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Evaluation of Light Transmission Through Translucent and Opaque Posts

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Clinical Relevance

The resin cement polymerization inside the root is decreased, because transmission of light in the apical direction is difficult. This study suggests that the use of translucent posts presents advantages in relation to the opaque posts, however, both do not allow polymerization in the apical region.

SUMMARY

Objectives: The transmission of light through translucent posts was observed, and the microhardness of light-cured cement used to secure these posts was evaluated at different depths.

Methods: Fifteen single-rooted standard bovine teeth, 16 mm in size, were used. The root canals were prepared using #3 drills Light-Post (five teeth) and Aestheti Post (five teeth) systems (BISCO), with a working-length of 12 mm. In five teeth, translucent posts were cemented (Light-Post #2), while another five teeth received opaque posts (Aestheti Post #2). The roots were painted with black nail varnish to prevent the passage of light through the lateral walls of the roots. The root canals of all the specimens were treated with the All-Bond 2 adhesive system (BISCO) and cemented with light-cured cement (Enforce, Dentsply). All the roots were transversally cut to obtain six specimens 1.5 mm thick. Every two sections corresponded to a specific region of the root (cervical, middle, apical), making it possible to observe the cement microhardness at different levels. The groups (n=10) were defined as: G1: translucent post (TP)/cervical region; G2: TP/middle region; G3: TP/apical region; G4: Opaque post (OP)/cervical region; G5: OP/middle region; G6: PO/apical region. Five root canals were only filled with cement for use as a control (G7). Then, Vickers microhardness analyses were performed. Results: In G3, G5 and G6,

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the cement was not sufficiently hard to allow for microhardness analysis. When submitted to the ANOVA test, G1 (35.07), G2 (24.28) and G4 (28.64) presented no statistical differences. When the previous groups were compared to G7 (51.00) using the Kruskal-Wallis test, a statistical difference was found. Conclusion: Translucent posts allow cement polymerization up to the middle portion of the root.

INTRODUCTION

Resin cementing agents are meant to bind several restoration materials to dental structure in order to form an integrated tooth-material structure. The cementation of fiber posts to these dental structures is now possible and can promote a force distribution to the post and dental structure when properly used, reducing the force concentration and preventing root fractures.[1]

Resin cements can be classified into three groups, based on the method of polymerization: chemical, light and dual cure.[2]

Dual cure cements have polymerization initiators that are activated by a light source that activates chemical initiators, providing complete polymerization in regions where light cannot reach. However, this type of cement does not present the total conversion of monomers when initial light activation is not possible,[3] as in the cementation of intra-radicular retainers.

This factor is significant, since the degree of conversion is directly related to the mechanical properties of the resin materials and, consequently, to the longevity of the restoration. Furthermore, biocompatibility may be affected by the remaining non-converted monomers when a resin cement is inadequately polymerized.[4-5]

Therefore, light-cured and dual cements are not indicated for the cementation of intra-radicular posts, because of their difficulty in leading the light to the apical portion of the preparation for complete polymerization of the cementing agent. However, the use of a translucent post that can transmit light up to 11 mm into the root canal has been suggested.[6]

Although this type of post has primarily been used in the dental clinic, there are a few studies[6-8] that have evaluated the amount of light transmitted along the root canal. This study compared light transmission through a translucent and an opaque fiber post by measuring the microhardness of a light-cured cement in different depths of the post space.

METHODS AND MATERIALS

Fifteen single-rooted bovine teeth were cleaned with periodontal curettes and frozen in distilled water at -18°C for up to 15 days until used in this study.

The teeth were sectioned at 16 mm of the root apex to standardize the root length. The pulp was then removed with a #30-K file (Maillefer, Ballaigues, Switzerland) and the root canals were widened with a #3 Largo drill (Maillefer). To receive the posts, five canals were prepared with a #3 bur from the Light-Post system (BISCO, Schaumburg, IL, USA), and another five root canals were prepared with a #3 bur from the Aestheti Post system (BISCO).

Before cementation, the lateral walls of the roots were painted with two layers of black nail vanish to avoid any external light curing.

All of the teeth were treated with All-Bond 2 (BISCO), and Enforce cement (Dentsply International, York, PA, USA) was used for cementation (Table 1).

The five teeth prepared with the Light-Post system bur were cemented with #2 Light-Post posts (BISCO), a translucent quartz fiber post, and the five teeth prepared with the Aestheti Post bur received a #2 Aestheti-Post post (BISCO Inc), an opaque carbon fiber post coated with quartz fibers.

Each root was positioned in the center of a silicone mold, and the surrounding space was filled with clear chemically-cured acrylic resin (Jet, Artigos Odontológicos Clássico, São Paulo-SP, Brazil). The specimens were then fixed on a metallic base in a sectioning machine (LabCut 1010) and transversally sectioned with a diamond disk under copious coolant irrigation. Initially, a 0.5 mm cut was obtained and discarded. Then, six specimens (sp), with an approximate thickness of 1.5 mm, were prepared: 2 cervical, 2 middle and 2 apical (Figure 1).

The following groups were created (n=10) according to the post type and root region (Table 2).

To create a control group (G7), cylindrical specimens were made in resin cement (Enforce, Dentsply)

Table 1: *Application Procedures for the Adhesive, Cement and Post*

All-Bond 2 + Enforce
1. Etch with 32% phosphoric acid for 30 seconds.
2. Rince with 10 ml of distilled water, using a syringe.
3. Dry with #80 absorbing paper points.
4. Apply Primer A + B with a microbrush (SDI, Victoria, Australia).
5. Apply “PREBOND Resin.”
6. Mix equal amounts of Enforce Porcelain Mixing Paste (Green Label) and Base, A2 shade.
7. Insert cement with a lentulo drill.
8. Insert a fiber post previously cleaned with 37% phosphoric acid for 15 seconds.
9. Light cure for 40 seconds with Optilight Plus (Gnatus Equipamentos Médico-Odontológicos Ltda, Ribeirao Preto, SP, Brazil, light intensity: 500mW/cm²).

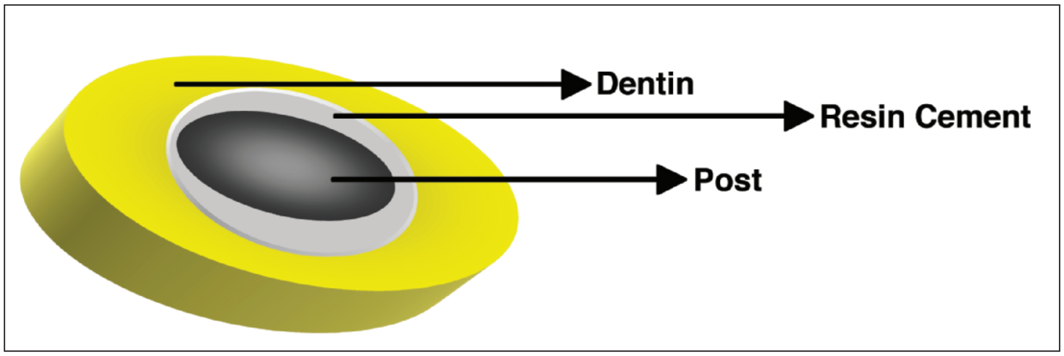

Figure 1. *Diagram of the specimen.*

Table 2: *Post Type and Root Region*

Post	Region	Group
Aestheti Post	Cervical	G1
	Middle	G2
	Apical	G3
Light-Post	Cervical	G4
	Middle	G5
	Apical	G6

Table 3: *Means ± Standard Deviations (HV) of G1, G4, G5 and G7*

Group	Mean ± standard deviation (HV)
G1	28.65 ± 13.03
G4	35.07 ± 8.69
G5	24.30 ± 13.00
G7	51.00 ± 2.05

(height=3 mm; diameter=4 mm). The control specimens were light cured in the same manner as described in the experimental post cementation.

In order to facilitate microhardness analysis, the specimens were ground flat using SiC paper of 600, 800, 1200 and 1400 grit for 30 seconds at a speed of 300 rpm.

After preparation and curing, the samples were kept in distilled water at 37°C for 24 hours. The samples were then taken to the hardness tester (FM 700—Future-Tech, Equilam, Diademal, SP, Brazil) for Vickers hardness analysis. Three readings were performed on each sample at 50 g loading for 30 seconds.

The data were analyzed with the Analysis of Variance (ANOVA) and Kruskall Wallis tests ($p<0.05$).

RESULTS

During specimen cutting, displacement of the cemented posts in groups G2, G3 and G6 was observed. This displacement was a result of poor cement polymerization. Therefore, it was not possible to perform hardness analysis on these groups.

The means and standard deviations of the other groups are shown in Table 3.

A comparison was made between the control group and group 5 (translucent post, middle region) using the Mann-Whitney test, and a statistically significant difference was observed.

No statistically significant difference was found when the specimens with opaque (G1) and translucent (G4) posts from the cervical region were compared using the Kruskall-Wallis and Dunn tests. Therefore, for the two types of posts, there was no difference in the amount of polymerization of cement in the cervical region. Additionally, the hardness of G7 was greater than with the opaque and translucent posts, indicating that the translucent post reduces the transmission of light and, consequently, the degree of cement polymerization.

No statistically significant differences were observed between G1, G4 and G5 when performing an ANOVA.

DISCUSSION

The self-curing of dual cure cements decrease the flexural strength of the material and is insufficient to achieve maximum hardness.[5] The reduction in the degree of conversion of these cements not only affects the intrinsic properties of the cement, leading to cohesive failures,[9] but it can also impair adhesion.[10]

The current results demonstrated that a translucent post shows a greater capacity to transmit light than an opaque post, as hardness could not be determined in the middle and apical regions of samples where an opaque post was used, due to poor cement polymerization.

However, a reduction in the degree of cement polymerization was observed when analyzing the different root depths of translucent post samples. The apical portion was not polymerized, indicating that minimal light reaches that region, reducing the mechanical performance of the cement in that region. However, the middle portion polymerized comparably to the cervical region. These results are similar to those obtained by Roberts and others,[8] who also observed a gradual reduction in the quantity of light through the root. In the Roberts study, the authors evaluated the hardness of cement in all regions of the root, because the resin material was light-cured for two minutes. An exposure time longer than that recommended by the manufacturers can most likely increase the degree of conversion in the apical region, yielding better properties of the cement.

Youldas and Alaçam[11] declared that the depth of cure of a resin composite is increased with a translucent fiber post in a simulated root canal. Interestingly, Kalkan and others[12] found increased bond strengths to root sections cemented with an opaque fiber post. Therefore, other studies involving the cure of resin cements with different types of posts are still needed.

The current study showed that cement hardness is even higher when no posts are used to transmit light. However, an increased C-Factor[13] can lead to the pull-out of a restoration, which is one drawback that must be considered before filling the root canal with only resin cement.

The most commonly used method to determine the degree of conversion of dental composites is the microhardness test.[8,13] This test was shown to have a good correlation with the spectroscopic approach of determining the degree of conversion. The spectroscopic approach is a direct method of quantifying monomer conversion by measuring the degree of conversion (DC) of methacrylate dental resins. The DC is determined by evaluating the ratio, before and after polymerization, of the vinyl (C=C) stretching band at 1640 cm^{-1} (aliphatic) compared to an internal standard (aromatic ring quadrant stretching vibration at around 1609 cm^{-1}).[14-15]

CONCLUSIONS

This study leads to the following conclusions: 1) the translucent post allowed for more light transmission than the opaque post; 2) the translucent post did not allow light transmission to the most apical region and 3) light transmission using posts was reduced in comparison to that of the control group, where no posts were used.

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