Microhardness of luting agents used for fiber post cementation submitted to thermo cycling

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Abstract

Aims and Objectives: The aim of this study was to analyze the microhardness of three resin cements used in cementing glass fiber posts in bovine incisor. The microhardness was analyzed in cervical, middle and apical thirds before and after thermocycling process.

Materials and Methods: Bovine teeth were instrumented and divided into 3 groups composed of 10 teeth each. Then, the teeth were sectioned and obturated and had their canals prepared at a depth of 12mm. Once proceeded the desobturation, the roots and glass fiber posts were prepared for adhesive cementation. After cementation, the microhardness reading was carried out. After initial reading, the samples were placed in a thermocycler and subjected to 2,000 cycles and a new microhardness reading. The data collected were subjected to analysis of variance (ANOVA) and Turkey’s test.

Results: It was observed a statistical difference among the microhardness of resin cements. However, the statistical difference of microhardness before and after thermocycling appeared only in group U-200.

Conclusion: Thermocycling reduced microhardness values in all cements evaluated in this study. The autopolymerizing cement Multilink presented the most stable microhardness mean values after thermocycling in the coronal, middle and apical thirds.

Keywords
Fiber posts, microhardness, resin cement, thermocycling

Introduction

Depulped teeth need to be restored with techniques and materials that strengthen and protect the remaining tooth structure.[1] The intra-radicular post have fundamental importance in the preservation of tooth structure, retention and stability of the prosthesis, and in cases where only the root is present are the only means available to fabricate crowns and return to the patient the tooth shape and appropriate function.[2,3]

Prefabricated posts present greater ease of preparation and installation, in addition to possessing mechanical characteristics that are more similar to dentin and that offer them greater retention and better distribution of forces in relation to cast metallic posts. These posts have two major functions which are to increase the resistance against fractures of the root and provide retention for the core material.[4,6]

However, the flexural strength and survival probability of restorations containing post and core depend on several factors, such as: Quantity and condition of remaining dental tissue, tooth preparation for restorative procedure, and characteristics of fixed restoration, such as luting line, bonding procedures, post and core materials, and type of cement.[5,9]

The resin cements provide increased retention and increasing the fracture toughness of the roots, compared to the conventional cements.[10,12] These properties can be compromised if the cement does not reach its full polymerization.[13] Accordingly, the root canal depth can hinder light irradiation, since it occurs from coronal to apical thirds, therefore, the cement can present different properties in the various depth levels into the cavity.[14,15]

Microhardness testing has been described as a valid indirect method to determine the degree of cure because it presents a good correlation with the infrared spectroscopy approach. Since the degree of conversion achieved by a resin cement influence on its mechanical properties, biocompatibility and water and oral acids degradation, this work aims to analyze the microhardness and differences in cementation line at cervical, middle and apical cementing agents in cementation of fiberglass posts in bovine incisors submitted to thermocycling.[16,17] The study hypothesis was that the type of resin cement, the root canal depth, and thermocycling will influence the hardness of cements.
Materials and Methods

Selection and treatment of bovine incisors

50 bovine incisors (Industrial slaughterhouse Guararapes, Guararapes, SP, Brazil) were sectioned with a diamond wheel diamond wafering blade 4 “DIA × 0.012” (10.2 cm × 0.3 mm) size Arbor ½” (12.7 mm) (Buehler, Lake Bluff, IL, USA) so to obtain a standardized root length of 17 mm. The bovine roots were prepared for post cementation by a Largo drill no. 5 (Maillefer, Dentsply, Catanduva, SP, Brazil).

The canals were filled with gutta percha (Tanari - Tanariman Industrial Ltda., Manacapuru, AM, Brazil) and the sealer sealapex (Sybron-Kerr, Orange, CA, USA). The canals were then prepared with a specific drill for fiberglass post white post DC 2 (FGM, Joinville, SC, Brazil) at a depth of 12 mm.

Experimental groups

The roots were distributed randomly into experimental groups until each group had 10 samples (n = 10). The post fiberglass used was white post DC 2, which was cemented with resin cements: Allcem (FGM, Joinville, SC, Brazil), multilink (Ivoclar Vivadent, Schaan, Liechtenstein) and Rely-X U-200 (3M ESPE, Sumaré, SP, Brazil). The cementation followed the instructions of the resin cements manufacturers.

Sectioning of roots

After 48 h of the cementation, roots were sectioned perpendicular to its long axis with a diamond blade wafering diamond blade 4 “DIA × 0.012” (10.2 cm × 0.3 mm) Arbor size ½” (12.7 mm) in a special machine for serial sections (Isomet low speed saw - Buehler, Lake Bluff, IL, USA) at low speed and constant irrigation. The cuts were made at the cervical, middle and apical root with 3 mm gap between slices.

Surface treatment of specimens for testing microhardness

The specimens from the 3 groups were fixed in disks of acrylic resin (3 cm diameter by 8 mm thick) with its inner surface facing up, and brought to polishing under constant cooling water according to the following sequence: 600, 800, 1200 sandpaper granularity (Carbimet Paper Discs, Buehler, Lake Bluff, IL, USA).

Evaluation of the initial microhardness

The analysis was performed on Shimadzu Micro Hardness Tester HMV-2000 (Shimadzu Corporation, Kyoto, Japan) linked to software for image analysis cams-win (Newage Industries, USA), with a knoop indenter, a static load of 25 g and time of 10 s. Each specimen measurements were conducted in four distinct areas. At the end of the tests, was obtained average microhardness value for each third.

Procedure for thermocycling of samples

The samples were placed in a thermocycler (Convel, Sao Paulo, SP, Brazil). The samples were subjected to 2000 cycles simulating 2 years of clinical use, they were immersed in distilled water, suffering alternated 60 s baths at a temperature of 5 ± 1°C and ± 55°C. At the end of the procedure, the samples were again polished to conduct further microhardness readings.

Results

After statistical analysis of the data obtained, it was found difference among the trademarks evaluated using the analysis of variance test, an interaction was detected between “resin cement” and “root third” factors, and between “resin cement” and “thermocycler” factors (P < 0.05). Then the Turkey test was performed, which demonstrated the statistical difference among the microhardness of the cement, a statistical difference (P < 0.05) between the initial microhardness and after thermal cycling was found only in group U-200 [Table 1].

Furthermore, according to results, even though multilink resin cement showed the lowest levels of the average microhardness, it also presented the lowest variation after 2000 cycles of thermocycling. Despite being the only group to show a statistical difference after thermocycling, the resin cement U-200 was the one that had the highest average microhardness both before and after thermocycling test.

Figures 1-3 show representative standard error of the mean (SEM) images of the cement line surface (dentin/cement/post) for all groups evaluated before and after thermocycling.

Discussion

According to the results of this study, the hypothesis that type of resin cement, the root canal depth and thermocycling influenced the knop hardness of cement was accepted.

Microhardness was different between cements evaluated, thus multilink resin cement showed lower microhardness values, however, with low variation after thermocycling, a fact

| Table 1: Average microhardness (knoop) before and after exposure to thermocycler |
|---------------------------------|----------------|----------------|----------------|
| Before thermocycling            | After thermocycling |
| Cervical | Middle | Apical | Cervical | Middle | Apical |
| Allcem   | 49.804 | 47.959 | 49.243 | 47.959 | 49.243 | 46.214 |
| Multilink| 36.042 | 37.033 | 38.092 | 34.384 | 35.764 | 35.768 |
| U-200    | 65.859 | 65.229 | 60.728 | 61.864 | 59.091 | 55.744 |

Figure 1: Microhardness before and after exposure to thermocycler of allcem
that maybe due to its chemical cure, because as there is no light source for your immediate polymerization, there action takes place over a longer time, providing the material microhardness lower levels, but more stable.

This result was also observed by Baena et al. who evaluated the microhardness of dual cements and one chemical polymerization resin cement. According to authors, this may be related to the low filler content. Vrochari et al. assessed the conversion degree of 4 resin cements in its auto and a dual polymerization mode, and found that in the chemical polymerization mode conversion values were lower; it was also observed that multilink showed the highest conversion values in dual mode.

Among the dual cements analyzed, self-adhesive cement Rely-X U-200 showed the highest value of microhardness before and after thermocycling when compared to conventional cement Allcem. Aguiar et al. compared the conventional and self-adhesive dual cements under different conditions and indicated that self-adhesive cements showed high level of adhesion to dentin than conventional one, due to its composition that promotes reactions with the base fillers present in the material and calcium ions from hydroxyapatite. One can also infer that the statistical difference in the microhardness of Rely-X U-200 after thermocycling, maybe associated with the fact that the material is self-adhesive, which may indicate the presence of acidic primers or other substances that maybe structurally modified after thermocycling.

Regarding the thirds, it was observed that in dual resin cements, microhardness values were higher at the cervical third level, probably due to the lack of light radiation across the post, therefore, the absence of light may have hindered the complete polymerization of cement, as observed in other studies. The autopolymerizing resin cement presented a totally opposite situation showing the highest hardness value in apical third, and the lowest value in cervical third, before and after thermocycling.

In our study there was an unexpected event, in which conventional cementation (without syringe centrix) group U-200 resulted in numerous failures along the line of cementation, precluding the analysis of samples. Similar events were observed by Aksornmuang et al. who evaluated manual spatulation cements and observed, through SEM, bubbles formation in the cementation line. The authors explained that these defects occurred as a result of air trapping during spatulation.

This event enhances the high sensitivity of the intraradicular posts cementation technique, even when using self-adhesive cement. Therefore, the handling of factors such as, cavity moisture control and proper curing of the resin cement along the canal, is of utmost importance in adhesive cementation, however, the difficulty of access to the area by the professional is an inherent technique factor, which must be overcome to achieve an excellent treatment.

**Conclusion**

According to the methodology used, and the results obtained, it could be concluded that:

- Thermocycling reduced the microhardness values in all cements evaluated in this study.
- The autopolymerizing cement multilink presented the most stable microhardness means after thermocycling in coronal, medial and apical thirds.

**References**


