Short Communication

Effect of Post Length on the Fatigue Resistance of Bovine Teeth Restored with Bonded Fiber Posts: A Pilot Study

Roberto Scotti, MD[a]/Luiz Felipe Valandro, PhD[b]/Graziela Avila Prado Galhano, MSc[c]/
Paolo Baldissara, DDS[d]/Marco Antonio Bottino, PhD[e]

This study evaluated the influence of the cementation length of glass fiber-reinforced composite (FRC) on the fatigue resistance of bovine teeth restored with an adhesively cemented FRC. Thirty roots of single-rooted bovine teeth were allocated to 3 groups (n = 10), according to the ratio of crown length/root length (post cementation length): group 1 = 2/3, group 2 = 1/2, and group 3 = 1/1. The roots were prepared, the fiber posts (FRC Postec Plus) were cemented, and the specimens were submitted to 2 million mechanical cycles. After fatigue testing, a score was given based on the number of fatigue cycles until fracture, and data were submitted to statistical analysis. All specimens were resistant to fatigue. Taking into account the methodology and results of this study, the evaluated fiber posts can be cemented based on the ratio of crown/root at 1/1. Further clinical studies must be conducted to verify this ratio.
Int J Prosthodont 2006;19:504–506.

With the use of adhesive techniques, it has become possible to make restorations with minimal intervention. Thus, adhesive cementation of a fiber-reinforced composite (FRC) post was suggested to preserve tooth structure. This preservation is accomplished by using adhesive systems and posts with elasticity moduli (E) similar to that of dentin, therefore reducing the risk of root fracture,[1,2] while also increasing the retention of the post.

Retention of the root post is crucial for the success of prosthetic therapy. It has been established that when the length of the root post is increased, the retention is also increased. However, when adhesive techniques are used, the additional preparation of the dental structure may be reduced, thereby minimizing the intervention and preserving sound dental structure.

Mechanical fatigue tests conducted in a humid environment are considered strong methodologies for predicting the clinical performance of different materials and restorative techniques.[3,4] Fatigue tests can lead to the fracture of a structure after repeated load, which may be explained by the spread of microscopic cracks from areas of force concentration, usually in areas presenting with macroscopic or molecular structural defects.[3,4] Pontius and Hutter[5] showed that 1,200,000 cycles in a mechanical fatigue test correspond to approximately 5 years of clinical function.

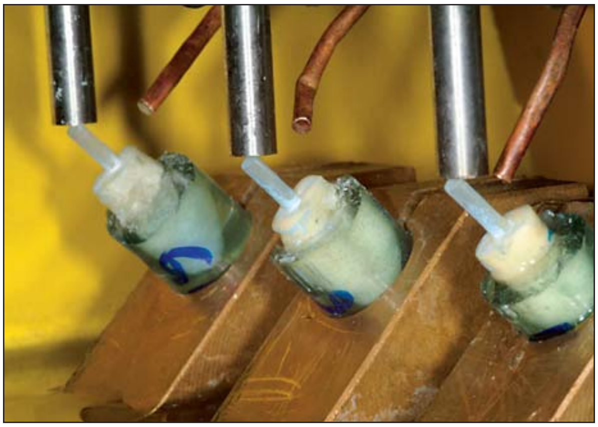
The purpose of this study was to evaluate the influence of the cementation length of glass FRC on the fatigue resistance of bovine teeth restored with an adhesively cemented FRC. The hypothesis was that a longer length provides better fatigue resistance.

Materials and Methods

Thirty single-rooted bovine teeth (mandibular incisors) were cleaned with periodontal curettes and stored in distilled water. The coronal and cervical portions of the root were sectioned to standardize the size of the specimens at 16 mm. Next, the coronal diameters of the

[a]*Chairman and Professor, Department of Oral Sciences (Prosthodontics), Alma Mater Studiorum, University of Bologna, Bologna, Italy.*
[b]*Associate Professor, Department of Restorative Dentistry, Federal University of Santa Maria, Brazil.*
[c]*PhD Student, São José dos Campos Dental School, São Paulo State University, São José dos Campos, Brazil.*
[d]*Researcher, Department of Oral Sciences (Prosthodontics), Alma Mater Studiorum, University of Bologna, Bologna, Italy.*
[e]*Chairman and Professor, Department of Dental Materials and Prosthodontics, São Paulo State University, São José dos Campos, Brazil.*

***Correspondence to:** Dr Luiz Felipe Valandro, Federal University of Santa Maria, School of Dentistry, Department of Restorative Dentistry, Rua Marechal Floriano 1184, 97015-372 Santa Maria, Rio Grande do Sul, Brazil. E-mail: lfvalandro@hotmail.com*



Figs 1a and 1b The fatigue tester.

canals were measured with a digital caliper (Starrett 727, Starrett), and specimens presenting diameters much larger than the diameter of the post (1.8 mm) were discarded and replaced with specimens that met this requirement. The canals were sequentially instrumented and irrigated with 0.5% sodium hypochlorite.

The 30 specimens were allocated to 3 groups (n = 10), according to the ratio of crown length/root length of the post (Table 1).

Root preparation was performed with no. 3 burs of a double-tapered glass FRC post system (FRC Postec Plus, Ivoclar-Vivadent) (height = 20 mm; $ø_{\mu}$ of the post = 1.5 mm; 70 wt% of preimpregnated unidirectional glass fibers ($ø_{fibers} \geqslant$ 12 µm) in a polymer matrix (dimetacrylates, 30 wt%). The FRCs were positioned into the prepared root cavity and their coronal portion was cut and standardized to 6 mm. The same procedures were used to cement the posts:

1. *Post surface treatment with the CoJet system (3M ESPE): (1)* Air abrasion was performed with 30-µm aluminum oxide particles modified with silicon oxide (blasting protocol: pressure = 2.8 bars; distance = 10 mm; perpendicular to the post surface; time = 20 seconds); *(2)* ESPE-Sil silane was applied and allowed to dry for 5 minutes.
2. *Root canal treatment with the All Bond 2 system (Bisco): (1)* Etching was performed with 32% phosphoric acid for 30 seconds; *(2)* the preparation was washed with 10 mL of water using a disposable syringe; *(3)* excess water was removed with no. 80 absorbent paper points; *(4)* Primer A and Primer B were mixed and applied, and excess material was removed with the Cavi-tip brush (SDI); *(5)* prebond resin was applied and excess material was removed with a brush.
3. *Post cementation with the resin cement Duolink (Bisco): (1)* The A and B pastes of the cement were measured, mixed, and placed on the root canal and post with a Lentulo no. 40 spiral (Maillefer); *(2)* light curing was performed on the incisal surface for 40 seconds with the XL 3000 unit (3M ESPE) at a light intensity of 450 mW/cm².

Table 1 Experimental Groups

Group	Crown length/root length ratio	Length of post above the crown after cementation	Post cementation length	Post length/root length ratio
1	2/3	6 mm	9 mm	≈ 3/5.3
2*	1/2	6 mm	12 mm	3/4
3	1/1	6 mm	6 mm	3/8

*Control group: crown length/root length ratio traditionally indicated for cast post and cores.

After cementation, each specimen was embedded in a polyvinyl chloride cylinder (height = 25 mm; diameter = 10 mm) filled with epoxy resin (resin 285, Schaller) up to 3 mm of the most coronal portion of the specimen. The long axis of the specimen was embedded as perpendicularly as possible to the y-axis. The specimens were then stored in distilled water at 37°C for 24 hours, until fatigue testing.

Fatigue Testing

The specimens were placed in a metallic base at a 45-degree angle, so that a point with a 1.6-mm diameter at the upper rod of the cycling machine could induce load pulses of 50 N, at a frequency of 8 Hz, directly onto the post. During cycling, the specimens were irrigated with water at 37 ± 1°C, as regulated by a thermostat (Figs 1a and 1b).[3] The specimens were subjected to 2 million cycles.[3,4]

Fatigue Resistance Scores and Statistical Analysis

After fatigue testing, a score was given to each specimen based on the number of fatigue cycles until fracture:

- Score 0: fracture between 0 and 499,000 cycles
- Score 1: fracture between 500,000 and 999,999 cycles
- Score 2: fracture between 10^6 and 1,499,000 cycles
- Score 3: fracture between 1.5 million and 2 million cycles
- Score 4: no root or post fracture and no loss of retention of the post

The collected data were submitted to statistical analysis (Kruskal-Wallis test), using a level of significance of 5%.

Results

All specimens were resistant to fatigue. No root or post fracture and no loss of retention of the post were observed. All groups had score 4. The hypothesis was rejected.

Conclusion

Taking into account the methodology and results of this study, the evaluated fiber posts can be cemented based on the ratio of crown/root at 1/1. Further clinical studies must be conducted to verify this ratio.

References

1. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. Int J Prosthodont 2003;16:39–44.
2. Monticelli F, Grandini S, Goracci C, Ferrari M. Clinical behavior of translucent-fiber posts: A 2-year prospective study. Int J Prosthodont 2003;16:593–596.
3. Baldissara P. Mechanical properties and in vitro evaluation. In: Scotti R, Ferrari M (eds). Fiber Post: Characteristic and Clinical Application. Milan: Masson, 2002:39–51.
4. Wiskott HWA, Nicholls JL, Belser UC. Stress fatigue: Basic principles and prosthodontic implications. Int J Prosthodont 1995;8:105–116.
5. Pontius O, Hutter JW. Survival rate and fracture strength of incisors restored with different post and core systems and endodontically treated incisors without coronoradicular reinforcement. J Endod 2002;28:710–715.

Literature Abstract

Metameric effect between resin composite and dentin

The purpose of this in vitro study was to determine the metameric color difference between resin composites and dentin. Changes in lightness, chroma, hue, and hue angle under the 3 standard illuminants were also evaluated. Spectral reflectance of 5 selected shades (n = 5 of each shade) of 1 brand of resin composites (2 mm thickness and 10 mm in diameter) and actual dentin (n = 10) were measured to obtain CIELAB values relative to standard illuminants: daylight (D65), incandescent lamp (A), and fluorescent lamp (F2). Spectral curves of resin composites and 2 average dentin specimens were compared. Color difference and their ratios of color difference (modification of metamerism index) by illuminant were compared. The ratio of change in hue angle between resin composites and dentin relative to the illuminant (A/D65 and F/D65) were also calculated. The difference in value depending on shade was analyzed by analysis of variance and Scheffe multiple range test. Three of the 5 composite shades made 3 crossing points with dentin, indicating a metameric effect. Color differences between resin composite and dentin changed when the illuminant changed. Their ratio ranged from 0.74 to 0.98. Differences in hue angle were found: *(1)* A and D65: resin (-10.1 to -7.2) and dentin (-13.8 to -14.0); *(2)* F and D65: resin (2.6 to 5.2) and dentine (-3.9 to -2.8). Changes in optical properties of resin composites relative to different illuminants that varied from those of dentin may reveal potential problems of metamerism of resin composites over dentin clinically. Bonding different shades of resin composite to dentin and then comparing to actual dentin/enamel samples under different lighting may improve secondary validity of this line of research.

Lee YK, Powers JM. *Dent Mater* 2005;21:971–976. **References:** 13. **Reprints:** Dr Lee, Department of Dental Biomaterials, Dental Research Institute, College of Dentistry, Seoul National University, Seoul, South Korea. E-mail: ykleedm@snu.ac.kr—*Alvin G. Wee, OSU College of Dentistry, Columbus, OH*