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Influence of different posts's composition and shape on bond strength to radicular dentin

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ABSTRACT

Aim The goal of this *in vitro* study was to evaluate the bond strength to radicular dentin of a new post in combination with two different luting resin materials and comparing it with a well known translucent post available on the market.
Materials and methods A pilot study was conducted on 30 single-rooted extracted teeth, in order to study the link between the dentine-cement interface on the one hand and the post-cement interface on the other hand. Push out bond strength test was perfomed on two types of cement: Kuraray Panavia (Japan) and Gradia Core (GC Tokyo Japan) in combination with two types of fiber posts: Edelweiss post (Edelweiss Dentistry Products GmbH, Wolfurt, Austria) and GC Fiber Post (GC Gradia Core Tokyo Japan).
Results According to the results of this study, the GC Post / Gradia Core group recorded push-out forces significantly higher than those of the groups in which the new post was used ($p < 0.05$).
Conclusion Within the limits of this *in vitro* study, it can be concluded that the highest values of adhesive strength in the push-out test were achieved by GC post/Gradia Core GC. Regarding the area of root that can produce the best push out bond strength, it clearly resulted that the coronal third of the root was the best substrate to lute posts.

KEYWORDS Adhesive interfaces, Bond strength, Fiber posts, Luting materials.

INTRODUCTION

Many clinical studies have shown the high success rate of fiber posts without failures due to root fracture under medium and long term clinical service (1-3).
These findings gave fiber posts a high popularity, so that they were well received by practitioners.
Fiber posts can be composed of different materials and type of fibers and can be divided in two main groups: translucent and not translucent posts. Therefore, posts can be highly translucent (when quartz fibers are used) or not translucent (when no fibers are embedded into the resin matrix and the last is not translucent) (4, 5).
Retention of fiber posts and composite restorations is mainly due to quality of adhesion at the different adhesive interfaces; several studies were performed at the adhesive interface with both coronal and radicular dentin (6,7).
Shape and composition of the post directly influence the quantity of light passing through the post and consequently the degree of polymerization of luting material. The capacity of the light to move from coronal to apical part of the root canal space is a key factor on setting the luting material properly. When a proper set of the luting material is achieved, the bond strength to radicular dentin should increase creating a good bond to dentinal walls.
Another important aspect is the shape of the post: posts generally have an endodontic shape in order to better fit into the radicular anatomy.
Recently a new type of post was proposed (Edelweiss Post; Edelweiss Dentistry Products GmbH, Wolfurt, Austria) (Fig. 1). This post has a shape that replaces the coronal part of the abutment aiming to provide a simplification of the build up steps, being the core material part of the post itself. However, this new post is made of not translucent resin composite and without fibers.
The goal of this study was to evaluate the bond strength to radicular dentin of the new Edelweiss posts in combination with two different luting resin materials and comparing it with a well known translucent post

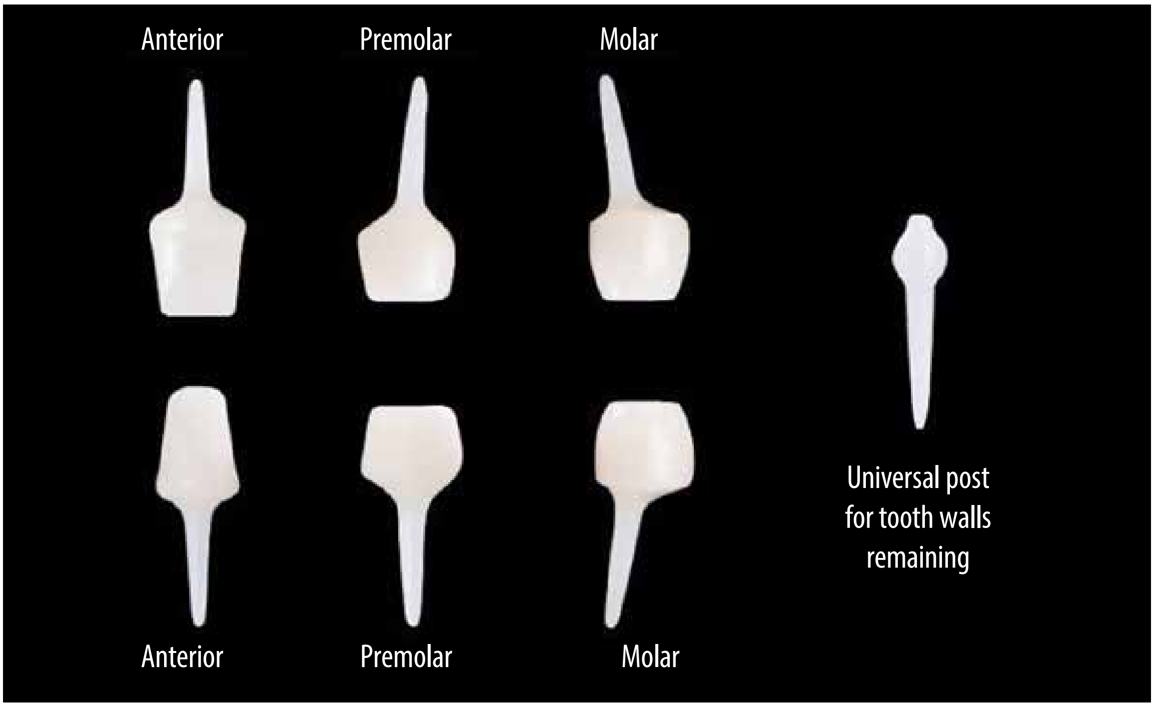


FIG. 1 The new type of post analyzed in the study.

available on the market. The null hypothesis was that Edelweiss posts can achieve better bond strength to radicular dentin irrespective of the type of luting material used.

MATERIALS AND METHODS

The posts

It was conducted a pilot study on 30 single-rooted extracted teeth, in order to study the link between the dentine-cement interface on one side and the post-cement interface on the other side. It is important that the bond strength of both interfaces is sufficiently strong to withstand the stresses during functional loading.
The push-out test (Fig. 2a-2b) with a thin layer was performed in order to evaluate the retentive strength of the abutments. The portion of each root that contained the post was sectioned into six/seven slices of 1 mm thickness using the saw Isomet under water cooling.
The first section was realized at a distance of 1 mm from the CEJ. The cutting led to 62 sections for the first group, 70 sections for the second group, 78 sections for the third group, for the evaluation of the strength of push-out bond. The apical surface of each slice of the root was marked so that the loading force was applied in apical-coronal direction, to move the post towards the largest part of the section.
Two types of cement were selected:

- Kuraray Panavia (Japan);
- Gradia Core (GC Tokyo Japan).

Two types of fiber posts were used:

- Edelweiss post (Edelweiss Dentistry Products GmbH, Wolfurt, Austria);
- GC Fiber Post (GC Gradia Core Tokyo Japan).

The 30 single-rooted teeth were shaped with NiTi Reciprocating files Reciproc (R25, 0.25mm diameter, and R40, diameter 0.40 mm).

- Root canal cleaning was performed with sodium hypochlorite (5.25%) and ethylenediaminetetraacetic acid, better known as EDTA (17%).
- Root canal drying was performed with sterile absorbent paper points (Mynol S, Italy).
- Root canal obturation was performed with warm gutta-percha (Mynol S, Italy) and vertical condensation technique, and pulp canal sealer EWT (Kerr USA), a zinc oxide-eugenol based sealer.

The samples were randomly divided into three groups of 10 teeth; each root canal was shaped with the calibrated burs system proposed by Edelweiss for the insertion of the post.

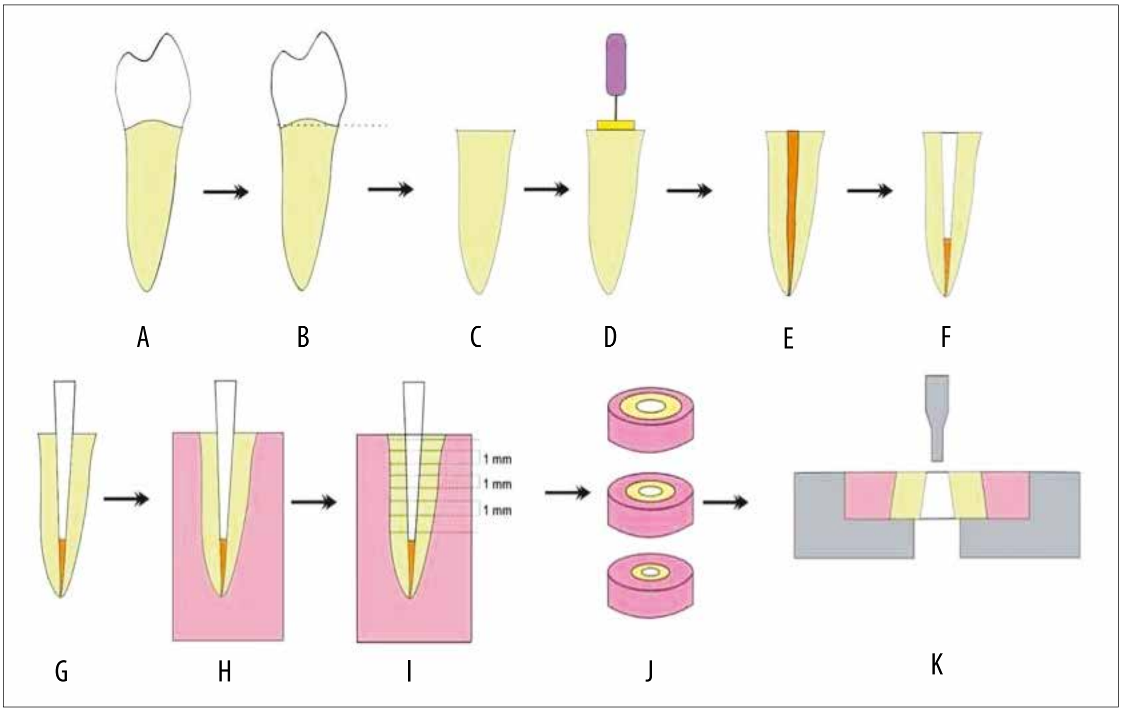
Group 1

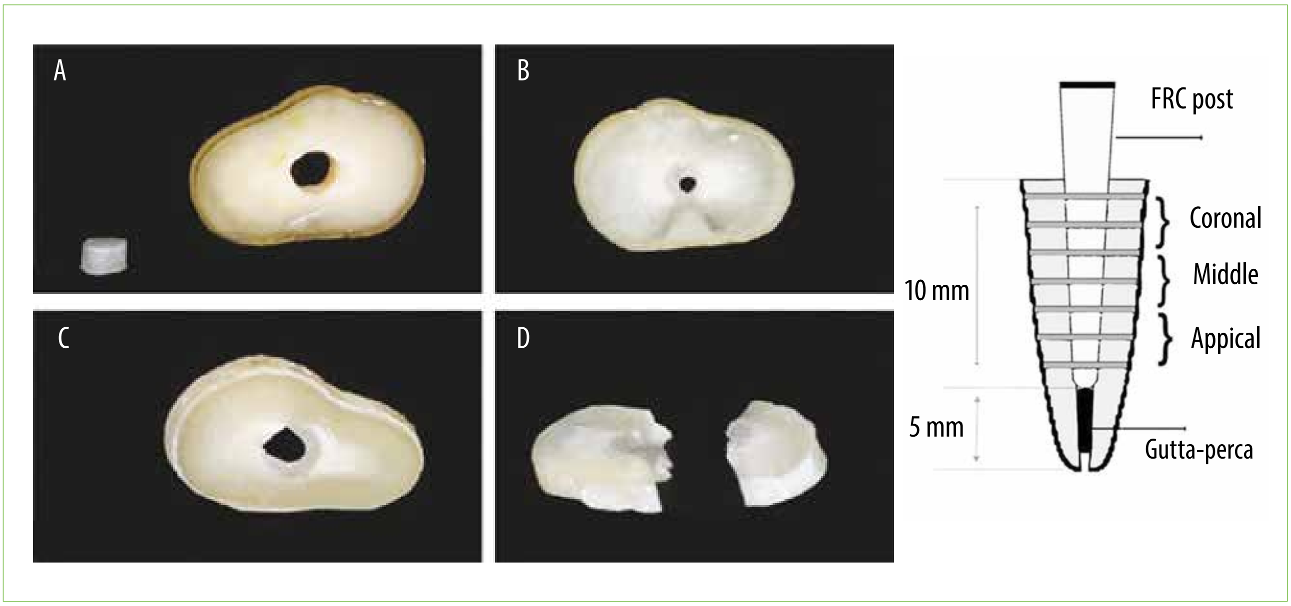
Edelweiss Posts - Kuraray Panavia Cement

Panavia V5 TM was used to lute the posts. This resin cement is a dual-curing resin cement, radiopaque and fluoride releasing with self-etching primer and a primer for the prosthesis.
The self-etching primer, available in a self-mixing system, was carried out by a standard procedure on the prepared tooth. Then the tooth primer was applied on the entire prepared tooth surface using an applicator brush and left in place for 20 seconds. Paper points were used to carefully remove any primer liquid in

FIG. 2 The push-out test

A Complete test procedure.





B

excess from the prepared tooth and finally the whole adhesive surface was dried out with a gentle air blow. In the meantime the selected post surface was etched for 5 seconds, and then rinsed and dried. Then, Clearfil Ceramic Primer Plus primer was applied for at least one minute on the post surface. The Kuraray Panavia dual-curing cement was applied on the post and on the entire surface of the prepared tooth. At a time when Panavia V5 Tooth Primer comes into contact with the paste the polymerization process was accelerated (polymerization "touch-care").
Finally the resin cement was light cured for 20 seconds.

Group 2

Edelweiss Posts - Gradia Core
The 10 teeth were prepared and shaped (post - space) with the appropriate Edelweiss burs kit. Then Edelweiss posts were tried in and calibrated to the shape of the root canal. Ceramic primer (silane) was applied on the post. One drop of each Primer A and B bottle of the Gradia Core self-etching adhesive were mixed. The self-etching adhesive was carried into the root canal prepared and on the coronal tooth structure and left undisturbed for 30 seconds. Then air was blown for 10 seconds. The Gradia Core was carried into the root canal

and the selected Edelweiss post was placed into the root canal space. After removing excess resin cement, the luting material was light cured for 10 seconds from each tooth surface.

Group 3

Gc Posts - Gradia Core Cement

The 10 roots had been already prepared and shaped with the appropriate Edelweiss burs kit. A proper fiber post was positioned and calibrated to the root canal (GC Posts). Then, the post surface was coated with ceramic primer (silane) and left for at least 1 minute.

A drop of liquids A and B Gradia Core self-etching adhesive were mixed and then applied into the prepared root canal and on the coronal tooth structure. The adhesive was left for 30 seconds and finally air blown for 10 seconds'. Then, the root canal was filled with Gradia Core, and then the selected post was placed into the root canal. After removing the excess resin cement, the luting materials was light cured for 10 seconds from each side if the tooth.

Statistics

Since the push-out strength data were not normally distributed according to the Shapiro-Wilk test (test for statistical hypothesis testing), it was decided to use the two-way ANOVA (analysis of variance). Analysis of Variance is a set of statistical techniques that are part of inferential statistics that allow to compare two or more groups of data by comparing the internal variability in these groups with the variability between groups, with push-out strength as the dependent variable, group level and root as factors was precluded.

In this way, they were applied two separate one-way ANOVA to assess the statistical significance of differences between the groups in the strength of push-out, as well as between the root-level differences in the strength of push-out within each group.

In assessing the statistical significance of differences between groups, since the push-out strength data were found not normally distributed according to the Shapiro-Wilk test, it was necessary to apply the ANOVA on ranks of Kruskal-Wallis one-way (non-parametric method) to test the equality of medians of different groups; this in order to verify that these groups come from one and the same population (or populations with the same median), followed by Dunn test for post hoc comparisons.

Similarly, when evaluating the statistical significance of differences in level between the roots within each group, since the push-out strength data were found not normally distributed according to the Shapiro-Wilk test, the ANOVA on Kruskal-Wallis ranks in a way had to be applied, followed by Dunn's more intervals tests for post hoc comparisons as needed.

RESULTS

Results are reported in Table 1 and Figure 3, which reports the descriptive statistics of the push-out strength (MPa), together with the statistical significance of the differences between groups. In the "Significance" column, different letters label statistically significant differences in groups.

The one way ANOVA on Kruskal-Wallis ranks revealed the existence of statistically significant differences between the groups ($p < 0.001$). According to Dunn's Multiple Range Test, the GC Post / Gradia Core group measured significantly higher push-out forces than in groups in which Edelweiss Post was used ($p < 0.05$).

Tables 2, 3, 4 show the descriptive statistics of the push-out force data for root level within groups 1, 2, 3 respectively. In the "Significance" column of Table 4 different letters indicate statistically significant

Group	N Mean	(Mpa)	Standard deviation	Significance p< 0,05
1 Edelweiss-Post/ Panavia Kuraray	62	6.04	2.5	B
2 Edelweiss post/ Gradia Core GC	69	7.27	4.12	B
3 GC Post/Gradia Core GC	77	9.06	2.95	A

TABLE 1 Results of the study.

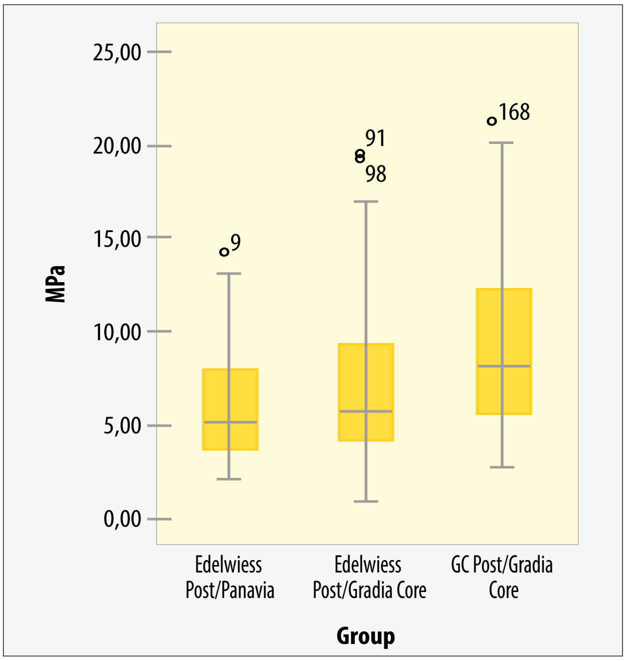


FIG. 3 Descriptive statistics of the push-out strength (MPa), together with the statistical significance of the differences between groups. In the "Significance" column, different letters label significantly statistically different groups.

GROUP 1	N	Mean (MPa)	Standard deviation
Coronal	30	5.82	2.82
Middle	30	6.22	3.2
Apical	2	6.51	3.83

TABLE 2 Descriptive statistics of the push-out force data for root level in Group 1 (Edelweiss-Post/Panavia- Kuraray).

GROUP 2	N	Mean (MPa)	Standard deviation
Coronal	30	8.85	4.62
Middle	30	6.07	3.05
Apical	9	5.97	4.09

TABLE 3 Descriptive statistics of the push-out force data for root level in Group 2 (Edelweiss Post/Gradia Core GC).

GROUP 3	N	Mean (MPa)	Standard deviation	Significance $p<0.05$
Coronal	35	12.36	4.01	A
Middle	35	6.47	3.01	B
Apical 9	5.74	2.31	B	

TABLE 4 Descriptive statistics of the push-out force data for root level in Group 3 (GC Post/Gradia Core GC).

differences between the levels of the root within group 3.
In group 3, the one way ANOVA on Kruskal-Wallis ranks revealed the existence of statistically significant differences between the levels of root ($p <0.001$). Specifically, it has emerged, from Dunn dual spectrum tests, that measured thrust forces in output were significantly higher on coronal levels compared to the middle and apical levels, where the values recorded were statistically comparable for push-out.
In groups 1 and 2 no significantly different conditions of adhesion to different levels of root were found.

DISCUSSION

The fiber posts are today widely used in clinical practice, since they have many convenient features for tooth restoration (8).
The loss of dental tissue at the coronal level sometimes forces the clinician to perform an endodontic treatment followed by a restoration with intracanal retention to recreate the masticatory function (1-3,9).
A good adaptation of the post to the root canal reduces the amount of cement, and this is a clinically important factor (10,11). The cement thickness can be a critical component for the clinical performance of the fiber post; in fact, some studies have correlated an excessive layer of resin cement around the post to a greater debonding frequency which is the most frequent cause of clinical failure (10).
Another determinant factor in the debonding of the fiber post is the lack of a dentin collar (ferrule effect), i.e. 2 mm of dentinal healthy tissue at the level of the closure of the restoration. When a good ferrule effect can not be obtained, a crown lengthening procedure or orthodontic extrusion is needed (12).
To reduce the thickness of the resin cement it is necessary to increase the fitting of the post which is linked to the shape of the canal. Equally important for the clinical success of the fiber post is the choice of the adhesive-cement system that has to achieve a good adhesion strength between the root dentin and the post-cement system (5, 12-14).
This study evaluated the bond strength of the Edelweiss post by means of push-out test using different types of cement and compared to another post.
The push-out test is a practical method which, by means of shear forces along the bonding interface, allows to evaluate the many variables that can affect retention of the posts, type of cement, polymerization method, adhesive system used, posts , etc. This test is the one closest to clinical reality for the evaluation of the retentive strength of the materials used for post cementation. The present study compared the force of adhesion of different types of posts and cements used in tooth restoration. According to the results of this study, the GC Post / Gradia Core group recorded push-out forces significantly higher than the groups in which Edelweiss Post was used ($p <0.05$).

For that the null hypothesis was rejected.
Based on the results obtained from this study, the highest bond strength was achieved by Group 3 (Post GC / GC Gradia Core) that has shown to be the most resistant to the forces exerted by the push-out test, than Group 2 (Edelweiss post / GC Gradia Core) and Group 1 (Post edelweiss / Kuraray Panavia) that has shown to be less resistant.
Based on the different types of posts and cements measured for the study, it emerged that thrust forces in apical levels, where the push- out values were recorded, were statistically comparable. We did not find any conditions of adhesion significantly different at the different levels of the roots in the groups 1 and 2.

CONCLUSIONS

Within the limits of this *in vitro* study, it can be concluded that the highest values of adhesive strength in the push-out test were achieved by GC post / Gradia Core GC. Regarding the area of root that can produce the best push out bond strength it was clearly shown that the coronal third of the root was the best substrate to lute posts.

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