micro-tensile strength of the specimens were tested with Microtensile tester (BISCO, T6102 K Microtensile United States) (Figure 3). The specimen were attached to the Microtensile tester with metal primer Z (GC, Japan) and G-aenial Universal Flow (GC, Japan). The fracture types were categorized into cohesive or adhesive fractures.

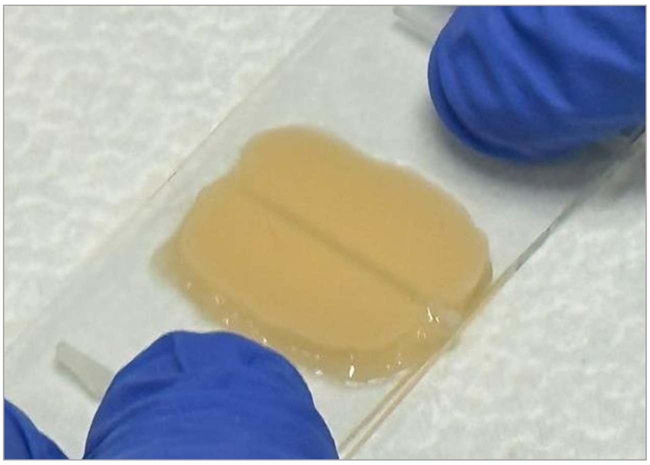

Figure 2. Manufacturing of post-composite plates between glass plates before cutting them into microtensile specimens.

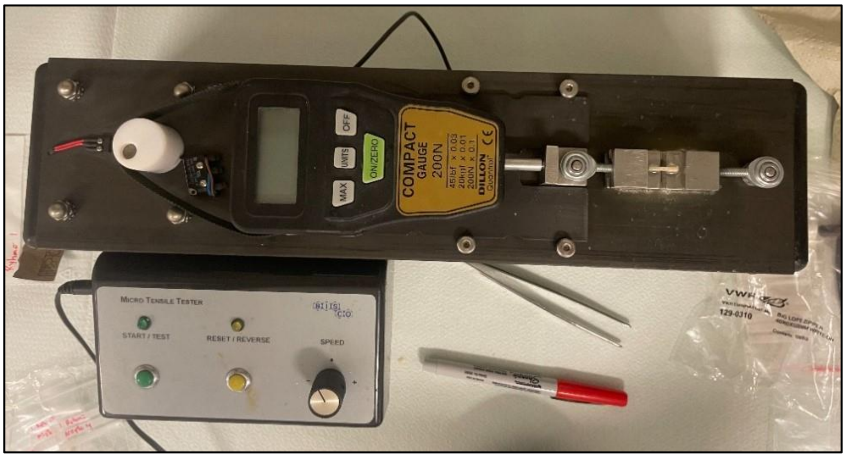

Figure 3. Micro-tensile strength of the specimens was tested with Microtensile tester.

Statistical Analysis

Statistical Analysis were performed with SPSS. The data was analyzed using ANOVA and subsequent comparisons between groups were performed with Tukey Post Hoc Tests. The level of statistical significance was considered to be 0.05.

Results

Both composite groups (everX Flow and Gradia Core) had similar bonding values being between 7.5-13.5 MPa. No significant difference in tensile strength between the post and the cement material was found between the groups ($p > 0.05$). The microtensile strength values are shown in Figure 4. The type of primer did not affect the bonding ($p > 0.05$).

The fracture types showed significant differences between the post groups ($p < 0.001$) (Table 3). The main fracture type for GC Fiber Post group was adhesive and the main fracture type in Snowpost group was cohesive (Figures 5 and 6). Although fracture type was adhesive in the GC Fiber Post group, the microtensile strength values were almost similar to those of the Snowpost group.

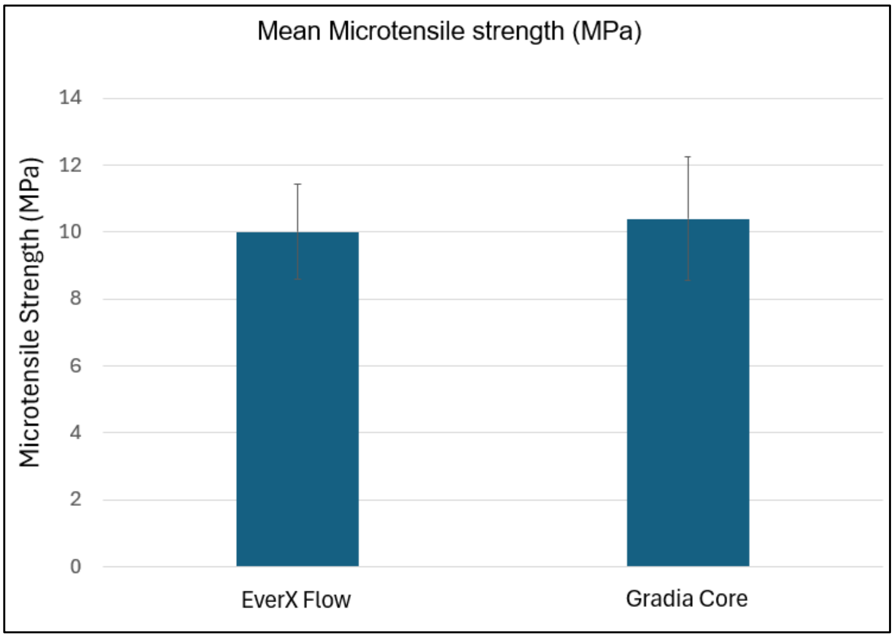

Figure 4. Average bonding values with everX Flow and Gradia Core.

Table 3. Fracture type varied between the post groups.

		GC Fiber Post	Snowpost	Total
Fracture type	Adhesive	31	5	36
	Cohesive	0	23	23
Total		31	28	59

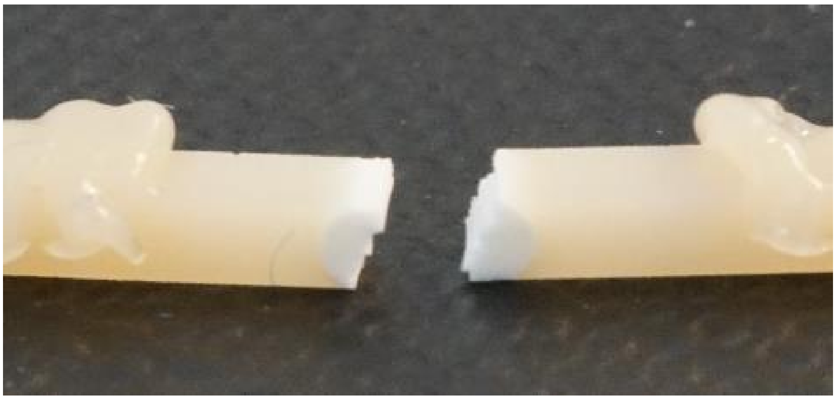

Figure 5. Cohesive fracture type was the main fracture type in Snowpost group.

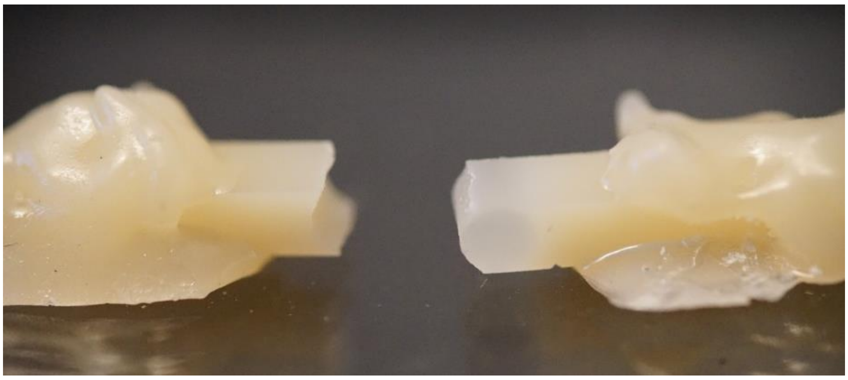

Figure 6. Adhesive fracture type was the main fracture type in GC Fiber post group.

Discussion

In this in vitro study bonding of resin composites of two kinds, used as luting cement for fiber-reinforced composite post, was investigated. The objective was to find out the potentiality of using short fiber reinforced composite as luting cement in post cementation.

According to the results of this study EverX Flow revealed similar bonding properties to Gradia Core and could alternatively be used as a luting cement material with fiber-reinforced composite post if light curing of the EverX Flow can be confirmed. The material used in this study was EverX Flow dentin shade which is not as transparent as EverX Flow bulk shade. The bulk shade could be a better option to be used in clinical work because of the better light curing potential. Improper light curing of the resin cement could lead to secondary caries or even post decementation and failure in bonding.

According to the literature flowable SFRC has been evaluated as core material in combination with individual glass fiber-reinforced composite post in laboratory studies with promising results[24]. The good light conducting and scattering properties of the individual glass fiber-reinforced composite post (everStick Post, GC) has been shown in earlier studies[25-28], which improves the light-polymerization of the flowable SFRC when used as cement with these posts. The concept of using individual fiber-reinforced composite posts with a high amount of fibers coronally, resulting in short and thick posts[29], also justifies the using of light-cure flowable SFRC (everX Flow, GC) as luting cement.

Therefore, it can offer clinicians an alternative approach for the cementation and core build up, that requires less different materials. Given the better physical properties of SRFC, it could offer a more durable solution for restorations.

Both used composites presented similar microtensile bond strength values, although GC Fiber post presented adhesive fractures whereas Snowpost presented cohesive fractures within the post. This might indicate favorable bonding between glass fiber bundles and resin in GC Fiber post compared with bonding between silica-zirconia fibers and resin in Snowpost. In this study setup, the weakest point in tensile test of GC Fiber post seemed to be the adhesive interface between luting agent and post. Whereas in Snowpost, the strength of the post appeared to be weaker than the adhesive interface. Cohesive strength of SFRC and PFC luting materials were not a concern in this study.

This was an in vitro study and might not present similar results clinically. Degree of conversion of light-cured SFRC might be a concern in clinical situations. It is noteworthy that adhesion between dental tissue and luting agents needs to be considered.

Although this study gave promising results in the bonding properties of the fiber reinforced composite post, further research is needed to generalize the use of SFRC in fiber post cementation. The development of dual-cure fiber reinforced composites could be a field to develop and investigate in the future.

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